

# Crop Production Techniques of Horticultural Crops

Trade Mark of TNAU

## 2013



**HORTICULTURAL COLLEGE AND RESEARCH INSTITUTE**  
**TAMIL NADU AGRICULTURAL UNIVERSITY**  
**COIMBATORE – 641 003**

## Contents

---

### Part I - Fruits

Page No.

#### Chapter A - Tropical and Sub Tropical Fruits

Mango .....	
Banana .....	
Acid Lime .....	
Sweet Orange .....	
Mandarin Orange .....	
Grapes .....	
Guava .....	
Pineapple .....	
Sapota .....	
Papaya .....	
Pomegranate .....	
Jack .....	
Ber .....	
Amla .....	

#### Chapter B - Temperate Fruits

Apple .....	
Pear .....	
Plum .....	
Peach .....	

#### Chapter C - Minor Fruits

### Part II – Vegetables

#### Chapter A - Fruit Vegetables

Tomato.....	
Brinjal.....	
Bhendi.....	
Chillies.....	
Capsicum.....	
Paprika.....	
Pumpkin.....	
Snake gourd.....	
Ribbed gourd.....	
Bottle gourd.....	
Bitter gourd.....	
Ash gourd.....	

Cucumber.....  
Gherkin.....  
Watermelon.....  
Muskmelon.....  
Tinda.....  
Chow chow.....  
Cluster beans.....  
Vegetable Cowpea.....  
Lab lab or Dolichos bean.....  
French bean.....  
Broad beans.....  
Peas.....  
Annual moringa.....  
Baby corn.....

#### Chapter B Cole Vegetable

Cabbage.....  
Cauliflower.....

#### Chapter C - Root and Tuber vegetables

Carrot.....  
Radish.....  
Beet root.....  
Potato.....  
Sweet potato.....  
Tapioca.....  
Elephant foot yam.....  
Colocasia .....

Dioscorea.....  
Chinese potato.....

#### Chapter D - Bulb vegetables

Common Onion - Small onion.....  
Bellary onion-Big onion.....

#### Chapter E - Leafy vegetables

Amaranthus.....  
CurryLeaf.....

#### Chapter F - Minor Vegetable Crops

### Part III – Spices and Condiments

#### Chapter A - Major Spices

Pepper.....  
Cardamom .....

Turmeric .....

Ginger.....

#### Chapter B -Tree Spices

Clove .....

Nutmeg.....  
 Cinnamon .....  
 Tamarind .....  
 Allspice.....

Chapter - C Seed Spices

Coriander .....  
 Fenugreek .....  
 Fennel .....

Chapter - D Other Spices

Vanilla .....  
 Paprika.....

**Part IV - Plantation crops**

Tea .....  
 Coffee .....  
 Cashew .....  
 Cocoa.....  
 Rubber.....  
 Coconut.....  
 Arecanut .....  
 Oil palm.....  
 Palmyrah.....  
 Betel vine.....

**Part V - Medicinal and Aromatic Plants**

Chapter A - Medicinal Plants

*Gloriosa* *superba*.....  
*Coleus* *forskohlii*.....  
 Senna .....  
 Periwinkle .....  
 Medicinal solanum .....

Chapter B - Aromatic Plants

Lemongrass .....  
 Citronella .....  
 Palmarosa.....  
 Geranium .....  
 Patchouli .....  
 Mint .....

Production techniques for others important medicinal plants .....

**Part VI - FLORICULTURE**

Chapter A - Loose Flowers

Rose.....  
 Malligai (Gundumalli).....  
 Mullai.....  
 Jathi malli (Pitchi).....  
 Crossandra.....  
 Chrysanthemum.....



Marigold (African marigold).....	
Tuberose.....	
Nerium.....	
Golden Rod.....	

#### Chapter B - Cut Flowers

Cut Roses.....	
Cut Chrysanthemum.....	
Carnation .....	
Anthurium.....	
Dendrobium orchid.....	
Lilium .....	
Gladiolus .....	
Gerbera.....	
China Aster.....	

<b>Part VII - Particulars on improved Varieties of Horticultural Crops .....</b>	
<b>Part VIII - Drip irrigation for Fruit Crops .....</b>	
<b>Part IX - Organic Cultural Practices .....</b>	
<b>Part X - Protected Cultivation of Vegetables (for Information).....</b>	
<b>Part XI - Seed Production Technology of Horticultural Crops</b>	
<b>Part XII - Important Plant Nutrients Their Deficiency Symptoms and Remedial Measures .....</b>	
<b>Part XIII - Mushroom Cultivation .....</b>	
<b>Part XIV - Season of Flowering and Fruiting of Fruit Crops .....</b>	
<b>Part XV - Chemical and Commercial Names of Insecticides and Nematicides .....</b>	
<b>Part XVI - Chemical and Commercial Names of Fungicides .....</b>	
<b>Part XVII - Weed Management and Herbicides usage in Horticultural crops.....</b>	
<b>Part XVIII - Cultural tips for F<sub>1</sub> hybrid vegetables .....</b>	
<b>Part XIX - Farm implements for Horticultural crops.....</b>	
<b>Part XX - Food Processing Technologies</b>	
<b>Part XXI - Soil Test Crop based Integrated Plant Nutrition System for Horticultural Crops (STCR-IPNS).....</b>	
<b>Part XXII - Appendices.....</b>	

# Part I

# Fruits

## Chapter A

### Tropical and Sub Tropical Fruits

**Mango: *Mangifera indica* L.; Anacardiaceae**

**Varieties:** Neelum, Bangalora, Alphonso, Rumani, Banganapalli, Kalepad, Peter, PKM 1, PKM 2, Sendura, Jahangir, Mulgoa, Himayuddin, Paiyur 1, Mallika, Amrapali and Salem Bangalora, Arka Anmol, Arka Aruna, Arka Neelkiran, Arka Puneeth.

Processing varieties : Alphonso, Banganapalli, Totapuri  
Export varieties : Alphonso, Banganapalli, Sendura

**Soil and Climate:** Red loamy soil with good drainage is preferable. pH range 6.5 to 8.

**Season of planting:** July to December.

**Planting material:** Use plantable size grafts propagated through approach, soft wood or epicotyl grafting.

**Field preparation:** Dig pits of 1 m x 1 m x 1 m in size. Fill in with topsoil mixed with 10 kg of FYM and 100 g of Lindane 1.3% dust per pit.

**Planting:** Plant the grafts at the centre of the pits with ball of earth intact and keeping the graft union 15 cm above the ground level. Stake and water the plants immediately after planting.

**Spacing:** Adopt any one of the following spacing depending on requirements.

1. Under conventional system of planting: 7-10 m either way
2. High Density Planting : 5 m x 5 m (400 plants / ha)
3. Double hedge row system : Adopt a spacing of 5 m x 5 m within double rows and 10 m between successive double rows (266 plants / ha)

**Irrigation:** Regular watering till establishment. For cultivation under irrigated conditions, adopt drip system of irrigation.

**Intercropping:** Short duration crops like legumes, vegetables, groundnut etc. can be raised during pre- bearing age.

### Manures and Fertilizers (Kg per tree)

Manures and Fertilizers	1 <sup>st</sup> Year	Annual increase	6 <sup>th</sup> year onwards
FYM	10.00	10.00	50
N	0.20	0.20	1.0
P	0.20	0.20	1.0
K	0.30	0.30	1.5

Manures and fertilizers may be applied during September - October, 45 - 90 cm away from the trunk up to the peripheral leaf tip and incorporated.

### Fertigation technology under HDP

Apply 1.0:0.5:1.0 kg of NPK / bearing tree / year under HDP through drip fertigation adopting the following schedule:

Nutrient	Stage of application *				
	Immediately after harvest (2 months)	Pre-flowering (2months)	Flowering to fruit set (2 months)	Fruit development (4 months)	Total
N	25 %	40 %	20 %	15 %	100 %
P	50 %	30 %	20 %	-	100 %
K	25 %	20 %	25 %	30 %	100 %

\* At each stage, the above schedule has to be split into six or more doses and applied at weekly intervals

\* Avoid irrigation and fertigation for 30 days for induction of stress before flowering season; resume as soon as flowering commences.

### Canopy management:

Remove root stock sprouts and low lying branches nearer to ground to facilitate easy cultural operations. Remove overlapping, intercrossing, diseased, dried and weak branches in old trees to get good sunlight and aeration. Carry out judicious pruning of the internal branches during August – September, once in three years. Do not allow flowering upto three years by removing the inflorescences as and when they appear. Retain two healthy shoots by trimming away the weak shoots among the crowded terminal shoots during August-September annually. Prune back 20 cm of annual growth of the terminals immediately after harvest.

### Top working of senile orchards for rejuvenation:

Use scions of choice varieties like Alphonso and Banganapalli for top working. Behead the trees to be top worked portion during July- August leaving the main trunk at a convenient height and allow for new shoots to develop. Adopt cleft method of grafting or softwood grafting on the emerging shoots on the main stem from the cut end during September- October.

**Growth regulators:** Spray NAA @ 20 ppm at flowering to increase the fruit retention. During February 0.5% Urea (5 g / lit.) or 1% Potassium nitrate (10 g / lit.) may be sprayed to induce flowering, if trees do not flower by that time. Spray 2% KNO<sub>3</sub> at mustard size to increase fruit set

and retention of fruits. Spray 2 % Sulphate of potash at pea stage and 15 days after to improve yield and quality.

Apply Paclobutrazol @ 0.75 g a.i. per meter of canopy radius in full bearing tree during first fortnight of September to get maximum number of fruits and yield during off years.

**Off-season crop induction:** This technology is recommended only for irrigated conditions to shift production from on- season to off- season. To induce off-season flowering, heading back of 10 cm terminal growth after the emergence of new growth (vegetative and floral growth) during December to January along with soil application of Paclobutrazol @ 0.75g a.i. per tree during March and April is recommended for mango cv.Neelum. Keeping good soil moisture conditions and nutrient health status of the plant are very important when Pacloburazol application is resorted.

## Plant Protection

### Pests

- Removal of criss-cross branches, infested shoots, dense branches and proper training and pruning reduces the hopper infestation
- Apply *Metarhizium anisopliae* @  $1 \times 10^8$  cfu/ml or *Beauveria bassiana* @  $10^8$  cfu /ml on tree trunk once during off season and twice at 7 days interval during flowering season
- Spray any of the following insecticides first at the time of panicle emergence and the second two weeks after first spray. Neem oil @ 5 ml/lit of water can be mixed with any insecticides for the control of hopper.

Insecticide	Dose
Buprofezin 25 % SC	1.5 ml/lit.
Dimethoate 30 % EC	1.6 ml/lit.
Imidacloprid 17.8 % SL	3.0 ml/10 lit.
Malathion 50 % EC	1.5 ml/lit.
Oxydemeton -Methyl 25 % EC	1.0 ml/lit.
Phosalone 35 EC	1.5 ml/lit
Phosphamidon 40 SL	2.0 ml/lit

Spray volume of 5-15 litres of water per tree is required

### Leaf galls and Aphids:

Mealy bug:

- Dissolve Fish oil rosin soap @ 25g /lit, initially in luke warm water, then in required quantity of spray fluid in the sprayer.
- Release Australian ladybird beetle, *Cryptolaemus montrouzieri* @ 10 beetles/tree or 1500/ha
- Band the trees with 20 cm wide 400 gauge polythene sheets
- Spray chlorpyrifos 20 EC @ 2.5 ml/lit or any one of the following insecticide

Insecticide	Dose
Dimethoate 30 % EC	1.6 ml/lit.
Malathion 50 % EC	1.5 ml/lit.

**Flower webber:** Spray phosalone 35 EC @ 2ml/lit.

**Stem borer:**

Padding with tree soaked in absorbent

cotton when the trees are not in bearing stage. Application of carbofuran 3 G @ 5g per bore hole and plugging with mud after mechanically removing or killing the grub by introducing a needle or wire.

**Fruit fly:**

- Plough the inter spaces to expose pupae.
- Prepare bait with methyl eugenol 1% solution mixed with malathion @ 2.0 ml/lit. Take 10 ml of this mixture per trap and keep them in 25 different places in one hectare between 6 a.m. and 8 a.m. Collect and destroy the fallen fruits.
- Spray *Neem oil* @ 3.0 % as need based

**Sooty mould:**

Spray Maida 5% (1 kg Maida or starch) boiled with 1 lit of water and diluted to 20 litres. Avoid spraying during cloudy weather.

**Diseases**

**Powdery mildew:** Apply Sulphur dust (350 mesh) in the early morning to protect new flush or spray Wettable sulphur 0.2% or Tridemorph 0.05%.

**Anthracnose and Stalk end-rot:** Spray Mancozeb 2 g / lit or Carbendazim 1 g / lit or Thiophanate methyl 1 g / lit or Chlorothalonil 2 g / lit as pre-harvest spray, 3 times at 15 days interval (or) Spray chitin based *Pseudomonas fluorescens* (Pf 7) immediately after flowering @ 5 g / lit five times at 21 days interval.

**Sooty mould:** Spray phosphamidon 40 SL @ 2 ml / litre + Maida 5% (1 kg Maida or starch) boiled with 1 lit of water and diluted to 20 litres. Avoid spraying during cloudy weather.

**Harvest Season:** March to June.

**Harvest:** Yield varies with varieties and spacing adopted. 8 -10 t / ha upto 15 years; 15-20 t / ha from 15-20 years.

**Post harvest treatment:** Dip the fruits in  $52 \pm 1^\circ\text{C}$  hot water immediately after harvest for 5 minutes followed by 8% plant wax (Fruitox or Waxol) to reduce anthracnose disease in mango during storage. Two pre-harvest sprays of 0.2% Mancozeb (2.0 g / lit) will also reduce the incidence.

**Waiting Period**

Methyl demeton 0.05%	- 14 days
Fenthion 0.05%	- 14 days
Quinalphos 0.05	- 12 days
Lindane 300 g a.i /ha	- 2 days

**Market Information**

Growing Districts	Krishnagiri, Vellore, Dindigul, Thiruvallur, Dharmapuri, Theni
Major Markets in Tamil Nadu	Theni, Dharmapuri, Salem, Tirunelveli.

Preferred Varieties and Hybrids	Banganapalli, Bangalora, Neelum, Rumani, Mulgoa, Alphonso, Totapuri
Grade Specification	Firmness, lack of decay / defects, uniformity of size and shape, skin color, flesh color and flavor Small - Less than 200 g Medium - 201- 400 g Large -401- 600 g Extra-large - 601 - 800 g
Export Market	UAE, Kuwait and other Middle East countries.

Trade Mark of TNAU





**Banana:** *Musa* sp; Musaceae

**Varieties**

**Dessert :** Grand Naine, Robusta, Dwarf Cavendish, Rasthali, Vayal vazhai, Poovan, Nendran, Red Banana, Karpooravalli, Udhayam, CO 1, Matti, Sannachenkadali and Ney poovan. Cavendish groups are generally preferred for export.

**Culinary:** Monthan, Nendran, Vayal vazhai, Ash Monthan and Chakkia.

**Hill areas:** Virupakshi, Sirumalai and Namaran, Red Banana, Manoranjitham (Santhana vazhai) and Ladan.

**Soil and Climate:** Well drained loamy soils are suitable. Alkaline and saline soils should be avoided.

**Season of planting**

**Wet lands:** Feb - April: Poovan, Rasthali, Monthan, Karpooravalli and Ney poovan.  
April - May: Nendran and Robusta

**Garden lands:** January - February and November - December.

**Padugai lands:** January - February and August - September.

**Hill Banana:** April - May (lower Palani hills); June - August (Sirumalai)

**Selection and pre-treatment of suckers:** Select sword suckers of 1.5 to 2.0 kg weight, free from diseases and nematodes. Trim the roots and decayed portion of the corm, cut the pseudostem leaving 20 cm from the corm and grade the suckers to size. To avoid wilt disease, infected portions of the corm may be pared, dipped for 5 minutes in Carbendazim 0.1% (1 g in 1 lit of water) for Rasthali, Monthan, Neyvannan, Virupakshi and other wilt susceptible varieties. Pralinage with 40 g of Carbofuran 3 G granules per sucker (Dip the corm in slurry solution of 4 parts clay plus 5 parts water and sprinkle Carbofuran to control nematodes). Alternatively, dip the corm, shade dry for atleast 24 hours and plant. Sow Sunhemp on 45<sup>th</sup> day; incorporate it after about a month. This operation reduces nematode build up.

Use well hardened tissue cultured banana plants with 5-6 leaves. At the time of planting, apply 25 g *Pseudomonas fluorescens* / plant.

**Field preparation**

**Wet lands:** No preparatory cultivation is necessary.

**Garden land:** 2 - 4 ploughings.

**Padugai :** One deep mammutti digging.

**Hill Banana:** Remove scrub jungle and construct contour stone walls.

**Wet lands:** Place the suckers at ground level and earth up.

### Digging pits

**Garden land, Padugai and Hill Banana:** Dig pits of 45 cm x 45 cm x 45 cm in size. The pits are refilled with topsoil, mixed with 10 kg of FYM, 250 g of Neem cake and 50 g of Lindane 1.3 %.

### Spacing (Conventional method)

	Variety	Spacing	No. of plants / ha
Garden land	Robusta, Nendran,, Dwarf Cavendish	1.8 x 1.8 m	3086
		1.5 x 1.5 m	4444
Wet land	Poovan, Monthan, Rasthali, Neyvannan, Ney poovan	2.1 x 2.1 m	2267
Hills	Virupakshi (Sirumalai), Namarai and Ladan	3.6 x 3.6 m	750 (When mixed with coffee)

Adopt high density planting for higher productivity - Plant 3 suckers / pit at a spacing of 1.8 x 3.6 m (4600 plants / ha) for Cavendish varieties and 2 m x 3 m for Nendran (5000 plants / ha).

**Irrigation:** Irrigate immediately after planting; give life irrigation after 4 days; subsequent irrigations are to be given once in a week for irrigated plantations of garden lands and once in 10 – 15 days for wet lands. Irrigate the fields copiously after every manuring. Use drip irrigation @ 15 litres / plant / day from planting to 4<sup>th</sup> month, 20 litres / plant /day from 5th month to shooting and 25 litres / plant / day from shooting till 15 days prior to harvest.

### Application of fertilizers

Details	N	P	K
	(g / plant / year)		
<b>Garden land</b>			
Varieties other than Nendran	110*	35*	330*
Nendran	150	90	300
<b>Wet land</b>	210	35	450
Nendran, Rasthali	210	50	390
Poovan,Robusta	160	50	390



**Hill bananas**

After forming semi circular basins on uphill side, apply 375 g of 40:30:40 NPK mixture, plus 130 g muriate of potash per clump per application during October, January and April. Apply *Azospirillum* and *Phosphobacteria* 20 g each at planting and 5<sup>th</sup> month after planting preceding chemical fertilizer application.

Apply N as Neem coated urea. Apply N and K in 3 splits on 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> month, Phosphorous at 3<sup>rd</sup> month of planting. Apply 20 g in each of *Azospirillum* and *Phosphobacteria* at planting and five months after planting (This should be applied prior to chemical fertilizer application).

\* For Tissue culture banana, apply 50% extra fertilizers at 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> month after planting.

**Fertigation**

For maximizing productivity follow fertigation technique - Apply 25 litres of water / day + 200:30:300 g N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O / plant using water soluble fertilizers.

For economizing the cost of fertilizers, fertigate using normal fertilizers (Urea and Muriate of potash) with 50% of the recommended dose along with recommended dose of phosphorus as basal at 2<sup>nd</sup> month after planting. Fertigate at weekly intervals as per the following schedule:

**Fertigation schedule**

Weeks after planting	N (%)	P <sub>2</sub> O <sub>5</sub> (%)	K <sub>2</sub> O (%)
9-18 (10 weeks)	30	100	20
19-30 (12 weeks)	50	--	40
31-42 (12 weeks)	20	--	32
43-45 (3 weeks)	--	--	8
Total	100	100	100

**Aftercultivation**

**Garden Land:** Give mammutti digging at bi-monthly intervals and earth up. Prune the suckers at monthly intervals. The dry and diseased leaves are removed and burnt to control the spread of leaf spot diseases. Male flowers may be removed a week after opening of last hand. The plants at flowering may be propped. Cover the peduncle with flag leaf to prevent stalk end rot. Cover the bunches with banana leaves to avoid sun scald.

**Wet land:** Form trenches in between alternate rows and cross trenches at every 5<sup>th</sup> row. The trenches are periodically deepened and the soil is spread over the bed. Surface diggings may be given at bi-monthly intervals and desuckering at monthly intervals. Remove the male flower a week after opening of last hand. Prop plants at or prior to flowering. Cover the peduncle with flag leaf and the bunch with leaves to avoid sun scald. For ratoon crops, in respect of Poovan, Monthan and Rasthali allow the follower at flowering of the mother plant and remove the other suckers at harvest.

**Perennial banana:** Give surface digging with mammutti once in two months. Give one deep digging with mammutti during January - February. Other operations as in garden land.

**Hill banana:** Give four forkings in January, April, July and October. Remove outer sheaths to keep the corm inside the soil and ward off borer. Maintain two bearing plants and two followers per clump along the contour.

**Growth regulators:** To improve the grade of bunches, 2,4-D at 25 ppm (25 mg / lit.) may be sprayed in Poovan and CO 1 banana after the last hand has opened. This will also help to remove seediness in Poovan variety. Spray CCC 1000 ppm at 4<sup>th</sup> and 6<sup>th</sup> month after planting. Spray Plantozyme @ 2ml / l at 6<sup>th</sup> and 8<sup>th</sup> month after planting to get higher yield.

**Micronutrients:** Spray micronutrients viz., ZnSO<sub>4</sub> (0.5%), FeSO<sub>4</sub> (0.2%), CuSO<sub>4</sub> (0.2%) and H<sub>3</sub>BO<sub>3</sub> (0.1%) at 3<sup>rd</sup>, 5<sup>th</sup> and 7<sup>th</sup> MAP to increase yield and quality of banana.

**Bunch cover:** Use transparent polyethylene sleeves with 2% (during cool season) and 4% (during summer season) ventilation to cover the bunches immediately after opening of the last hand

**Inter cropping:** Leguminous vegetables, Beet root, Elephant foot yam and Sun hemp. Avoid growing Cucurbitaceous vegetables.

## **Plant protection**

### **Pests**

**Corm weevil:** Apply Lindane 1.3% @ 20 g / plant or Carbaryl @ 10 – 20 g / plant in the soil around the stem.

**Stem weevil (*Odoiporus longicollis*):**

- Remove dried leaves periodically and keep the plantation clean.
- Prune the suckers every month.
- Do not dump infected materials in the manure pit. Infected trees should be uprooted, chopped into pieces and burnt.
- Alternatively, inject 4 ml (2 ml at 45 cm from the ground level another 2 ml 150 cm from the ground level) in the pseudostem at monthly interval from 5<sup>th</sup> to 8<sup>th</sup> month.

**Rhizome weevil:**

Trap adult weevils with pseudostem chopped into small pieces.

Apply carbofuran 3 % G @ 35 g /sucker or carbaryl @ 20 g/plant in the soil around the stem.

**Banana aphid:**

Administer injection of (1 ml diluted in 4 ml of water) at 45 days interval from the 3<sup>rd</sup> month till flowering. Use 'Banana injector' devised by the Tamil Nadu Agricultural University.

**Avoid injection after flowering.**

Apply carbofuran 3 % G @ 35 g /sucker or phorate 10% G @ 15 g/sucker or spray any one of the following insecticide. The spray may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice.

Insecticide	Dose
Dimethoate 30%EC	1.0 ml/lit.
Oxydemeton -Methyl 25% EC	2.0 ml/lit.

**Thrips and Lace wing bugs:** Spray any one of the following insecticide

Insecticide	Dose
Dimethoate 30 %EC	1.0ml/lit.
Oxydemeton -Methyl 25% EC	1.0ml/lit.
Quinalphos 25%EC	2.0ml/lit.

### Bunchy-top:

The Banana Aphid *Pentalonia nigronervosa* is the vector of Bunchy-top virus disease. Spray phosphamidon 40 SL @ 2 ml/lit or methyl demeton 25 EC @ 2 ml/lit . The spray may be directed towards crown and pseudostem base upto ground level at 21days interval at least thrice.

### To prevent the disease,

i) Use virus-free suckers

ii) Paring and pralinage

Pare the corm and sprinkle 40 g of Carbofuran 3 G over the Corm (Before sprinkling, corm should be dipped in mud slurry).

iii) Destroy virus affected plants.

iv) Insert a gelatin capsule containing 200 mg 2,4 - D into the corm 7 cm deep using capsule applicator or inject 5 ml 2,4 - D solution (125 gm/lit of water) into the pseudostem by using the injection gun. The plant collapses and topples in 3 – 5 days.

### Nematode:

- Pare the corm and sprinkle 40 g of Carbofuran 3 G cover the corm. Before sprinkling, corm should be dipped in mud slurry (or) pare and dip the corm into 0.75 % (15 ml / lit water). Monochrotophos solution; shade dry and plate (or) Pare the corms and coat (Pralinage) with *Bacillus subtilis* (BbV 57) and *Pseudomonas fluorescens* (Pf1) each at 10 g / corm follows by soil application @ 1.25 kg each/ha.
- If pre-treatment is not done, apply 40 g Carbofuran around each plant twice at 1<sup>st</sup> and 3<sup>rd</sup> month after planting.
- Grow Sunhemp in and around the basin of plants and incorporate their biomass one month later (or) apply press mud @ 15 t per ha one month after planting (or) apply neem cake 1.5 t per ha one month after planting (or) Apply *Pseudomonas fluorescens* (Pf1) liquid formulation @ 4 lit/ha at 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> MAP through drip system to manage panama wilt and nematode complex.

### Diseases

**Sigatoka leaf spot:** Remove affected leaves and burn. Spray any one of the following fungicides commencing from November at monthly interval. Carbendazim 1 g / lit., Benomyl 1 g / lit., Mancozeb 2 g / lit., Copper oxychloride 2.5 g / lit., Ziram 2 ml / lit, Chlorothalonil 2 g / lit. Alternation of fungicides prevents fungicidal resistance. Alternatively spray Propiconazole 1 ml/lit or 0.5 ml/lit along with petroleum based mineral oil 10ml / lit or *Pseudomonas flourescens* (0.5%),

three times at 15 days interval to effectively control sigatoka leaf spot incidence. Always add 5 ml of wetting agent like Sandovit, Triton AE, Teepol etc. per 10 lit of spray fluid.

**Bunchy-top:** The Banana Aphid *Pentalonia nigronervosa* is the vector of Bunchy top virus disease. Spray any one of the following systemic insecticides to control it. Phosphamidon 1 ml / lit or Methyl demeton 2 ml / lit . The spray may be directed towards crown and pseudostem base upto ground level at 21 days interval atleast thrice. Use 'Banana Injector' devised by the Tamil Nadu Agricultural University.

#### To prevent the disease,

1. Use virus-free suckers.
2. Paring and pralinage. Pare the corm and sprinkle 40 g of Carbofuran 3 G over the corm (Before sprinkling, corm should be dipped in mud slurry).
3. Destroy virus affected plants. Insert a gelatin capsule containing 200 mg 2,4 - D into the corm 7 cm deep using capsule applicator or inject 5 ml 2,4 - D solution (125 g / lit of water) into the pseudostem by using the injection gun. The plant collapses and topples in 3 – 5 days.

**Panama Disease (Fusarium wilt):** Uproot and destroy severely affected plants. Apply lime at 1 - 2 kg in the pits after removal of the affected plants.

#### Corm injection

Remove a small portion of soil to expose the upper portion of the corm. Make an oblique hole at 45° angle to a depth of 10 cm. Immediately insert a gelatin capsule containing 60 mg of Carbendazim or of 50 mg of *Pseudomonas fluorescens* or inject 3 ml of 2 % Carbendazim solution into the hole with the help of 'corm injector' on 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> month after planting. Apply press mud at 5 kg per tree to reduce the wilt incidence (or) apply *Pseudomonas fluorescens* (Pf1) liquid formulation @ 4 lit/ha at 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> MAP through drip system to manage panama wilt and nematode complex.

**Kottaivazhai in Poovan:** Spray 2,4 - D @ 25 ppm within 20 days after opening of last hand (1 g / 40 lit / 200 bunches) or 1.2 g of Sodium salt of 2,4 - D dissolved in 40 lit of water for 200 bunches.

**Crop duration:** The bunches will be ready for harvest after 12 to 15 months of planting.

**Harvest:** Bunches attain maturity from 100 to 150 days after flowering depending on variety, soil, weather condition and altitude.

#### Yield (t / ha / year):

Poovan & Rasthali	:	40 - 50 t / ha
Monthan	:	30 - 40 t / ha
Ney Poovan	:	30 - 35 t / ha
Robusta	:	50 - 60 t / ha
Grand Naine	:	70 - 80 t / ha; under HDP: 115-130 t / ha

#### Market information

Growing Districts	Coimbatore, Erode, Thoothukudi, Tirunelveli, Trichy, Vellore, Kanyakumari and Karur districts
Major Markets in Tamil Nadu	Trichy, Coimbatore, Theni
Preferred Varieties and Hybrids	Grand Naine, Dwarf Cavendish, Robusta, Rasthali, Poovan, Nendran, Red Banana, Ney Poovan, Pachanadan, Monthan, Karpuravalli
Grade Specification	The hands are graded based on the number and size of fingers in each hand. Over ripe and injured fruits are discarded. Banana is sent to the local market as bunches.





## **Acid Lime: *Citrus aurantifolia* (Christm) Swingle; Rutaceae**

**Varieties:** PKM1, Vikram

**Soil and Climate:** Tropical and sub tropical. Can be grown up to 1000 m above MSL. Deep well drained loamy soils are the best.

**Season:** December - February and June - September.

**Planting:** Healthy seedlings may be planted during June to December at 5 to 6 m spacing in 75 cm x 75 cm x 75 cm pits.

**Irrigation:** Irrigate copiously after planting. After establishment, irrigation may be given at 7 - 10 days interval. Avoid water stagnation. Adopt drip system for new plantations.

**Manures and Fertilizers per plant:** 'N' to be applied in two doses during March and October. FYM, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are to be applied in October.

<b>Manures and Fertilizers</b>	<b>1<sup>st</sup> year</b>	<b>Annual increase</b>	<b>From 6<sup>th</sup> year</b>
FYM	10 kg	5 kg	30 kg
N	200 g	100 g	600 g
P	100 g	25 g	200 g
K	100 g	40 g	300 g

Spray Zinc sulphate @ 0.5% (500 g /100 lit of water) thrice in a year (March, July and October) after the emergence of new flushes.

**After cultivation:** Remove branches of main stem up to 45 cm from ground level. Application of green leaves 30 kg per tree once in 3 months.

**Intercropping:** Legumes and vegetable crops can be raised during pre-bearing age.

**Growth regulator:** To increase fruit set, spray 2, 4 - D @ 20 ppm (200 mg / 10 l) during flowering. For fruit retention, spray 2, 4 - D @ 20 ppm or NAA 30 ppm (300 mg / l) after fruit set (marble size).

### **Plant protection**

#### **Pests**

##### **Leaf miner:**

Apply carbofuran 3 % G @ 50 kg /ha or phorate 10 % G @ 15 kg/ha or spray neem seed kernel extract (NSKE) 5 % or neem cake extract or neem oil 3 % or imidacloprid 17.8% SL @ 2.0 ml in 10 lit of water or Thiodicarb 75 WP @ 1g /lit.

##### **Aphids :**

Spray neem oil @ 3 ml/lit or Fish oil rosin soap 25 g/lit.

##### **Rust mite :**

Apply carbofuran 3 % G @ 50 kg /ha or phorate 10 % G @ 15 kg/ha or dicofol 18.5 EC @ 2.5 ml/lit or imidacloprid 17.8% SL @ 2.0 ml in 10 lit of water

**Fruit sucking moth:**

- Destroy *Tinospora* weed host.
- Bait with fermented molasses plus malathion 50 EC @ 1 ml/lit.
- Bag the fruits with polythene bags punctured at the bottom.
- Apply smoke and set up light traps or food lures (pieces of citrus fruits).

**Shoot borer:**

Prune the withered shoots 4 cm below the dried portions,

**Citrus Butterfly:**

Spray two rounds of *Bacillus thuringiensis* @ 1g/lit or neem oil @ 10 ml/lit during new flush formation is recommended for the management of citrus butterfly

**Fruit fly**

1. Set up bait with methyl eugenol 0.1% solution mixed with malathion 50 EC @ 1 ml/lit between 6 a.m. and 8 a.m.
2. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.
3. *Neem oil* @ 3.0 % as foliar spray as need based

**Mealy bugs**

- Debark the branches
- Use sticky trap on the shoot bearing the fruits at a length of 5 cm.
- Use dichlorvos (0.2%) in combination with fish oil rosin soap (25g/lit) as spray or for dipping the fruits for two minutes.
- Dissolve Fish oil rosin soap @ 25g /lit, initially in luke warm water, then in required quantity of spray fluid in the sprayer.

**Tree banding:**

- Band the trees with 20 cm wide alkathene or polythene (400 gauge) 50 cm above the ground level and just below the junction of branching and secure them with jute thread.
- Apply a little mud or fruit tree grease on the lower edge of the band. Or, put a band of carbaryl swab around the tree trunk leaving 30 cm from the main stem
- Follow ant control methods such as destruction of ant holes, red ant nests and skirting of citrus trees after fruit harvest which prevents the ant migration through side branches.
- Release predator, *Cryptolaemus montrouzieri* beetles @ 10 beetles/tree once the patrolling of the ants on the trunk is stopped. Make one to three releases per annum depending on the mealy bug populations. Make periodic check during the first fortnight and put dried leaf mulch around the tree trunk 20 days after the release of the beetles to facilitate pupation of the full grown grubs.

**Tristeza virus:**

Remove the infected trees and destroy. Spray methyl demeton 25 EC or to control the aphids which spread the disease. Use pre-immunized acid lime seedlings for planting.

**Nematodes:** Application of Carbofuran 3 G @ 75 g / tree to control citrus nematodes in severe infestations. Application of 20 g *Pseudomonas fluorescens* formulation per tree at a depth of 15 cm and 50 cm away from the trunk once in four months. Soil application of Phorate @ 2 g followed by drenching with Metalaxyl plus Mancozeb 72 WP @ 1 % 50 ml / cutting / poly bag / kg of nursery soil for citrus decline.

## Diseases

**Twig blight:** Prune dried twigs and spray 0.3% Copper oxychloride or 0.1% Carbendazim at monthly intervals to reduce the spread of disease.

**Scab:** Spray 1% Bordeaux mixture.

**Canker :** Immediately after pruning one spray of Copper oxychloride (COC) 0.3% followed by 4 sprayings with Streptocyclin 100 ppm + COC 0.3 % at monthly intervals.

**Tristeza virus:** Remove the infected trees and destroy. Spray Methyl demeton 25 EC to control the aphids which spread the disease. Use pre-immunized acid lime seedlings for planting.

**Harvest:** Starts bearing from 3<sup>rd</sup> year after planting.

**Post harvest treatment:** Treating the fruits with 4% wax emulsion followed by pre-packing in 200 gauge polythene bags with 1 % ventilation improves the shelf life for more than 10 days.

**Yield:** 25 t /ha /year.

## Market information

Growing Districts	Dindigul, Tirunelveli, Trichy, Perambalur
Major Markets in Tamil Nadu	Dindigul, Tirunelveli, Trichy, Perambalur
Preferred Varieties and Hybrids	PKM 1, Vikram
Grade Specification	Size and colour



## Sweet Orange: *Citrus sinensis*; Rutaceae

**Varieties:** Sathugudi.

**Soil and Climate:** Deep well drained loamy soils are the best for the cultivation of Citrus. pH of soil should be 6.5 to 7.5 and EC of water less than 1.0. A dry climate with about 50 – 75 cm of rainfall from June - September and with well defined summer and winter season is ideal. Comes up well in tropical zone below 500 m.

**Season:** July to September.

**Planting material:** Budded plants (Root Stock: Rangpur lime is best, now Rough lemon is also preferred).

**Preparation of field:** Dig pits at 75 cm x 75 cm x 75 cm in size at 7 x 7 m spacing. Fill up the pits with top soil and 10 kg of FYM. Plant the budded plants in the centre of the pits and stake it.

**Irrigation:** Immediately after planting irrigate copiously. Irrigations may be given once in 10 days. Avoid water stagnation near the plant.

**Manures and Fertilizers per plant:** N to be applied in two doses during March and October. FYM, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are to be applied in October.

Manures and Fertilizers	1 <sup>st</sup> year (kg)	Annual increase (kg)	From 6 <sup>th</sup> year (kg)
FYM	10.000	5.000	30.000
N	0.200	0.100	0.600
P	0.100	0.020	0.200
K	0.100	0.040	0.300

Manures are applied in the basin 70 cm away from the trunk and incorporated in the soil. Spray solution containing Zinc Sulphate (0.5%), Manganese (0.05%), Iron (0.25%), Magnesium (0.5%), Boron (0.1%) and Molybdenum (0.003%) once in 3 months at the time of new flush production. In addition to that, apply 50 g in each of Zinc Sulphate, Manganese and Iron per tree per year.

### Plant protection

**Leaf miner :** Spray Dichlorvos 76 WSC @ 1 ml / lit or Dimethoate 30 EC 2 ml / lit or Fenthion 100 EC @ 1 ml / lit or 5% of Neem Seed Kernel Extract (NSKE) or Neem oil 3%.

**Citrus root nematode:** Apply *Pseudomonas fluorescens* at 20 g per tree at a depth of 15 cm and 50 cm away from the trunk for the management of slow decline due to the citrus root nematode (*Tylenchulus semipenetrans*). Soil application of Phorate @ 2 g followed by drenching with Metalaxyl plus Mancozeb 72 WP @ 0.1% 50 ml / poly bag / kg of nursery soil for citrus decline.

**Little leaf malady:** To control little leaf, spray Zinc sulphate at 1.0 per cent plus Teepol 1 ml / lit of solution at following stages.

- 1) New flush
- 2) One month after first spray
- 3) At flowering
- 4) Fruit set

**After cultivation:** Remove water shoots, rootstock sprouts, dead and diseased shoots. Remove laterals upto 45 cm from ground level.

**Intercropping:** Legumes and vegetable crops can be raised during pre-bearing age.

**Harvest:** Starts bearing from 5<sup>th</sup> year after planting.

**Yield:** 30 t / ha.



## **Mandarin Orange: *Citrus reticulata* Blanco; Rutaceae**

**Varieties:** Coorg Orange and Kodai Orange.

**Soil and Climate:** Sub tropical climate with an elevation of 500- 1500 m above MSL. A rainfall of about 150 cm to 250 cm is required. The winter should be mild and there should be no strong, hot winds during summer. Deep well drained loamy soils are the best. Soil pH should be between 5.5 and 6.5.

**Season:** November - December.

**Planting:** Seedlings and budded plants.

**Spacing:** 6 x 6 m, pit size 75 x 75 x 75 cm. Planting during May – June and September – October.

**Manures and Fertilizers:** Apply twice in a year during June and October.

### **a) For Palani Hills**

Manures & Fertilizers	1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	4 <sup>th</sup> year	5 <sup>th</sup> year	6 <sup>th</sup> year onwards
	Kg / plant / year					
FYM	10.000	15.000	20.000	25.000	25.000	30.000
N	0.100	0.200	0.300	0.400	0.500	0.600
P	0.040	0.080	0.120	0.160	0.160	0.200
K	0.050	0.100	0.200	0.300	0.300	0.400

### **a) For Shervaroyan hills (for trees above 6 years old):**

Apply 700:375:600 g / tree NPK along with AM fungi (*Glomus fasciculatus*) @ 1 kg / tree.

Manures are to be applied in the basin 70 cm away from the trunk and incorporated. Apply micronutrients as suggested for sweet orange. Apply agricultural lime or Dolomite at 4 kg / tree during January – February once in 2 – 3 years. This should not be combined with other chemical fertilizers.

**After cultivation:** Remove water shoots, root stock sprouts, dead and diseased shoots. Remove laterals of the main stem up to 45 cm from ground level. Basins should be provided for each tree with gradient slope.

## Plant protection

### Pests

#### Leaf miner:

Spray 5% of neem seed kernel extract (NSKE) or neem cake extract or neem oil 3%.

#### Aphids :

Spray neem oil 3 ml/lit or Fish oil rosin soap @ 25 g/lit

Fruit sucking moth: Destroy *Tinospora* weed host. Bait with fermented molasses plus malathion 50 EC @ 1 ml/lit.

Bag the fruits with polythene bags punctured at the bottom.

Apply smoke and set up light traps or food lures (pieces of citrus fruits).

**Shoot borer:** Prune the withered shoots 4 cm below the dried portions

**Stem borer:** Prune the branches containing grubs.

#### Fruit fly:

Collection and destruction of fallen fruits.

Set up methyl eugenol trap 0.1% solution mixed with malathion 50 EC @ 1 ml/lit between 6 a.m. and 8 a.m.

Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively

.Neem oil @ 3.0 % as foliar spray as need based

Green scale: Apply Carbofuran 3% G @ 15 g/plant

Safe waiting period: Methyl demeton

#### Sooty mould

Boil 1 kg Maida or starch with 5 lit of water, cool, dilute to 20 lit and spray. Avoid spraying during cloudy weather.

### Diseases

#### Powdery mildew

Apply Sulphur dust 25 - 30 kg (350 mesh) in the early morning hours to protect new flush or spray Wettable Sulphur 0.3% (or) Triademefon 0.1% - 3 sprays at 15 days interval.

#### Sooty mould

Spray Phosphamidon 40 SL @ 2ml / litre. Boil 1 kg Maida or starch with 5 lit of water, cool, dilute to 20 lit and spray. Avoid spraying during cloudy weather.

**Growth regulators:** To increase the fruit retention spray the trees at flowering and again at marble stage with 2, 4 - D at 20 ppm or NAA 30 ppm.

**Harvest:** Budded plants start bearing from 3 – 5 years after planting while seedlings take 5-7 years.

**Yield:** 15 - 20 t / ha / year.

## **Grapes: *Vitis vinifera*; Vitaceae**

**Varieties:** Muscat (Panneer), Pachadraksha, Anab-e-Shahi, Thompson Seedless, Arka Shyam, Arka Kanchan, Arka Hans, Manik Chaman, Sonaka, Sharadh Seedless and Flame Seedless.

Muscat is the major variety grown in Tamil Nadu.

**Soil and Climate:** Well-drained rich loamy soil with a pH of 6.5 - 7.0 with low water table with EC less than 1.0. Soil depth should be atleast 1 m.

**Field preparation and Planting:** Trenches of 0.6 m width and 0.6 m depth are to be dug at a distance of 3 m apart for Muscat and pits of 1m x 1m x 1m should be dug for other varieties. Well decomposed FYM or compost or green leaf manure has to be applied in the trenches or pits as the case may be and then covered with soil. Plant the rooted cuttings in June-July.

**Spacing:** 3 x 2 m for Muscat, 4 x 3 m for other varieties.

**Irrigation:** Irrigate immediately after planting and on the 3<sup>rd</sup> day and then once in a week. Withheld irrigation 15 days before pruning and also 15 days before harvest.

**Training:** The vines are trained with single stem upto pandal with a stalk on tipping at 2 m height. The main arms are developed and trained on opposite directions. On further tipping, secondary and tertiary arms are developed for spreading all over pandal.

**Pruning:** In general four bud level of pruning for Muscat, Pachadraksha, Bangalore Blue, Anab- e-Shahi and Arka hybrids and two bud level for Thompson Seedless may be adopted. It is better to decide the level of pruning as per bud forecasting technique. Weak and immature canes should be pruned to one or two buds to induce vegetative growth.

### **Pruning Season**

**Summer crop:** Pruning in December - January and harvesting in April - May.

**Monsoon crop:** Pruning in May - June and harvesting in August - September.

### Manures and Fertilizers (Kg per vine)

Variety	FYM			Green leaves			N			P			K		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Muscat	50	50	100	50	50	100	0.10	0.20	0.20	0.08	0.16	0.16	0.30	0.40	0.60
Pachadraksha Thompson seedless	50	50	100	50	50	100	0.20	0.30	0.40	0.08	0.16	0.24	0.40	0.80	1.20
Sonaka, Manikchaman Sharad seedless, Anab- e-Shahi	50	50	100	50	50	100	0.20	0.40	0.60	0.08	0.16	0.24	0.40	0.80	1.20

The manures should be applied twice after pruning. Apply half the dose of potash immediately after pruning and the other half after 60 days of pruning. Foliar spray of 0.1% Boric acid + 0.2% ZnSO<sub>4</sub> + 1.0% Urea twice before flowering and 10 days after first spray to overcome nutrient deficiency.

**Special practices:** Tipping of shoots and tying of clusters in the pandal after the fruit set. Remove tendrils. Nipping the growing shoots of axillary buds and terminal buds at 12 to 15 buds. Thinning the compact bunches by removing 20 % of the berries at pea stage. Dip the clusters in solution containing Brassinosteroid 0.5 ppm and GA<sub>3</sub> 25 ppm at 10-12 days after fruit set to maintain vigour, yield and quality parameters.

### Plant protection

#### Pests

**Nematodes:** Apply 60 g of Carbofuran 3 G or 20 g Phorate 10 G per vine a week before pruning and the plots are irrigated profusely. Do not disturb the soil for atleast 15 days. Thereafter normal manuring may be done. Apply of neem cake 200 g / vine or alternatively apply *Pseudomonas fluorescens* formulation in talc containing 15 x 10<sup>8</sup> colony forming units / g, 30 cm away from base of the vine atleast 15 cm depth at the time of pruning to control nematodes.

**Flea beetles:** Spray Phosalone 35 EC (2 ml / lit of water) immediately after pruning and followed with The loose bark may be removed at the time of pruning to prevent egg laying. Spray Malathion 50 % EC @ 7.0 ml in 10 litres of water

#### Thrips:

Spray methyl demeton 25 EC or dimethoate @ 30 EC 2 ml/lit of water.

#### Mealy bug:

Release Coccinellid beetle, *Cryptolaemus montrouzieri* @ 10 per vine. Spray methyl demeton 25 EC of water or spray dichlorvos 76 WSC @ 1 ml/lit with fish oil rosin soap @ 25 g/lit or Buprofezin 25 % SC @ 1.0 ml/lit.

#### Stem girdler:

Swab the trunk with carbaryl 50 WP@ 2 gm/lit.

**Safe waiting period:** Five days for dimethoate and carbaryl



## Diseases

**Powdery mildew:** Spray 0.3% Wettable sulphur or Dust sulphur @ 6-12 Kg / ha in the morning or Azoxystrobin @ 150 ai / ha (600 ml / ha) 30 days after pruning 5 sprays at 10 days interval.

**Downy mildew:** Spray *Pseudomonas fluorescens* @ 20 g / lit on 25<sup>th</sup> and 45<sup>th</sup> days after pruning followed by spraying of Azoxystrobin @1 ml / lit on 35<sup>th</sup> and 55 days after pruning. Remove infected tendrils and spray *Pseudomonas fluorescens* @ 20 g / lit at 65 days after pruning (Or) Apply FYM @ 20 kg + Pf1 100 g/vine after pruning followed by spray with *Pseudomonas fluorescens* (Pf 1) on 25, 35, 45, 55 and 65 days after pruning to check the Downy mildew.

**Anthraco nose:** Spray 1 % Bordeaux mixture or Copper fungicide 0.25 % or Fluopicolide and Forestyl aluminium formulation (Profler-Fluopicolide 4.44% + Fosetyl Aluminium 66.7% - 71.14% WG) @ 0.225 % three times [First spray 15 days after pruning (at 4-5 leaf stage) and the second and third spray at 10 days interval depending upon disease severity]. Depending upon the weather conditions the sprays have to be increased

**Quality improvement:** To get uniform ripening in Muscat, spray the bunches with 0.2% Potassium chloride (2 g / lit) at 20<sup>th</sup> day after berry set and followed by another spray on 40<sup>th</sup> day

Dip the clusters of Thompson seedless and other seedless varieties at calyptra fall stage with 25 ppm GA (25 mg / lit) and repeat again at pepper stage to increase the size of berries.

## Yield

Seedless	:	15t / ha / year
Muscat	:	30t / ha / year
Pachadraksha	:	40t / ha / year
Anab-e-Shahi and Arka hybrids	:	20 t / ha / year

## Preparation of 1% Bordeaux mixture:

A quantity of 500 g of Copper sulphate should be dissolved in 25 lit of water and 500 g of lime in another 25 lit of water separately. The copper sulphate solution should be added to the lime solution constantly stirring the mixture. Earthen or wooden vessels and plastic containers alone should be used and metallic containers should not be used. To find out whether the mixture is in correct proportion, a polished knife should be dipped in the mixture for one minute and taken out. If there is reddish brown deposit of copper, additional quantity of lime should be added till there is no deposit in the knife.

## **Guava: *Psidium guajava* L.; Myrtaceae**

**Varieties:** Allahabad, Lucknow 49, Arka Amulya, Arka Mridula, Banarasi, TRY(G) 1, Arka Kiran, Lalit.

**Soil and Climate:** Guava grows well both in wet and dry regions but it does better under irrigation in the dry tracts. It can be grown upto 1000 m altitude. Well drained soils are the best. Tolerates salinity and alkalinity. In saline soils add 3 kg Gypsum / plant during planting and once in three years after planting.

**Planting material:** Layers.

**Season of planting:** June - December.

**Spacing:** 5 - 6 m either way.

**Planting:** Plant the layers with the ball of earth in the centre of pit of 45 cm x 45 cm x 45 cm size filled with FYM 10 kg, neem cake 1 kg and top soil + 50 g Lindane 1.3%.

**Irrigation:** Irrigate copiously immediately after planting, again on third day and afterwards once in 10 days or as and when necessary.

**Manures and Fertilizers:** FYM 50 kg and one kg in each of N, P and K per tree in two split doses during March and October. To increase the yield, spray Urea 1 % + Zinc sulphate 0.5% twice a year during March and October. To correct the boron deficiency (reduction in size of leaves and fruit cracking and hardening), spray 0.3% borax (30 g / l) during flowering and fruit set stages.

**Micronutrients spray for controlling bronzing of leaves:** Spraying of a combination spray containing  $\text{ZnSO}_4$ ,  $\text{MgSO}_4$  and  $\text{MnSO}_4$  @ 0.5% and  $\text{CuSO}_4$  and  $\text{FeSO}_4$  @ 0.25 % plus Teepol @ 1ml per 5 lit of solution on various stages

1. New flush
2. One month after first spray
3. Flowering
4. Fruit set

**Inter cropping:** Legumes and short duration vegetable crops may be raised during pre-bearing stage.

**After cultivation:** Pruning of past season's terminal growth to a length of 10-15 cm is to be done during September – October and February – March to encourage more laterals. The erect growing branches are to be bent by tying on to pegs driven on the ground. Old unproductive but healthy trees may be either pollarded or cut the trunks at 75 cm from ground level or dehorned by cutting the secondary branches at a distance of 75 cm from their origin.

## **Plant protection**

### **Pests**

#### **Tea Mosquito Bug:**

Spray malathion 50 EC @ 2ml/lit or Spray Neem formulations @ 2ml/lit or neem oil 3 %. Spraying should be done in early mornings or late evenings, at least four times at 21 days interval during fruiting season.



**Aphid:**

Spray or dimethoate 30EC @ 2ml/lit. Mealy bug:  
Release *Cryptolaemus* predatory beetles @10/tree.

**Fruit fly:**

Collection and destruction of fallen fruits.

Set up methyl eugenol 0.1% solution mixed with malathion 50 EC @ 1 ml/lit between 6 a.m. and 8 a.m.

Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

Stir the soil around the tree during pest incidence and dust carbaryl 10 D @ 10 kg/ac.

*Neem oil* @ 3.0 % as foliar spray as need based

Safe waiting period: malathion 50 EC - 9 days.

**Diseases**

**Red rust:** Spray Copper oxy chloride 2.5 g / lit or Bordeaux mixture 0.5 % or Wettable sulphur 2 g / litre.

**Harvest:** Layers come to bearing in 2 - 3 years.

First crop : February – July.

Second crop : September - January.

**Yield:** 25 t / ha.

**Market information**

Growing Districts	Dindigul, Madurai, Virudhunagar, Villupuram, Vellore, Tirunelveli
Major Markets in Tamil Nadu	Palani, Madurai, Koyambedu Wholesale Market

## **Pineapple: *Ananas sativus*; Bromeliaceae**

**Varieties:** Kew, Mauritius and Queen.

**Soil and Climate:** Mild tropical climate as found in the humid hill slopes is best suited. Can be grown in plains under shade. Elevation from 500 m to 700 m is ideal. A light well drained soil with pH of 5.5 to 7.0 is preferable. Heavy soils can also be used if drainage facilities are available.

**Spacing:** Plant in double rows either in beds or in trenches with the plants into the second rows set in the middle of the plants in the first row. The spacing between two trenches will be 90 cm. Row to row spacing in the same bed per trench will be 60 cm and plant spacing within the row is 30 cm.

**Planting:** Use suckers and slips of 300-350 g weight for planting. Give a slanting cut to the suckers before planting and dip in Mancozeb 0.3 % or Carbendazim 0.1%.

**Season:** July - September

**Manures and Fertilizers:** FYM 40-50 t / ha. N 16 g, P 4 g and K 12 g / plant in two equal splits at 6<sup>th</sup> and 12<sup>th</sup> month after planting. Apply as foliar spray 0.5% - 1.0 % Zinc sulphate and Ferrous solutions at 15 days interval to overcome the deficiencies in the early crop phase.

**After cultivation:** To have uniform flowering, apply the following when the crop attains 35 – 40 leaf stage. NAA 10 ppm + 2 % urea (20 g in 1 lit of water) @ 50 ml / plant poured into crown or 2 % urea + 0.04 % Sodium carbonate + 20 ppm Ethephon (ethrel) @ 50 ml / plant poured into the crown. To increase the size of the fruit, 200– 300 ppm NAA should be sprayed after fruit formation. To avoid calcium induced Iron chlorosis, provide adequate shade.

### **Plant protection**

**Mealy bug:** Spray Methyl demeton 2 ml / lit

**Crop duration:** 18 - 24 months.

**Harvest:** Fruits can be harvested from 18 to 24 months. Slight colour change at the base of the fruit indicates maturity.

**Yield:** 50 t / ha.

A plant crop and two ratoon crops are normally taken and in Mauritius variety upto five crops can be taken.

### **Market information**

Growing Districts	Namakkal, Dindigul, Kanyakumari
Major Markets in Tamil Nadu	Koyambedu Wholesale Market, Coimbatore
Grade Specification	Size, Shape, Maturity, free from disease, pest and blemishes Crowns should be trimmed to less than 10 cm and the stalk end trimmed to 5 -7 cm

**Sapota: *Manilkhara achras*; Sapotaceae**

**Varieties:** Oval, Cricket Ball, Kirtibarti, Guthi, CO 1, CO 2, CO 3, PKM 1, PKM 2, PKM 3, PKM 4, PKM (Sa) 5 and Kalipatti.

**Soil and Climate:** It is a tropical crop and can be grown up to an altitude of 1000 m. It can be grown in all types of soils.

**Planting materials:** Grafted on *Manilkhara hexandra* (Pala) rootstock.

**Season of planting:** June - December

**Spacing:** 8 x 8 m (156 plants / ha) for conventional planting.

Adopt high density planting at 8 x 4 m (312 plants / ha) for high productivity

**Planting:** Dig pits of 1 m x 1 m x 1 m in size. Fill up with top soil mixed with 10 kg of FYM, 1 kg of Neem cake and 100 g of Lindane 1.3%. Plant the grafts in the center of the pit with ball of earth intact. The graft joint must be atleast 15 cm above the ground level. Stake the plants properly to avoid bending or damage to graft joint.

**Irrigation:** Irrigate copiously immediately after planting and on the third day and once in 10 days afterwards till the graft establishes.

**Manures and Fertilizers** (Kg / tree)

Manures and Fertilizers	1 <sup>st</sup> year old	Annual increase	6 <sup>th</sup> year onwards
FYM	10.000	10.000	50.000
N	0.200	0.200	1.000
P	0.200	0.200	1.000
K	0.300	0.300	1.500

Manures and fertilizers may be applied in September - October, 45 cm away from the trunk upto the leaf tip and incorporated.

**After cultivation:** Remove the root stock sprouts, water shoots, criss-cross and lower branches.

**Inter cropping:** Legumes and short duration vegetable crops may be raised as inter crop during pre-bearing stage.

**Plant protection**

**Pests**

**Leaf webber:** Spray Phosalone 35 EC 2 ml / lit.

**Hairy caterpillars:** Spray Chloropyriphos 20 EC or Phosalone 35 EC 2 ml / lit of water.

**Bud worm:** Spray neem seed kernel extract 5 %.

## Diseases

**Sooty mould:** Boil 1 kg maida or starch with 5 lit of water, cool and dilute to 20 lit (5 %) and spray. Avoid spraying during cloudy weather.

**Harvest:** A mature fruit is dull brown in colour and the colour immediately below the skin when scratched is of lighter shade, while in the immature fruits it is green. The mature fruits are harvested by hand picking.

**Season:** February - June and September - October. Ripen the fruits in air tight room by keeping a beaker containing 5000 ppm Ethrel + 10 g NaOH pellets in an air tight chamber (5 ml Ethrel in one lit of water is 5000 ppm). Alternatively, fruits can be exposed to ethylene gas at 100 - 200 ppm for 18 – 20 hrs to induce ripening.

**Yield:** 20-25 t / ha / year.

## Market information

Growing Districts	Dindigul, Coimbatore, Virudhunagar, Theni, Namakkal
Major Markets in Tamil Nadu	Dindigul, Coimbatore, Anna fruit market, Koyambedu, Chennai
Preferred Varieties and hybrids	Cricket ball, PKM 1, Kalipatti, PKM 4
Grade Specification	Based on size and shape, large, medium and small

## **Papaya: *Carica papaya* L.; Caricaceae**

**Varieties:** CO 2, CO 3, CO 4, CO 5, CO 6, CO 7 and TNAU Papaya CO 8, CO 3 and CO 7 are gynodioecious (bisexual + female) types highly suitable for table purpose and CO 2, CO 5, CO 6 and CO 8 are dual-purpose varieties for table and papain production. 'Red Lady' is also being grown for commercial purposes.

**Soil and Climate:** It is a tropical fruit and grows well in regions where summer temperature ranges from 35° C – 38° C. Tolerates frost and comes up to an elevation of 1200 m. Well drained soils of uniform texture are preferable. If drainage is not adequate, collar - rot disease may occur.

**Sowing:** 500 g of seeds is required for planting one ha. June - September is the best season for planting. Avoid planting in rainy season.

**Nursery:** Treat the seeds with Captan @ 2 g / kg of seeds. Dibble 5-6 seeds in dioecious varieties and 3-4 seeds in gynodioecious varieties in polythene bags at a depth not exceeding one cm. Raise the seedlings in a protected structure to avoid Papaya Ring Spot Virus incidence. Provide partial shade. Water the bags in rose can. Seedlings will be ready in about 60 days.

**Planting:** Plant the seedlings at 1.8 m either ways in pits of 45 cm x 45 cm x 45 cm size. Avoid planting in severe summer as well as in peak rainy season. Avoid water stagnation in the basin.

**Irrigation:** Irrigate copiously after planting. Irrigate the field once in a week.

**Application of fertilizers:** Apply FYM 10 kg / plant as basal. Apply 50 g in each of N, P and K per plant at bi-monthly intervals from the third month of planting after removing unwanted sex forms. Apply 20 g in each of *Azospirillum* and *Phosphobacterium* at planting, again six months after planting.

### **Fertigation technique**

Apply 10 litres of water per day + 13.5 g urea and 10.5 g muriate of potash / week through drip irrigation and soil application of super phosphate 300 g per plant at bimonthly intervals starting from 3-4 months after planting immediately after thinning of plants is recommended.

**After cultivation:** Male trees should be removed after the emergence of inflorescence maintaining one male tree for every 20 female trees for proper fruit-set. In each pit only one vigorously growing female / hermaphrodite tree should be retained and other plants should be removed. In gynodioecious type like (CO 3, & CO 7) keep one hermaphrodite type / pit and remove female trees.

**Micronutrients:** Spray 0.5% Zinc sulphate and 0.1% Boric acid at 4<sup>th</sup> and 8<sup>th</sup> MAP to improve growth and yield.



## Plant protection

**Nematodes:** To control in the nursery, apply Carbofuran 3 G @ 1 g / polythene bag after germination. Apply Neemcake @ 250 g per plant + Carbofuran 3G 1 g a.i / plant + *P. fluorescens* @ 4 g / plant to minimize reniform nematode population.

## Diseases

**Root rot and wilt:** In water stagnated areas root-rot may appear. It is advisable to drench the soil with 1 % Bordeaux mixture or Metalaxyl @ 0.2% 2 or 4 times at fortnightly intervals. Good drainage is vital.

**Papaya ringspot virus disease:** Raise papaya seedlings in insect proof net house. Grow two rows of border crop of maize one month before transplanting of seedlings. Apply FYM @10 kg / plant. For vector management, spray Dimethoate @1.5 ml / lit at monthly intervals up to 5 months after planting followed by Zinc sulphate(0.5%)+ Boron 0.1% at 4<sup>th</sup> and 7<sup>th</sup> month.

**Crop duration:** 24 - 30 months.

**Harvest:** Fruits should be picked at colour break stage.

**Yield:** The average yield is as follows

- CO 2 : 200 - 250 t / ha
- CO 3 : 100 - 120 t / ha
- CO 5 : 200 - 250 t / ha
- CO 6 : 120 - 160 t / ha
- CO 7: 200 - 225 t / ha
- CO 8: 220 - 230 t / ha

**Papain extraction:** Papain has several industrial uses, the important one being in brewing industries. It is used as “meat tenderiser” and in textile and leather “sanforization” processes and drugs. The method of extraction of papain from papaya fruits is simple. The latex should be tapped from immature papaya fruits. Select 75 to 90 days old fruits. On the selected fruit, give incisions (cut) with a razor blade or stainless steel knife. The cuts should be given from stalk to tip of the fruit. The depth of the cut should not be more than 0.3 cm. Four such cuts are given spaced equally on the fruit surface. Tap the latex early in the morning and complete the tapping before 10.00 a.m. Repeat the tapping four times on the same fruit at an interval of three days. The cut should be given on the fruit surface in places not covered by previous cuts. The latex collected from all the trees in a day should be pooled, shade dried in an aluminium pan or tray and passed through a 50 mesh sieve to remove all foreign matter. In large plantations, vacuum driers can be adopted with advantage. Papain produced by artificial heating will have better colour and high quality. Add Potassium meta-bi-sulphite (KMS) at 0.5 % for better colour and keeping quality.

The latex should be dried very rapidly at temperatures of 50 to 55°C. Stop drying when the dried product comes off as flakes having a porous texture. Powder the dried papain by means of wooden mallets or in electrically operated granulators and sieves the powder through 10 mesh sieve. Pack the powder in polythene bags in convenient quantities and seal them. Put the sealed bags in a tin container and seal it after evacuating air. Exposure to air deteriorates the quality of papain and vacuum sealing is therefore necessary. For large scale manufacture of papain, vacuum sealing machine and a granulator will be useful. The green papaya fruits after extraction of papain can be used for pectin manufacture and “tasty fruity” or they can be allowed to ripen and made into other products. The CO 2, CO 5 and CO 8 varieties of papaya released by Tamil Nadu Agricultural University, Coimbatore are ideal for papain production.

**Yield:** The yield of crude papain is as follows: CO 2: 600 kg / ha, CO 5 & CO 8: 800 kg / ha.

### **Seed Technology**

**Germination improvement:** Store the seeds in airtight containers. Soak the seeds in 100 ppm GA<sub>3</sub> for 16 hours or in 2% fresh leaf extract of arappu or 1% pungam leaf extract or pellet the seeds with arappu leaf powder.

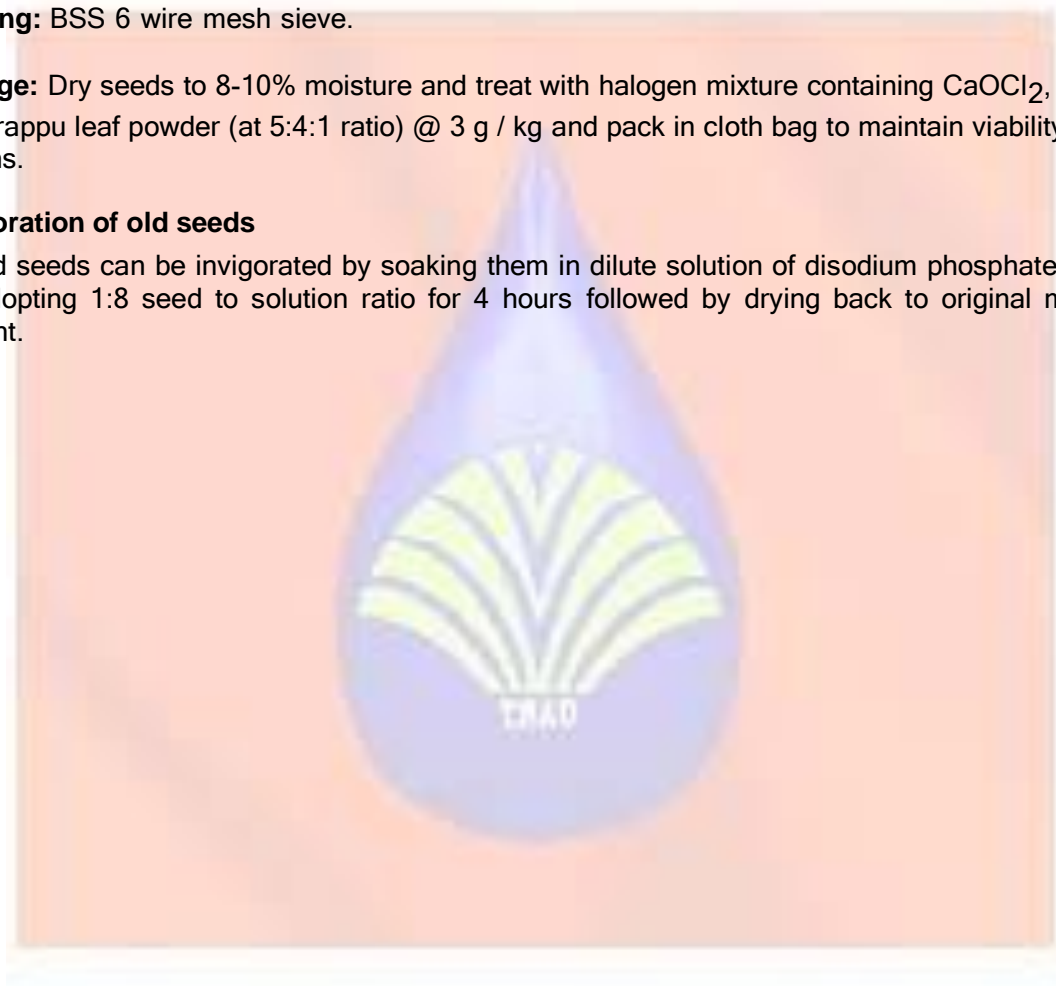
**Optimum depth of sowing:** Sow seeds at 1 cm depth for better germination and seedling growth.

**Grading:** BSS 6 wire mesh sieve.

**Storage:** Dry seeds to 8-10% moisture and treat with halogen mixture containing CaOCl<sub>2</sub>, CaCO<sub>3</sub> and arappu leaf powder (at 5:4:1 ratio) @ 3 g / kg and pack in cloth bag to maintain viability upto 5 months.

### **Invigoration of old seeds**

Stored seeds can be invigorated by soaking them in dilute solution of disodium phosphate (10<sup>-4</sup> M) adopting 1:8 seed to solution ratio for 4 hours followed by drying back to original moisture content.



## **Pomegranate: *Punica granatum* L.; Punicaceae**

**Varieties:** Jyothi, Ganesh, Araktha, Rudhra, Mirudhula, Bhagwa, Ruby.

**Soil and Climate:** It is grown in a wide range of soils; drought resistant and tolerant to salinity and alkalinity. Cool winter and dry summer are necessary for production of high quality fruits. It performs well upto 1800 m elevation.

**Planting:** Rooted cuttings or layers of 12 to 18 months age can be planted during June to December in pits of 60 cm x 60 cm x 60 cm at 2.5 to 3 m spacing either way.

**Irrigation:** Copious irrigation is essential during fruiting season.

**Application of fertilizers** (kg / plant)

<b>Manures and Fertilizers</b>	<b>1<sup>st</sup> year (kg)</b>	<b>2<sup>nd</sup> to 5th year (kg)</b>	<b>6<sup>th</sup> year onwards (kg)</b>
FYM	10.00	20.00	30.00
N	0.20	0.40	0.60
P	0.10	0.25	0.50
K	0.40	0.80	1.200

**Training and pruning:** Fruits are borne terminally on shoot emerging from mature wood. To promote new shoots on all sides annual pruning is done after harvest is completed during December by shortening of past season shoot by removing one third of the shoot. Besides, dried, diseased and criss-cross branches and root suckers are removed. The tree is trained to get a single stem upto 60 cm with 3 or 4 scaffold branches. Thinning of flower clusters ensures better size of the fruit. Spraying liquid paraffin at 1 % concentration at 15 days interval twice during June reduces fruit cracking.

### **Plant protection**

#### **Pests**

##### **Aphids:**

Release of first instar larvae of green lace wing predator *Chrysoperla carnea* @ 50 grubs/flowering branch four times at 10 days interval starting from flower initiation during April.

##### **Fruit Borer:**

- Remove calyx to discourage egg laying wherever possible
- Cover fruits with neem oil dipped cloth bags during flowering period to prevent egg-laying when the fruits are upto 5 cm diameter.
- Spray neem oil 3 % or NSKE 5% or spinosad @ 0.4 ml/lit at the time of butterfly activity. Repeat it if necessary twice at an interval of 15 days.
- Adopt ETL (5 eggs/plant with bearing capacity of 60 fruits)
- When the fruits are in marble stage, release *T. chilonis* @ 1 lakh/acre

**Scales:** Spray quinalphos 25 EC @ 2.5 ml per lit. of water

**Yield:** 20-25 t/ ha / year.



**Market information**

Growing Districts	Dindigul, Erode, Coimbatore, Tirunelveli
Major Markets in Tamil Nadu	Coimbatore, Chennai
Preferred Varieties and Hybrids	Bhagwa, Ruby (IIHR)
Grade Specification	Size, Shape , Colour, Softness of seeds

Trade Mark of TNAU



**Jack: *Artocarpus heterophyllus*; Moraceae**

**Varieties:** Velipala, Singapore, Hybrid jack, Panruti selection, Thanjavur jack, Burliar 1, PLR 1 and PLR (J) 2 and PPI 1.

**Soil and Climate:** Deep well drained soil is necessary. Soil pH around 5.5 at the time of planting is desirable. Otherwise treat the soil with 1% Aluminium sulphate in the pit to reduce the pH. Comes up well in the plains and upto an elevation of 1200 m.

**Propagation**

Soft wood grafting: Large scale propagation of jack can be done by cleft grafting during July - August on 4 month old seedling rootstock

**Preparation of field and planting:** Dig pits of 1 m x 1 m x 1 m in size. Fill up the pits with top soil mixed with 10 kg of FYM and 1 kg of Neem cake per pit. Apply Lindane 1.3% @ 100 g / pit and mix it thoroughly. Plant preferably grafts during June – December at 8 x 8 m spacing.

**Irrigation:** Once in a week till the plant is established. Thereafter irrigate as and when necessary.

**Manures and Fertilizers:** To be applied in two splits during May - June and September - October.

Sl. No	Manures & Fertilizers	1 year old (kg)	Annual Increase (kg)	6 <sup>th</sup> year and above (kg)
1	FYM	10.00	10.00	50.00
2	N	0.15	0.15	0.75
3	P	0.08	0.08	0.40
4	K	0.10	0.10	0.50

**Plant protection**

**Pest**

**Fruit borer:** Apply Carbaryl 50 WP @ 2 g / lit.

**Spittle bug:** Spray Methyl parathion 50 EC @ 2 ml / lit or Methyl demeton 25 EC @ 2 ml / lit Phosphamidon 40 SL @ 2 ml / lit or Dust Methyl parathion 2 D or Quinalphos dust 1.5 D.

**Diseases**

**Rhizopus rot:** Spray 1 % Bordeaux mixture or Copper oxychloride 2.5 g / lit three sprays at 15 days interval.

**Harvest:** Yield commences from 5<sup>th</sup> year in grafts and 8<sup>th</sup> year in seedling trees. Harvest during March-July.

**Yield:** 30-40 t / ha.

**Market information**

Growing Districts	Cuddalore, Kanyakumari, Dindigul, Pudukottai, Namakkal, Tirunelveli, Nilgiris
Major Markets in Tamil Nadu	Panruti, Coimbatore
Preferred Varieties and Hybrids	PLR 1 and Local

**Ber:** *Zizyphus mauritiana* Lam; Rhamnaceae

**Varieties:** Kaithali, Umran, Gola and Banarasi.

**Soil and Climate:** The ber plant comes under arid and semi-arid situation. Tolerates salinity and alkalinity.

**Planting material:** Budded plants.

**Planting:** Plant during July - August with a spacing of 7 x 7 m in pits of 60 cm x 60 cm x 60 cm. 8 x 3 m for Kaithali and 8 x 4 m for Banarasi.

**Irrigation:** Irrigate the plants initially for establishment. Provide 5 % slope towards the base of the tree for *in situ* water harvesting.

**Manures and fertilizers** (kg / plant / year)

Manures and Fertilizers	1 <sup>st</sup> year (kg)	2 <sup>nd</sup> year onwards (kg)
FYM	20.00	50.00
N	0.20	0.50
P	0.10	0.20
K	0.20	0.50

Manuring to be given immediately after pruning. Spray 2% KNO<sub>3</sub> thrice at monthly intervals in January, February and March.

**Training and Pruning:** Remove the root stock sprouts and have a straight stem upto 75 cm from the ground level. It is very important in the early years to build up a strong framework and in later years to maintain vigour to improve fruit size and quality. During February - March prune and thin the crowded branches to provide maximum fruit bearing area in the tree.

#### **Plant protection**

##### **Pests**

**Fruit fly: Destroy infested fruits.**

Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

.Neem oil @ 3.0 % as foliar spray as need based

##### **Scale insects:**

During pruning all the affected materials should be collected and burnt.

Spray quinalphos 25 EC @ 2.5 ml /lit of water

Leaf hopper: Spray chlorpyrifos 20 EC @1.5 ml per litre of water

## Diseases

**Black leaf spot:** Spray Carbendazim 1 g / lit or Chlorothalonil 2 g / lit or Propiconazole or Difenconazole 1 g / lit twice at 15 days interval from the initial appearance of the symptom.

**Powdery mildew:** Spray Dinocap 1 ml / litre

**Yield:** 70 - 80 kg of fruits / tree / year

**Seed Technology:** Seeds of Ber attain physiological maturity 13 weeks after anthesis. It is indicated by yellowish red colour of fruit pericarp. Stones can be size graded using 22 / 64" round perforated metal sieve. Ber stones can be stored upto 30 months without any treatment under ambient conditions.



## **Amla: *Phyllanthus emblica*; Euphorbiaceae**

**Varieties:** Banarasi, NA 7, Krishna, Kanchan, Chakaiya, BSR 1

**Soil and Climate:** Amla is a sub tropical plant and prefers dry climate. Hardy plant, it can be grown in variable soil conditions. Tolerates salinity and alkalinity.

**Planting material:** Seedlings, Grafts, Buddings

**Planting:** Plant during July - August with a spacing of 6 m x 6 m in pits of 1 m x 1 m x 1 m or 1.25 m x 1.25 m x 1.25 m.

**Irrigation:** Irrigate the plants initially for establishment. No irrigation is required during rainy and winter season. Drip irrigation is appropriate with water saving of 40-45%.

**Manures and fertilizers** (kg / plant / year)

Manures and Fertilizers	Bearing tree (kg)
FYM	10.00
N	0.20
P	0.50
K	0.20

Manuring to be given immediately after pruning.

**Training and Pruning:** The main branches should be allowed to appear at a height of 0.75-1 m above the ground level. Plants should be trained to modified central leader system. Two to four branches with wide crotch angle, appearing in the opposite directions should be encouraged in early years. During March – April, prune and thin the crowded branches to provide maximum fruit bearing area in the tree.

### **Plant protection**

#### **Pests**

##### **Gall caterpillar:**

Young caterpillars bore into the apical portion of the shoot during rainy season and make tunnel. Due to this, apical regrowth is checked, side shoots develop below the gall and subsequent growth in following season is greatly hampered. Cut the infected apices

##### **Bark eating caterpillar:**

Damages the stem and branches of grown up trees by eating bark. Affected portion should be cleared and a few drops of kerosene should be applied in holes to keep this in control.

#### **Disease**

**Rust:** Rust appear as circular reddish solitary or gregarious pustules on leaves and also on fruits. Spray 0.2 per cent Mancozeb at an interval of 7 to 28 days during July to September

**Yield:** 100 kg / tree annually

#### **Market information**

Growing Districts	Tirunelveli, Dindigul, Sivagangai, Thoothukudi
Major Markets in Tamil Nadu	Koyambedu market, Chennai, Ottanchathiram
Preferred Varieties and Hybrids	BSR 1, NA-7

## Chapter B

### Temperate Fruits

**Apple: *Malus sylvestris*; Rosaceae**

**Varieties:** Warm winter resistant varieties with low chilling requirements alone are suitable to the hills of Tamil Nadu.

**Early varieties:** Irish Peach and Zouches Pipin.

Yield: April - May.

**Mid season varieties:** Carrington and Winterstein.

Yield: June - July.

**Late varieties:** Rome Beauty, Parlin's Beauty and KKL 1.

Yield: August - September.

**Soil and Climate:** Red lateritic soils with good drainage and high organic matter are more suitable. The soil pH should be around 5.8 to 6.2. Can be grown from 1200 to 2000 m.

**Planting material:** One year old grafts on M.778 and M.779 rootstocks during June - July.

**Season:** June to December.

**Spacing:** 4 x 4 m in pits of 60 cm x 60 cm x 60 cm.

**Irrigation:** Water the plants till establishment.

**Application of fertilizer:** Apply FYM 25 kg. N 500 g and 1 kg in each of P and K per bearing tree.

**Training and Pruning:** The tree is trained to open center system. Prune the tree every December - January.

#### Plant Protection

##### Pests

**Wooly aphids:**

Use resistant rootstocks M 778, M 799, MM 104, MM 110, MM 112, MM 113, MM 114 and MM115.

The parasite *Aphelinus mali* and the coccinellid predators should be conserved in the field.

Apply carbofuran 3 % G @ 166 g/tree or phorate 10 % G @ 100 g/tree or spray any one of the following insecticide

Insecticide	Dose
Chlorpyrifos 20%EC	2.5 ml/lit.
Malathion 50%EC	1.0 ml/lit.
Oxydemeton -Methyl 25% EC	1.0 ml/lit.
Quinalphos 25%EC	2.0 ml/lit.

##### Disease

**Apple scab:** To control apple scabs follow the spray schedule:

1. Silver tip to green tip : Captafol or Mancozeb or 2 g / lit.
2. Pink bud or after 15 days : Mancozeb 2 g / lit.
3. Petal fall : Carbendazim 0.5 g / lit.
4. 10 days after petal fall : Mancozeb 2 g / lit.
5. 14 days after fruit set : Captafol 2 g / lit.



Add stickers like Triton AE or Teepol at 10 ml / 10 lit of spray fluid. Use low volume sprayers.

**Lichens:** Spray quick lime 1 kg / 20 lit of water after pruning to control lichens growth.

**Yield:** 10 - 20 kg / tree / year. The tree starts bearing from 4<sup>th</sup> year of planting.

Trade Mark of TNAU



**Pear: *Pyrus communis* L.; Rosaceae**

**Varieties:** Common pear, Kieffer, New Pear, William and Jargonelle.

**Soil and Climate:** Red laterite soil with good drainage and high organic matter content. Can be grown at an elevation of above 1200 m. pH 5.8 to 6.2.

**Planting material:** Plant one year old grafts / rooted cuttings.

**Planting season:** June - December.

**Spacing:** 5 x 5 m or 6 x 6 m in pits of 60 cm x 60 cm x 60 cm in size.

**Application of fertilizers:** Apply FYM 25 kg, N 500 g and 1 kg in each of P and K per bearing tree / year.

**Training and Pruning:** Remove stock sprouts regularly. Train the plants to open centre system and prune every year in November - December. Top working on country pear with choice varieties can be done during December - January with cleft grafting.

**Plant protection:** Prophylactic spraying with methyl demeton after pruning can be given.

**Harvest:** Early varieties will come to harvest in May - June and late varieties in July - October.

**Yield:** 100 to 120 kg per tree per year in common pear, 70 to 80 kg per tree per year in Kieffer and New Pear and 30 to 40 kg per tree per year in William and Jargonelle.



**Plum: *Prunus salicina* L. ; Rosaceae**

#### **Varieties**

**Early:** Rubio.

**Mid - season:** Hale, Gaviota and Abundance.  
(June - July)

**Late:** Shiro, Kelsey and Satsuma. Hale has to be planted along with other varieties to enhance pollination and fruit set (July – August).

**Soil and Climate:** Red lateritic soil with good drainage. The soil pH should be around 5.8 to 6.2 and rich in organic matter. Can be grown above 1200 m elevation.

**Planting material:** One year old budded plants may be planted during June - July or October - December with a spacing of 4 x 4 m in pits of 60 cm x 60 cm x 60 cm in size.

**Planting season:** June - November.

**Application of fertilizer:** Apply FYM 30 kg and 500 g of N and 1 kg in each of P and K for bearing tree during October – November.

**Training and Pruning:** The growing points tipped at a height of 50 – 60 cm to allow the side shoots to develop. Train to open centre system. Prune the trees during December – January. Dried, dead, diseased water shoots and criss-cross branches are removed.

#### **Plant protection**

##### **Pests**

**Fruit fly:** Set up methyl eugenol 1 % trap with malathion 50 EC 1 ml/lit between 6 a.m. and 8 a.m. Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

*Neem oil* @ 3.0 % as foliar spray as need based

**Yield:** 25 - 30 kg / tree / year.

**Peach: *Prunus persica*; Rosaceae**

**Varieties**

**Early:** Floridasun.  
(April - May)

**Mid season:** Shaw Pasand.  
(June - July)

**Late:** Red Shanghai.  
(July - August)

**Soil and Climate:** Red lateritic soil with good drainage and high organic matter is suitable. Grown at an elevation of 2000 m. Soil pH should be around 5.8 to 6.2.

**Planting material:** One year old budded plants.

**Planting season:** June - December.

**Spacing:** 4 x 4 m in pits of 60 cm x 60 cm x 60 cm.

**Manures and Fertilizers:** Apply FYM 25 kg. N 500 g and 1 kg in each of P and K per bearing tree.

**Training and Pruning:** Train to open centre system. The trees are pruned annually during December - January. Dried, diseased, water shoots and criss-cross branches may be removed.

**Plant protection**

**Lichens:** Against lichens growth, spray 1 kg of quick lime / 20 lit of water immediately after pruning.

**Pest**

**Fruit Fly:** Set up methyl eugenol 1 % trap with malathion 50 EC @ 2 ml/lit between 6 a.m. and 8 a.m.

Use polythene bags fish meal trap with 5 gm of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.

.Neem oil @ 3.0 % as foliar spray as need based

**Leaf curl aphids**

Apply carbofuran 3 % G @ 33 kg /ha or spray Oxydemeton -Methyl 25 % EC @ 1.0 ml per litre of water

**Diseases**

**Leaf curl:** To control aphids spray Methyl dimeton 25 EC @ 2 ml / lit.

**Powdery mildew:** Spray Carbendazim @ 0.5 g / lit or use Sulphur dust @ 25 kg / ha.

**Yield:** 10 - 15 kg / tree / year.

## Trade Mark of TNAU



## Chapter C

### Minor Fruits

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
1	2	3	4	5	6	7	8	9	10
Mangosteen ( <i>Garcinia mangostana</i> )	-	Seedlings	7 x 7 m	FYM, 75 kg N : 1 kg P : 0.8 kg & K : 3.0 Kg/treeJune - July.	Potting of plants at two leaf stage	-	April - June August - October	500 - 600 fruits / tree	-
Straw berry ( <i>Fragaria vesca</i> )	Phenomenal, Majestic, Chandler, Labella, Sujatha, Winter, Sweet charley	Runners/ Slips	40 x 25 cm(double row planting)	FYM : 3kg/m <sup>2</sup> N:8gP:8g and K:8 g/plant, apply during October and February	Removal of flower buds till Jan. Mulching with dry grass	Spray Methyl demeton against mealy bugs and aphids. Spray Copper fungicides against leaf diseases	Harvest at three months after planting	1 kg/m <sup>2</sup> or 10 t/ha	-
Passion fruit ( <i>Passiflora edulis</i> Sims.)	Purple for hills, yellow for plains cavery	Rooted cuttings or seedlings	2 x 2 m	FYM 10 kg, N 20 g, P 20 g and K 15 g/plant	Tying vine on trellies	Spray Methyl demeton against mealy bug and aphids	May - September	60 - 80 fruits/vine	Train on trellies or pandal.



Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Litchi ( <i>Litchi chinensis</i> Sonner.)	Muzafarpur, Dehradun, Calcutta, seedless late and Rose scented Cauvery Swarna roopa	Seedlings / Budded plants/layers	10 x 10 m	FYM : 60 kg, N:100 g, P:40 g and K:400 g for 10 year old tree. Apply N in two split doses in Feb. & April. FYM, P and K to be applied in Dec.	For Zinc deficiency spray Zinc sulphate (0.5%)	Spray dicofol 18.5 EC 2.5 ml/lit against mites. Use fumigants against bark borers	Harvest from 6th year onwards	80 - 100 kg/tree	
Bilimbi ( <i>Averrhoa bilimbi</i> )	-	Seedlings	-	N : 80 gP : 50 gK : 100 g/ bearing tree/year	-	-	-	50 kg/tree	-
Carambola ( <i>Averrhoa carambola</i> )	Sour and sweet	Seedlings	-	N : 100 g,P : 50 g andK : 100 g/Plant	-	-	-	-	-
Karonda ( <i>Carissa caranda</i> )	Green, pink, white	Seedlings & layers	2 x 2 m	FYM : 10 kg/ plant	Irrigation weekly	-	Aug-Sep	2 to 4 kg/tree	-
Loquat ( <i>Eriobotrya japonica</i> )	Mammoth, Safed batia, Golden red, Tanaka, California, Advance, Pale yellow, Golden yellow	Seedlings / Rooted cuttings / Grafts / Buddings	-	N : 50 g,P : 30 g,K : 150 g and Ca : 40 g per tree	-	-	Yield after third year	40 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Jamun ( <i>Eugenia jambolana</i> )	Local, Seedless, large	Seedlings/grafts	10 x 10 m	FYM : 20 kg, N : 100 g, P : 100 g and K : 100 g/tree	-	100 g Lindane 1.3 D pit against white ants	Yield 8 - 10 years after planting, harvest in June - July	50 - 80 kg/tree	-
Phalsa ( <i>Grewia asiatica</i> )	-	Seedlings / Rooted Cuttings / layers	2 x 2 m	N : 50 g, P : 20 g and K : 50 g/plant	Pruning at one m height; dormant during Dec - Jan. Irrigation once in 7 to 10 days in summer	-	Yield in third year pick ripe fruits on alternate days	2 - 3 kg/bush, fruits mature by May, June	-
Mulberry ( <i>Morus nigra</i> )	Black mulberry	Seedlings / Rooted cuttings / Budlings	Pits by 0.5 x 0.5 m at 7 m apart	FYM : or Tank silt 10 kg, N:50g, P:50 g and K:50 g per plant	Pruning in December - January	-	-	4 - 8 kg/tree	-
West Indian Cherry ( <i>Malpighia punicifolia</i> )	-	Seedlings/grafts / layers / rooted cuttings	2 x 2 m	FYM 10 kg, N:200 g, P:50 g and K:100 g/tree	Training and pruning	Spray Methyl demeton 2 ml/lit against mealy bugs and aphids	Harvest in Dec-Jan	10 - 15 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Annona ( <i>Annona squamosa</i> ;) ( <i>A. cherim noya</i> ; <i>A. reticulata</i> )	Balanagar, Mammoth, Atemoya, APK-1	Seedlings / grafts	5 x 5 m	FYM : 10 kg, neem cake one kg, BHC 10 % 100 g, N:250 g, P:125 g and K:250 g/treeApply 30 gm each of Azotobacter, VAM, Azospirillum, Phosphobacteria and 50% of 125:65:125 g N, P <sub>2</sub> O <sub>5</sub> , K <sub>2</sub> O per tree.	-	-	Yield after 4 - 5 years	80 - 100 Nos./tree	-
Lemon ( <i>Citrus limon</i> )	Malta, Nepali oblong, Nepali round, Rajamundry, Lisbon, Willafranka, Italin, Eureka, Seedless, Seville Mayor	Layers	5 x 5 m	FYM:30 kg N 400 g, P : 200 g and K : 300 g/tree twice in a year	-	Spraying Zinc, Manganese, Iron, Magnesium at 0.125 %	Harvest 1 1/2 to 2 years after planting	50 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Rambutan ( <i>Nephelium lappaceum</i> )	-	Layering and inarching on own root stock	7 x 10 m	-	-	-	Crops are obtained in September and December	10-20 kgs of fruits per tree.	-
Durian ( <i>Durio zebethinus</i> )	Specific varieties are not available	Seeds, Inarching on its own root stock as well as on seedling of <i>Cullenia excelsa</i>	10 x 10m, 12x 12 m	N - 38.3P - 8.2K - 20.9 kg/ha(bearing tree)	-	Dieldrin at 0.3-0.5% to control hawk moth.	August - September	40-50 fruits per tree	-
Avocado ( <i>Persea americana</i> )	TKD-1 Pollock, Fuelle and Peradenia Purple Hybrid	Inarching, soft wood grafting or budding on own root stock	5 x 5 m	40-45 kg FYM 1 kg urea 1kg Super phosphate	-	-	August-September	200-300 fruits/tree	-
Fig ( <i>Ficus carica</i> )	Capri fig, Smyrna fig, White San Pedro	Cuttings	4 x 4 m	36 kg FYM 2.25 kg Neem cake 680 g sulphate of Ammonia	-	Phosphotoxin 1 tablet /hole to control stem borer To control fig rust spray bordeaux mixture		10-12 kg/tree	-

Name of fruit with Botanical Name	Varieties	Method of propagation	Spacing	Manure and fertilizers	After cultivation (Spl. practices if any)	Plant protection	Harvest	Yield	Remarks
Persimmon ( <i>Diospyros kaki</i> )	Dai Dai Maru, Tanenashi, Martoria	Inarching on its own rootstock	5 x 5 m	-	Tipping past season shoots annually in December	-	-	20-25 kg /tree	-
Kiwi ( <i>Actinidia deliciosa</i> )	Abbott, Allison, Bruno, Hayward, Monty, Tomuri	Stem cuttings	6 x 6 m	20 kg FYM basal dose, 0.5 kg NPK mixture containing 15 % N is applied each year. After 4 years, N- 850-900gP - 500-600gK- 800-900g/vine	T baror Pergola system of training .Pruning in winter for 4-5 fruiting shoots at 4-5 bud interval between 2 such shoots	-	Harvest from 5th year onwards	50-100kg /vine	-
Apricot ( <i>Prunus americana</i> )	Alfred, Baiti, Beladi	Grafting or budding	6 x 6 m	40 kg FYMN- 500gP2O5- 250gK- 200g	Trained to open vase and modified leader system 25-30 % thinning of old shoots or 1/3 <sup>rd</sup> hedding	-	Harvest from 7th year onwards	50-80 kg / tree	-
Bread fruit ( <i>Artocarpus incise</i> )	-	Rootcuttings- .Air layeing	10 x 10 m	25 kg FYM7: 10 : 5 NPK mixure @ 1-2 kg/plant	-	Spray Bordeaux mixture 1 % to control	Harvest from 3rd year onwards Feb -- Mar-June- August	500-2000 fruits/ tree	-
Egg fruit ( <i>Pouteri campechian- a</i> )	-	Seeds, grafting, budding	6 x 6 m	-	-	-	Harvest from 3-4 year onwards	300-400 fruits/tree	-

# Part II

## Vegetables

### Chapter A

#### Fruit vegetables

**Tomato: *Solanum lycopersicum* L.; Solanaceae**

##### Varieties

PKM 1, CO 3 (Marutham) and Paiyur 1

##### Hybrids

COTH 2 and TNAU Tomato Hybrid CO 3

##### Soil

Well drained loamy soil rich in organic matter with a pH range of 6.5 - 7.5.

##### Season of sowing

May - June and November - December

##### Nursery bed preparation

Apply FYM 10 kg, Neemcake 1 kg, VAM 50 g, enriched Superphosphate 100 g and Furadon 10 g per square metre before sowing.

##### Seed rate

Varieties	: 300-350 g / ha
Hybrids	: 100-150 g / ha

##### Seed treatment

Treat the seeds with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 10 g or Carbendazim 2 g per kg of seeds 24 hours before sowing. Just before sowing, treat the seeds with *Azospirillum* @ 40 g / 400 g of seeds. Sow in lines at 10 cm apart in raised nursery beds and cover with sand.

##### Protected nursery

- ❖ Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- ❖ Cover the nursery area with 50 % shade net and cover the sides using 40/50 mesh insect proof nylon net.
- ❖ Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- ❖ Mix sterilized cocopeat @ 300 kg with 5 kg neem cake along with *Azospirillum* and Phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protrait. 238 protraits (98 cells) are required for the production of 23,334 seedlings, which are required for one hectare adopting a spacing of 90 x 60 x 60 cm in paired row system.



- ❖ Sow the treated seed in protrays @ one seed per cell.
- ❖ Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts
- ❖ After six days, place the protrays with germinated seeds individually on the raised beds inside the shade net
- ❖ Water with rosecan everyday and drench with NPK 19:19:19 @ 0.5% (5g/l) at 18 days after sowing

### Field preparation

Plough the land to fine tilth. Thoroughly prepare the field with the addition of FYM @ 25 t/ ha and form ridges and furrows at a spacing of 60 cm. Apply 2 kg/ha of *Azospirillum* and 2 kg/ha of Phosphobacteria by mixing with 50 kg of FYM. Irrigate the furrows and transplant 25 days old seedlings on the sides of ridges. Life irrigation to be given on 3<sup>rd</sup> day of planting.

### Spacing for varieties

PKM 1, Paiyur 1, COTH 2, TNAU Tomato Hybrid CO 3	: 60 x 45 cm
CO 3	: 45 x 30 cm

### Mulching

Mulch with black LDPE sheets of 25 micron thickness and bury both the ends into the soil to a depth of 10 cm

### Weed control

Apply Pendimethalin 1.0 kg a.i./ha or Fluchloralin 1.0 kg a.i / ha as pre-emergence herbicide, followed by hand weeding once at 30 days after planting.

### Irrigation

After establishment of seedlings, irrigate at weekly intervals.

### Layout and planting for drip irrigation & fertigation

- ❖ Apply FYM @ 25 t / ha as basal before last ploughing.
- ❖ Apply 2 kg/ha of *Azospirillum* and 2 kg/ha Phosphobacteria by mixing with 50 kg of FYM.
- ❖ Apply 75 % total recommended dose of superphosphate ie 1172 kg / ha as basal.
- ❖ Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- ❖ Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- ❖ Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of each bed.
- ❖ Before planting, wet the beds using drip system for 8-12 hrs.
- ❖ Planting to be done at a spacing of 90 x 60 x 60 cm in the paired row system, using ropes marked at 60 cm spacing.
- ❖ Spray Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i / ha as pre-emergence herbicide at 3<sup>rd</sup> day after planting.
- ❖ Gap filling has to be done at 7<sup>th</sup> day after transplanting.

## Manuring

### Varieties

Basal dose : FYM 25 t/ha, NPK 75:100:50 kg / ha  
Borax 10 kg and Zinc sulphate 50 kg / ha  
Top dressing : 75 kg N/ha on 30<sup>th</sup> day of planting or during earthing up.

### Hybrids

Basal dose : FYM 25 t/ha, NPK 50:250:100 kg/ha  
Borax 10 kg and Zinc sulphate 50 kg/ha  
Top dressing : N and K each 150 kg/ha in 3 equal splits at 30, 45 and 60 days after planting.

### Fertilization schedule for tomato hybrids

Recommended dose: 200:250: 250 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient applied			% of requirement		
					N	P	K	N	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 13:0:45 Urea (46%N)	65.78 27.77 8.44	12.50	12.50	12.50	10.00	5.00	10.00
					3.61	-	12.50			
					3.88	-	-			
2.	Flower initiation to flowering	30	12:61:0 13:0:45 Urea (46%N)	40.98 222.22 100.27	19.99	12.50	25.00			
					4.92	25.00	-	40.00	10.00	40.00
					28.89	-	100.00			
3.	Flowering to fruit set	30	19:19:19 13:0:45 Urea (46%N)	65.78 138.88 63.90	46.12	-	-			
					79.93	25.00	100.00			
					59.94	12.50	75.00			
4.	Alternate day from picking	80	12:61:0 13:0:45 Urea (46%N)	20.49 111.11 50.14	2.46	12.50	-	20.00	5.00	20.00
					14.44	-	50.00			
					23.06	-	-			
					39.96	12.50	50.00			
					199.82 or 200.00	62.50	250.00	100	25	100

75% of RD of P applied as superphosphate as basal application= 1172 kg/ha

1. 19:19:19 = 132 kg / ha
2. 12:61:0 = 62 kg / ha
3. 13:0:45 = 500 kg / ha
4. Urea = 223 kg / ha

### Growth regulators

- ❖ Spray 1.25 ppm (625 ml in 500 litres of water) Triaccontanol at 15 days after transplanting and at full bloom stage to increase the yield.

### Training of hybrids

- ❖ Stake the plants 30 days after planting with 1 - 1.5 m tall stakes.
- ❖ Remove the side branches up to 20 cm from ground level.

### Micronutrient spray

- ❖ Foliar spray of  $\text{ZnSO}_4$  @ 0.5 per cent thrice at 10 days interval from 40 days after planting.
- ❖ Spray 19:19:19 + Mn @ 1 % at 60 days after planting.

### Protected cultivation

#### Production practices for cultivation of tomato under shade net

During summer, the hybrid tomato can be grown in a shade level of 35 per cent under paired row planting system (80 x 40 x 60 cm - between pairs, rows and plants) with a basal application of 50 kg each of N and K and 250 kg of P / ha and fertigation of 200 kg each of N and K through straight fertilizers.

#### Protected cultivation of tomato in polyhouse

During rainy season, the indeterminate tomato hybrid has to be grown in the medium consisting of FYM : composted coir pith: sand (2:1:1) with irrigation regime of 20kPa and basal application of 50kg each of NPK/ha as straight fertilizers and 250 kg each of NPK as water soluble and straight fertilizers through fertigation along with black polyethylene mulch (50 microns)

### Plant protection

#### Pests

**Fruit borer:** *Helicoverpa armigera* and *Spodoptera litura* (common for both)

- Grow simultaneously 40 days old American tall marigold and 25 days old tomato seedlings @ 1:16 rows.
- Set up pheromone traps @ 12/ha.
- Collect and destroy damaged fruits and grown up caterpillars.
- Release *Trichogramma pretiosum* @ 1 lakh. /ha/release at an interval of 7 days starting from flower initiation stage.
- Release *Trichogramma chilonis* @ 50,000/ha/ release, coinciding with flowering time and based on ETL of 10% damage.
- For *Helicoverpa armigera*: H.a.NPV  $1.5 \times 10^{12}$  POBs/ha ie NPV of *H. armigera* 0.43% AS @ 3.0 ml/l or 2 % AS @ 1.0 ml per l
- For *Spodoptera litura*: S.l. NPV  $1.5 \times 10^{12}$  POBs/ha.
- Provide poison bait with carbaryl 50 WP 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 l/ha.
- Spray *Bacillus thuringiensis* 2g/l or any one of the following insecticide.

Insecticide	Dose
Azadirachtin 1.0 % EC (10000 ppm)	2.0 ml/ l
Indoxacarb 14.5 % SC	8 ml/10 l
Flubendiamide 20 WG	5 g/10 l
Flubendiamide 480 SC	2.5 ml/10 l
Novaluron 10 % EC	7.5 ml/10 l
Phosalone 35 % EC	13 ml/10 l
Quinalphos 20 % AF	1.5 ml/ l
Quinalphos 25 % EC	1.0 ml/ l

### Serpentine leaf miner

Spray Neem Seed Kernel Extract 5 %.

### Whitefly

1. Install yellow sticky traps @ 12 /ha to attract the adult.
2. Remove alternate weed host *Abutilon indicum*
3. Apply carbofuran 3 G @ 40 kg /ha or spray any one of the following insecticides

Insecticide	Dose
Dimethoate 30 % EC	1.0 ml/l.
Malathion 50 % EC	1.5 ml/ l.
Oxydemeton -Methyl 25 % EC	1.0 ml/ l.
Thiamethoxam 25 % WG	4.0 ml/10 l.

### Nematode

Soil application of *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* as seed treatment @ 10 g/kg of seeds and soil application (SA) @ 2.5 kg / ha for the management root knot and reniform nematode infestation in soil and root. Application of liquid formulation of *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* @ 1000 ml/ha through drip irrigation for the management of root knot nematode in tomato.

### Diseases

**Damping off** (nursery): Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g /kg of seed 24 hours before sowing. Apply *Pseudomonas fluorescens* through soil @ 2.5 kg/ha mixed with 50 kg of FYM. Avoid stagnation of water. Drench with Copper **Oxychloride at 2.5 g/l @ 4 l/sq.m.**

**Leaf spot:** Spray Zineb or Mancozeb @ 2 g/l.

**Fusarial wilt and Root knot nematode:** Soil solarization before preparation of nursery bed. Seed treatment with *Pseudomonas fluorescens* (PF) @ 10 g /kg of seed, followed by nursery application of Pf1@ 20 g/m<sup>2</sup> and seedling dip with Pf1 @ 5g/l along with soil application of Pf1 @ 2.5 kg mixed with 50 kg FYM /ha at 30 days of transplanting.

**Leaf curl:** Spray systemic insecticides like Methyl demeton or Dimethoate at 2 ml/l. to kill the insect vector, whitefly.

### Tomato spotted wilt virus:

Carbofuran 3 G @ 33 kg/ha in nursery at sowing and second application @ 40 kg /ha on 10 days after transplanting in main field and 3 sprays of phosalone 35 EC @ 1.5 ml/lit @ 25, 40, 55 days after transplanting.

**Peanut bud necrosis virus:** Selection of healthy seedlings and rouging of PBNV infected plants up to 45 days of planting. Apply Carbofuran 3 G 1 kg a.i./ha in nursery at sowing and second application at 1.25 kg a.i./ha 10 days after transplanting in mainfield and 3 sprays of Dimethoate 30 EC 1 ml/l or Methyl demeton 25 EC 1 ml/l or Phosphomidan 1.0 ml/l @ 25, 40 and 55 days after transplanting.

**Duration**

110- 115 days from transplanting (135 - 140 days from sowing)

**Yield**

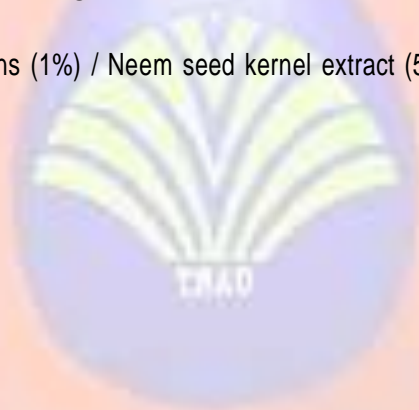
Varieties : 30-40 t / ha

Hybrids : 80-95 t / ha

Boom flower – N spray at 2ml / litre in three sprays – 30 days, 55 days and 75 days after planting increase the yield.

**IPM Package for Tomato**

- Seed treatment with *Pseudomonas fluorescens* @ 10g/kg of seeds
- Nursery application with *Trichoderma viride* and *Pseudomonas fluorescens*
- Application of Neem cake @ 250kg/ha
- Soil application of *Pseudomonas fluorescens* @ 2.5kg/ha
- Selection of good and virus disease free seedlings for planting
- Roguing out of virus infected plants upto 45 days of transplanting
- Grow marigold as a border crop
- Set up *Helicoverpa* / *Spodoptera* pheromone traps @ 12 numbers / ha
- Release *Trichogramma chilonis* @ 50000/ha
- Install yellow sticky traps
- Spraying Neem formulations (1%) / Neem seed kernel extract (5%)





## **Brinjal: *Solanum melongena* L. ; Solanaceae**

### **Varieties**

CO 2, MDU 1, PKM 1, PLR 1, PLR (B) 2, KKM 1, PPI 1, Annamalai and TNAU Brinjal VRM 1, hybrids coBH 2.

### **Soil**

Well drained soil rich in organic matter with pH of 6.5-7.5.

### **Season of sowing**

December - January and May - June

### **Nursery bed preparation**

Apply FYM 10 kg, neem cake 1 kg, VAM 50 g, enriched super phosphate 100 g and furadon 10 g per square metre before sowing. Area required for raising seedling for planting 1.0 ha is 100 sq.m.

### **Seed rate**

Varieties	: 400 g / ha
Hybrids	: 200 g / ha

### **Seed treatment**

Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g / kg of seed. Treat the seeds with *Azospirillum* @ 40 g / 400 g of seeds using rice gruel as adhesive. Irrigate with rose can. In raised nursery beds, sow the seeds in lines at 10 cm apart and cover with sand. Transplant the seedlings 30 – 35 days after sowing at 60 cm apart in the ridges.

### **Protected nursery**

- ❖ Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- ❖ Cover the nursery area with 50 % shade net and cover the sides using 40 / 50 mesh insect proof nylon net.
- ❖ Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- ❖ Mix sterilized cocopeat @ 300 kg with neem cake 5 kg along with *Azospirillum* and phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protray. 200 protrays are required for the production of 18,700 seedlings, which is required for one hectare adopting a spacing of 90 x 60 x 75 cm in paired row system.
- ❖ Sow the treated seeds in protrays @ 1 seed per cell.
- ❖ Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts.
- ❖ After 6 days, place the protrays with germinated seeds individually on the raised beds inside the shade net.
- ❖ Water with rose-can everyday and drench with 19:19:19 @ 0.5% (5g/l) at 18 days after sowing.



### Field preparation

Thoroughly prepare the field with the addition of FYM @ 25 t / ha and form ridges and furrows at a spacing of 60 cm. Apply 2 kg / ha of *Azospirillum* and 2 kg / ha of *Phosphobacteria* by mixing with 50 kg of FYM. Irrigate the furrows and transplant 30-35 days old seedlings at 60 cm apart on the ridges.

### Spacing

**Varieties** : 60 x 60 cm

**Hybrids** : 90 x 60 cm

### Mulching

Mulch with black LDPE sheets of 25 micron thickness and bury both the ends into the soil to a depth of 10 cm.

### Weed control

Apply Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i. / ha as pre-emergence herbicide, followed by hand weeding once at 30 days after planting.

### Irrigation

After establishment of seedlings, irrigate at weekly intervals.

### Layout and planting for drip irrigation and fertigation

- ❖ Apply FYM @ 25 t / ha as basal dose before last ploughing.
- ❖ Apply 2 kg/ha of *Azospirillum* and 2 kg/ha *Phosphobacteria* by mixing with 50 kg of FYM.
- ❖ Apply 75 % total recommended dose of superphosphate i.e. 703 kg / ha as basal.
- ❖ Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- ❖ Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- ❖ Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of the each bed.
- ❖ Before planting, wet the beds using drip system for 8-12 hrs.
- ❖ Planting to be done at a spacing of 90x60x75 cm in the paired row system, using ropes marked at 75 cm spacing.
- ❖ Spray Pendimethalin 1.0 kg a.i./ha or Fluchloralin 1.0 kg a.i/ha as pre-emergence herbicide at 3<sup>rd</sup> day after planting.
- ❖ Gap filling to be done at 7<sup>th</sup> day after transplanting.

### Manuring

Apply 2 kg each of *Azospirillum* and *Phosphobacteria* in the mainfield at planting.

### Varieties

Basal dose : FYM 25 t/ha, NPK 50:50:30 kg/ ha.

Top dressing : 50 kg N/ha on 30th day of planting or during earthing up.

### Hybrids

Basal dose : FYM 25 t/ha, NPK 100:150:100 kg/ha.

Top dressing : 100 kg N/ha on 30th day of planting or during earthing up.

### Fertigation schedule for hybrids

Recommended dose: 200:150: 100 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient applied			% of requirement		
					N	P	K	H	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 +MN 13:0:45 Urea	39.47	7.50	7.50	7.50	10.00	5.00	10.00
				5.50	0.70	-	2.50			
				25.65	11.80	-	-			
				Subtotal	20.00	7.50	10.00			
2.	Vegetative stage	30	12:61:0 13:0:45 Urea	24.50	2.94	15.00	40.00	40.00	10.00	40.00
				88.89	11.56	-	-			
				142.4	65.50	-	-			
				Subtotal	80.00	15.00	40.00			
3.	Flower initiation to first picking	30	19:19:19 +MN 13:0:45 Urea	39.47	7.50	7.50	7.50	30.00	5.00	30.00
				50.00	6.50	-	22.50			
				100.00	46.00	-	-			
				Subtotal	60.00	7.50	30.00			
4.	Harvesting	80	12:61:0 13:0:45 Urea	12.30	1.48	7.50	-	20.00	5.00	20.00
				44.40	5.80	-	20.00	-		
				71.13	32.72	-	-	-		
				Subtotal	40.00	7.50	20.00			
					200.00	37.50	100.00	100	25	100

75% RD of Phosphorus applied as superphosphate = 703 kg / ha.

1. 19:19:19 = 79 kg / ha
2. 13:0:45 = 189 kg/ ha
3. 12:61:0 = 37 kg / ha
4. Urea = 340 kg / ha

### Growth regulators

Spray 2 ppm (1 ml in 500 lit) Triacantanol plus Sodium Borate or Borax 35 mg/l of water 15 days after transplanting and at the time of full bloom to increase the yield.

### After cultivation

Hand weeding, top dressing and earthing up on 30<sup>th</sup> day of planting.

### Plant protection

#### Pests

#### Epilachna beetle

1. Collect the beetles, grubs, pupae and destroy.
2. Spray any one of the following insecticide

Insecticide	Dose
Azadirachtin 0.03 % WSP (300 ppm)	5.0 g/lit.
Quinalphos 20 % AF	1.7 ml/lit.
Triazophos 40 % EC	2.5 ml/lit.

### Whitefly

Monitor the whitefly with yellow sticky trap @ 12/ha. Spray Neem oil 3% plus Teepol 1 ml/lit or spray Neem Seed Kernel Extract 5 % or spray any one of the following insecticides.

Insecticide	Dose
Diafenthiuron 50 % WP	8.0 g/10 lit.
Phosphamidon 40 % SL	1.5 ml/lit.
Thiamethoxam 25 % WG	4.0 g/10 lit.

### Shoot & fruit borer

1. Remove the affected terminal shoot showing boreholes.
2. Remove the affected fruits and destroy.
3. Avoid using synthetic pyrethroids.
4. Spray Neem Seed Kernel Extract 5 % or any one of the following chemicals starting from one month after planting at 15 days interval

Insecticide	Dose
Azadirachtin 1.0% EC (10000 ppm)	3.0 ml/lit.
Azadirachtin 0.03 % WSP (300 ppm)	5.0 g/lit.
Chlorpyrifos 20 % EC	1.0 ml/lit.
Dimethoate 30 % EC	7.0 ml/10 lit.
Emamectin benzoate 5 % SG	4 g/10 lit.
Flubendiamide 20 WDG	7.5 g/10 lit.
Phosalone 35 % EC	1.5 ml/lit.
Quinalphos 20 % AF	1.7ml/ lit.
Quinalphos 25 % EC	1.5 ml/lit.
Thiodicarb 75 % WP	2.0 g/lit.
Thiometon 25 % EC	1.0 ml/lit.
Trichlorofon 50 % EC	1.0 ml/lit.
Triazophos 40 % EC	2.5 ml/lit.

**Aphid:** Release 1<sup>st</sup> instar larvae of Green lace wing predator (*Chrysoperla carnea*) @ 10,000/ ha. Apply phorate 10 % G @ 15 kg /ha or spray any one of the following insecticide.

Insecticide	Dose
Phosphamidon 40 % SL	1.5 ml/lit.
Thiometon 25 % EC	1.0 ml/lit.

### Red Spider mite:

Apply phorate 10 % G @15 kg /ha or spray any one of the following insecticide

Insecticide	Dose
Dicofol 18.5 % SC	2.0 ml/lit.
Spiromesifen 22.9 % SC	8.0 ml/10 lit.

## Diseases

**Damping off:** Treat the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* @ 10g /kg of seed 24 hours before sowing. Apply *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM. Stagnation of water should be avoided. Drench with Copper Oxchloride at 2.5 g/lit at 4lit /sq.m.

**Leaf Spot:** Spray Mancozeb @ 2 g/lit.

**Little Leaf:** Remove the affected plants in the early stages and spray dimethoate 30 EC @ 1.0 ml/lit. to control the vector.

## Yield:

Varieties : 25 - 30 t/ha  
Hybrids : 60 - 80 t/ha

## Market information

<b>Crop Growing districts</b>	Vellore, Salem, Krishnagiri, Dindigul, Coimbatore
<b>Major markets in Tamil Nadu</b>	Ottanchatram, Dindigul, Tirunelveli, Tuticorin and Nagercoil
<b>Grade Specification</b>	Colour, Size, Glossy, smooth and tender. Colour: light purple or dark purple, green, purple coloured with white stripes. Size: 25-30 cm long, oblong or round.

## IPM Package for Brinjal

- Seed treatment with *Trichoderma viride* (4g/kg) and *Pseudomonas* @ 10 g/ kg of seed
- Nursery + seedling dip treatment with *Pseudomonas* @ 10 g/ lit of water
- Soil application with Neemcake @250 kg/ha
- Maize as boarder crop against movement of whiteflies/ *Liriomyza*
- Use of yellow sticky traps against White flies and *Liriomyza*
- Clipping of shoot borer infested terminals
- *Leucinodes* adult monitoring with pheromone traps
- *Trichogramma* release after each brood emergence of *Leucinodes*
- Application of Neem oil formulations 10000ppm @1% / Neem seed kernel extract (5%)

## **Bhendi: *Abelmoschus esculentus* (L) Moench; Malvaceae**

### **Varieties**

Arka Anamika, Arka Abhay and Parbhani Kranti

### **Hybrid**

COBhH 1

### **Soil**

It is adaptable to a wide range of soils from sandy loam to clayey loam.

### **Season of sowing**

June - August and February

### **Seed rate**

<b>Varieties</b>	: 8.0 kg / ha
<b>Hybrids</b>	: 2.5 kg / ha

### **Seed treatment**

Seed treatment with *Tricoderma viride* @ 4 g/kg or *Pseudomonas fluorescens* @ 10 g/kg of seeds and again with 400 g of *Azospirillum* using starch as adhesive and dried in shade for 20 minutes. Sow three seeds per hill at 30 cm apart and then thin to 2 plants per hill after 10 days.

### **Field preparation**

Plough the land 4 - 5 times and form ridges and furrows at 45 cm apart.

### **Sowing**

Sow three seeds per hill at 30 cm apart and then thin to 2 plants per hill after 10 days.

**Spacing :** 45 x 30 cm

### **Layout and sowing for drip irrigation and fertigation**

- ❖ Apply FYM @ 25 t / ha as basal before last ploughing.
- ❖ Apply 2 kg/ha of *Azospirillum* and 2 kg/ha Phosphobacteria by mixing with 50 kg of FYM.
- ❖ Apply 75 % total recommended dose of super phosphate ie 469 kg / ha as basal.
- ❖ Form raised beds of 120 cm width at an interval of 30 cm.
- ❖ Install the drip irrigation with main and sub main pipes and place lateral tubes at the centre of the each bed at an interval of 1.5 m.
- ❖ Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- ❖ Before planting, wet the beds using drip system for 8-12 hrs.
- ❖ Sowing to be done at a spacing of 90 x 45 x 45 cm in the paired row system, using ropes marked at 45 cm spacing.
- ❖ Spray Oxyflourfen at 0.15 kg ai / ha or Fluchloralin @ 1.0 kg ai / ha or Metolachlor @ 0.75 kg a.i / ha as pre emergence application on third day of sowing.
- ❖ Gap filling to be done at 7<sup>th</sup> day after transplanting.

### **Irrigation**

After germination, irrigate at weekly intervals.

### Application of fertilizers

Apply *Azospirillum* and *Phosphobacteria* each at 2 kg/ha mixed with 100 kg of FYM before sowing.

### Varieties

Basal dose FYM @ 25 t/ha, N @ 20 kg, P @ 50 kg and K @ 30 kg/ha as basal and 20 kg N/ha at 30 days after sowing.

### Hybrids

Basal dose FYM @ 40 t / ha, N @ 100 kg, P @ 100 kg and K @ 100 kg/ha as basal and 100 kg N / ha 30 at days after sowing.

### Foliar nutrition

1 % urea (10 g/l) + muriate of potash (10 g/l) on 30 and 45 days after planting.  
For hybrids, foliar application of water soluble fertilizer 19-19-19 three times @ 0.5% (5 g/l) at 10 days interval from 30 days after planting.

### Fertigation schedule for hybrids

Recommended dose: 200:100: 100 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient applied			% of requirement		
					N	P	K	H	P	K
1.	Sowing to plant establishment stage	10	19:19:19 +MN 13:0:45 Urea	26.30	7.50	5.00	5.00	10.00	5.00	10.00
				5.50	11.10	-	5.00			
				25.65	29.48	-	-			
				Subtotal	20.00	5.00	10.00			
2.	Flower initiation to flowering stage	30	12:61:0 13:0:45 Urea	16.39	1.97	10.00	-	30.00	10.00	30.00
				88.88	11.55	-	40.00			
				144.52	66.48	-	-			
				Subtotal	80.00	10.00	40.00			
3.	Flowering to fruit set	30	19:19:19 +MN 13:0:45 Urea	26.30	5.00	5.00	5.00	30.00	5.00	30.00
				55.55	7.22	-	25.00			
				103.87	47.78	-	-			
				Subtotal	60.00	5.00	30.00			
4.	Alternate days from picking	30	12:61:0 13:0:45 Urea	8.20	0.98	5.00	-	30.00	5.00	30.00
				44.44	5.78	-	20.00	-		
				72.26	33.24	-	-	-		
				Subtotal	40.00	5.00	20.00			
	Total duration	100			200.00	25.00	100.00	100	25	100

75% RD of Phosphorus applied as super phosphate = 469 kg/ha.

- 1. 19:19:19 = 54 kg / ha
- 2. 13:0:45 = 200 kg / ha
- 3. 12:61:0 = 25 kg / ha
- 4. Urea = 350 kg / ha



### Weed control

Spray Oxyflourfen @ 0.15 kg ai/ha or Fluchloralin @ 1.0 kg ai / ha or Metolachlor @ 0.75 kg a.i / ha as pre emergence application on third day after sowing. Herbicide application should be integrated with hand weeding once on 30 days after sowing.

### Plant protection

#### Pests

##### Fruit borers

##### Integrated pest management

1. Set up pheromone trap @ 12 / ha.
2. Collect and destroy affected fruits.
3. Release egg parasite *Trichogramma chilonis* @ 1.0 lakh / ha.
4. Release 1<sup>st</sup> instar larvae of green lace wing predator *Chrysoperla carnea* @ 10,000/ha.
5. Dust carbaryl 10 % DP @ 25 kg / ha or spray *Bacillus thuringiensis* @ 2 g/l or spray any one of the following insecticide:

Insecticide	ml or g / l.
Azadirachtin 0.03% WSP (300 ppm)	5.0 g / l.
Azadirachtin 5% Neem Extract Concentrate	5.0 ml /10 l.
Emamectin benzoate 5 % SG	3.0 g /10 l.
Phosalone 35 % EC	1.5 ml / l.
Pyridalyl 10 % EC	1.0 ml / l.
Quinalphos 20 % AF	1.5 ml / l.
Quinalphos 25 % EC	8.0 ml /10 l.

##### Leaf hopper

Treat the seeds with imidacloprid 48 % FS or 70 % WS @ 7 g / kg or Thiamethoxam 70 % WS @ 2.8 g / kg of seed.

Dust carbaryl 5 % DP @ 20 kg /ha or carbaryl 10 % DP @ 25 kg /ha or apply carbofuran 3 % G @ 33 kg /ha or spray any one of the following insecticides.

Insecticide	ml or g / l.
Imidacloprid 70% WG	0.7 g /10 l.
Imidacloprid 17.8% SL	2 ml/10 l.
Thiamethoxam 25%WG	1.0 g /10 l.
Azadirachtin 0.03% WSP	5.0 g / l.
Azadirachtin 5% Neem Extract Concentrate	5.0 ml /10 l.
Dimethoate 30 % EC	2.0 ml / l.
Malathion 50 % EC	1.25 ml / l.
Oxydemeton - Methyl 25 % EC	1.6 ml / l.
Quinalphos 25 % EC	1.0 ml / l.

##### Diseases

**Yellow vein mosaic virus:** Spray systemic insecticides like Methyl demeton or Dimethoate @ 2 ml / l to kill the insect vector, whitefly.

**Powdery mildew:** Dust Sulphur 25 kg / ha or spray Dinocap 2 ml / l or Tridemorph 0.5 ml / l or Carbendazim 1 g / l or Wettable sulphur 2 g / l or Triademephon 0.5g / l immediately after noticing the disease and repeat after 15 days if necessary.

**Yield**

12 - 15 t / ha

**Market information**

Crop Growing districts	Vellore, Salem, Coimbatore, Dindigul
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	Light green or dark green, hairy or tender smooth surface, 5-ridged and remain tender for a longer period, medium length.

**IPM practices Package for Bhendi**

- Seed treatment with *Trichoderma viride* (4g/kg) and *Pseudomonas* (10 g/ kg)
- Soil application of *Pseudomonas* and *Trichoderma* (each 2.5kg/ha)
- Soil application with Neem cake @250 kg/ha
- Maize as border crop against movement of whiteflies/ *Liriomyza*
- Use of yellow sticky traps
- Periodical removal of yellow vein mosaic virus infected plants
- *Helicoverpa* and *Earias* adult monitoring with pheromone traps
- *Trichogramma* release after each brood emergence of *Helicoverpa* and *Earias*
- Application of Neem oil formulations 10000ppm @1% / Neem seed kernel extract (5%)

## Chillies: *Capsicum annuum* L.; Solanaceae

### Varieties

K 1, K 2, CO 2, CO 4 (vegetable type), PKM 1, PMK 1 (for semi-dry conditions in Southern Districts), PLR1 (for coastal regions of North - East Tamil Nadu) and KKM (Ch) 1.

### Hybrids

TNAU Chilli Hybrid CO 1

**Soil :** Well drained loamy soil rich in organic matter with pH range 6.5-7.5.

**Season of sowing :** January - February, June - July and September - October

### Seed rate

Varieties	: 1.0 kg / ha.
Hybrids	: 200 - 250 g / ha.
Nursery area	: 100 sq.m / ha.

### Seed treatment

Treat the seeds with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g/ kg and sow in lines spaced at 10 cm in raised nursery beds and cover with sand. Watering with rose can has to be done daily. Drench the nursery with Copper oxychloride @ 2.5 g/l of water at 15 days interval against damping off disease. Apply Carbofuran 3 G at 10 g/sq.m. at sowing.

### Protected nursery

- ❖ Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- ❖ Cover the nursery area with 50 % shade net and cover the sides using 40 / 50 mesh insect proof nylon net.
- ❖ Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- ❖ Mix sterilized cocopeat @ 300 kg with 5 kg neem cake along with *Azospirillum* and phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protay. 300 protrays (98 cells) are required for the production of 29,000 seedlings, which are required for one hectare adopting a spacing of 90 x 60 x 45 cm in a paired row system.
- ❖ Sow the treated seed in protrays @ 1 seed per cell.
- ❖ Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts.
- ❖ After 6 days place the protrays with germinated seedlings individually on the raised beds inside the shade net .
- ❖ Water with rose can everyday upto seed germination. Drench with 19:19:19 @ 0.5% (5g/l) at 18 days after sowing.

### Field preparation

Thoroughly prepare the field with the addition of FYM @ 25 t/ ha and form ridges and furrows at a spacing of 60 cm. Apply 2 kg/ha of *Azospirillum* and 2 kg / ha of Phosphobacteria by mixing with 20 kg of FYM. Irrigate the furrows and transplant 40-45 days old seedlings, with the ball of earth on the ridges.

**Spacing**

Varieties	: 60 x 45 cm
Hybrids	: 75 x 60 cm

**Weed control**

Apply Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i. / ha as pre-emergence herbicide followed by hand weeding once 30 days after planting.

**Irrigation**

Irrigate at weekly intervals.

**Layout and planting for drip irrigation and fertigation**

- ❖ Apply FYM @ 25 t / ha as basal before last ploughing.
- ❖ Apply 2 kg / ha of *Azospirillum* and 2 kg/ha Phosphobacteria by mixing with 20 kg of FYM.
- ❖ Apply 75 % total recommended dose of superphosphate *i.e.* 375 kg / ha as basal.
- ❖ Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- ❖ Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- ❖ Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of the each bed.
- ❖ Before planting wet the beds using drip system for 8-12 hrs.
- ❖ Planting to be done at a spacing of 90 x 60 x 45 cm in the paired row system, using ropes marked at 60 cm spacing.
- ❖ Spray Pendimethalin 1.0 kg a.i. / ha or Fluchloralin 1.0 kg a.i. / ha as pre-emergence herbicide at 3<sup>rd</sup> day after planting.
- ❖ Gap filling to be done at 7<sup>th</sup> day after transplanting.

**Manuring****Varieties**

Basal dose	: FYM 25 t/ha, NPK 30:60:30 kg/ ha. Potassium as K <sub>2</sub> SO <sub>4</sub> for quality improvement. Application of potassium in the form of potassium sulphate will increase quality of chilli.
Top dressing	: 30 kg N/ha in equal splits on 30, 60 and 90 days after planting.

**Hybrids**

Basal dose	: FYM 30 t / ha, NPK 30:80:80 kg / ha.
Top dressing	: 30 kg N / ha in equal splits on 30, 60 and 90 days after planting.

**Fertigation schedule****CHILLI F1 HYBRID**

Recommended Dose: 120:80:80 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient supplied			% requirement		
					N	P	K	H	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 MN 13:0:45 Urea	21.05	4.00	4.00	4.00	10.00	5.00	10.00
				8.88	1.15	-	3.98			
				14.86	6.83	-	-			
				Subtotal	11.98	4.00	7.98			
2.	Flower initiation to flowering	30	12:61:0 13:0:45 Urea	13.11	1.57	8.00	-	30.00	10.00	20.00
				71.04	9.24	-	31.97			
				80.72	37.13	-	-			
				Subtotal	47.94	8.00	31.97			
3.	Fruit set to first picking	30	19:19:19 13:0:45 Urea	21.05	4.00	4.00	4.00	30.00	5.00	20.00
				44.40	5.77	-	19.98			
				56.91	26.18	-	-			
				Subtotal	35.95	4.00	23.98			
4.	Alternate day from picking	80	12:61:0 13:0:45 Urea	6.52	0.75	3.81	-	30.00	5.00	50.00
				35.52	4.62	-	15.98			
				40.38	18.57	-	-			
				Subtotal	23.94	3.81	15.98			
					119.81 (or) 120.00	19.81 (or) 20.00	79.91 (or) 80.00	100.00	25.00	100.00

75% RD of Phosphorous applied as superphosphate = 375 kg / ha

1. 19:19:19 = 42 kg/ha
2. 13:0:45 = 160 kg/ha
3. 12:61:0 = 20 kg/ha
4. Urea = 193 kg/ha

**Effect of Endo root soluble and Mycorrhizae on Chilli**

Apply 250g of Endo Roots Soluble in two splits doses at 15 DAT and 45 DAT along with 100 % N and K and 50% P for higher yield and saving of Phosphorous.

Apply 250g of Mycorrhiza in two splits at transplanting and 30 DAT along with 100% N and K and 50% P for higher yield and saving of Phosphorous.

**Growth regulators**

- ❖ Spray Triacantanol @ 1.25 ml/l on 20, 40, 60 and 80<sup>th</sup> day of planting. Spray NAA 10 ppm (10 mg/l of water) on 60 and 90 days after planting to increase fruit set.

**Micronutrient spray**

- ❖ Foliar spray of Zn SO<sub>4</sub> @ 0.5 per cent thrice at 10 days interval from 40 days after planting.
- ❖ Spray 19:19:19 + Mn @ 1 % at 60 days after planting.

## Weed control

Spray Fluchloralin @ 1 lit a.i./ha or Pendimethalin @ 1 kg a.i./ ha. or Oxyflourfen @ 0.15 kg a.i./ha as pre-emergence herbicide and may be combined with hand weeding once and earthing up 45 days after planting. Raise intercrop of onion in paired row system to get additional income.

## Plant protection

### Pests

**Fruit borer:** Integrated pest management of fruit borer:

1. Set up pheromone traps for *Helicoverpa armigera* / *Spodoptera litura* @ 12 no. / ha.
2. Collection and destruction of damaged fruits and grown up caterpillars.
3. Spray *Bacillus thuringiensis* @ 2 g / lit.
4. Provide poison bait with carbaryl 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 lit / ha or spray any one of the following insecticide.

Insecticide	Dose
Emamectin benzoate 5 % SG	4 g/10 lit.
Fipronil 5 % SC	2.0 ml /lit.
Flubendiamide 20 WDG	6.0 g /10 lit.
Flubendiamide 480 SC	2.5 ml /lit
Indoxacarb 14.5 % SC	6.5 ml /10 lit.
Novaluron 10 % EC	7.5 ml /10 lit.
Spinosad 45 % SC	3.2 ml /10 lit.
Thiodicarb 75 % WP	2.0 g /lit.

### Thrips:

- Grow Agathi as Intercrop.
- Treat seeds with imidacloprid 70% WS @ 12 g /kg of seed.
- Apply carbofuran 3% G @ 33 kg /ha or phorate 10 % G @ 10 kg/ha or spray any one of the following insecticide.

Insecticide	Dose
Imidacloprid 17.8 % SL	3.0 ml /10 lit.
Dimethoate 30 % EC	1.0 ml /lit.
Emamectin benzoate 5 % SG	4 g /10 lit.
Ethion 50 % EC	2.0 ml /lit.
Fipronil 5 % SC	1.5 ml /lit.
Oxydemeton -Methyl 25 % EC	1.0 ml /lit.
Phosalone 35 % EC	2.0 ml /lit.
Spinosad 45 % SC	3.2 ml /10 lit.
Thiacloprid 21.7 % SC	6.0 ml /10 lit.

### Aphids:

- Treat seeds with imidacloprid 70% WS @12 g /kg of seed.
- Apply phorate 10 % G @ 10 kg/ha or spray any one of the following insecticide.



Insecticide	Dose
Carbosulfan 25 % EC	1.0 ml /lit.
Fipronil 5 % SC	1.0 ml /lit.
Imidacloprid 17.8 % SL	3.5 ml /10 lit.
Oxydemeton - Methyl 25% EC	1.6 ml /lit.
Phosalone 35 % EC	2.0 ml /lit.
Quinalphos 25 % Gel	1.0 ml /lit.
Quinalphos 25 % EC	1.0 ml /lit.

#### Yellow Murrain mite:

Apply phorate 10 % G @ 10 kg/ha or spray any one of the following insecticide:

Insecticide	Dose
Buprofezin 25 % SC	8.0 ml /10 lit.
Diafenthiuron 50 % WP	8.0 g /10 lit.
Dimethoate 30 % EC	1.0 ml /lit.
Ethion 50 % EC	2.0 ml /lit.
Fenazaquin 10 % EC	2.0 ml /lit.
Fenpyroximate 5 % EC	1.0 ml /lit.
Hexythiazox 5.45 % EC	8.0 ml /10 lit.
Milbemectin 1 % EC	6.5 ml /10 lit.
Oxydemeton -Methyl 25 % EC	2.0 ml /lit.
Phosalone 35 % EC	1.3 ml /lit.
Propargite 57 % EC	2.5 ml /lit.
Quinalphos 25 % EC	1.5 ml /lit.
Spiromesifen 22.9 % SC	5.0 ml /10 lit.

#### Aphids and Thrips:

Spray neem oil 1% or neem cake extract 5% to control aphids and thrips.

#### Diseases

**Damping off:** Treat the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g /kg of seed 24 hours before sowing. Apply *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM. Stagnation of water should be avoided. Drench with Copper oxychloride at 2.5 g /lit at 4 lit /sq.m.

**Leaf spot:** Spray Mancozeb @ 2 g/lit or Copper oxychloride @ 2.5 g/lit.

**Powdery mildew:** Spray Wettable sulphur @ 3 g/lit or Carbendazim @ 1 g/lit, 3 sprays at 15 days interval from the first appearance of symptom.

**Die-back and fruit rot:** Spray Mancozeb 2 g/lit or Copper oxychloride @ 2.5 g/lit thrice at 15 days interval starting from noticing the die-back symptoms.

**Chilli mosaic:** Raise 2 rows of maize or sorghum for every 5 rows of chilli crop against wind direction. Spray recommendations given for controlling the vector.

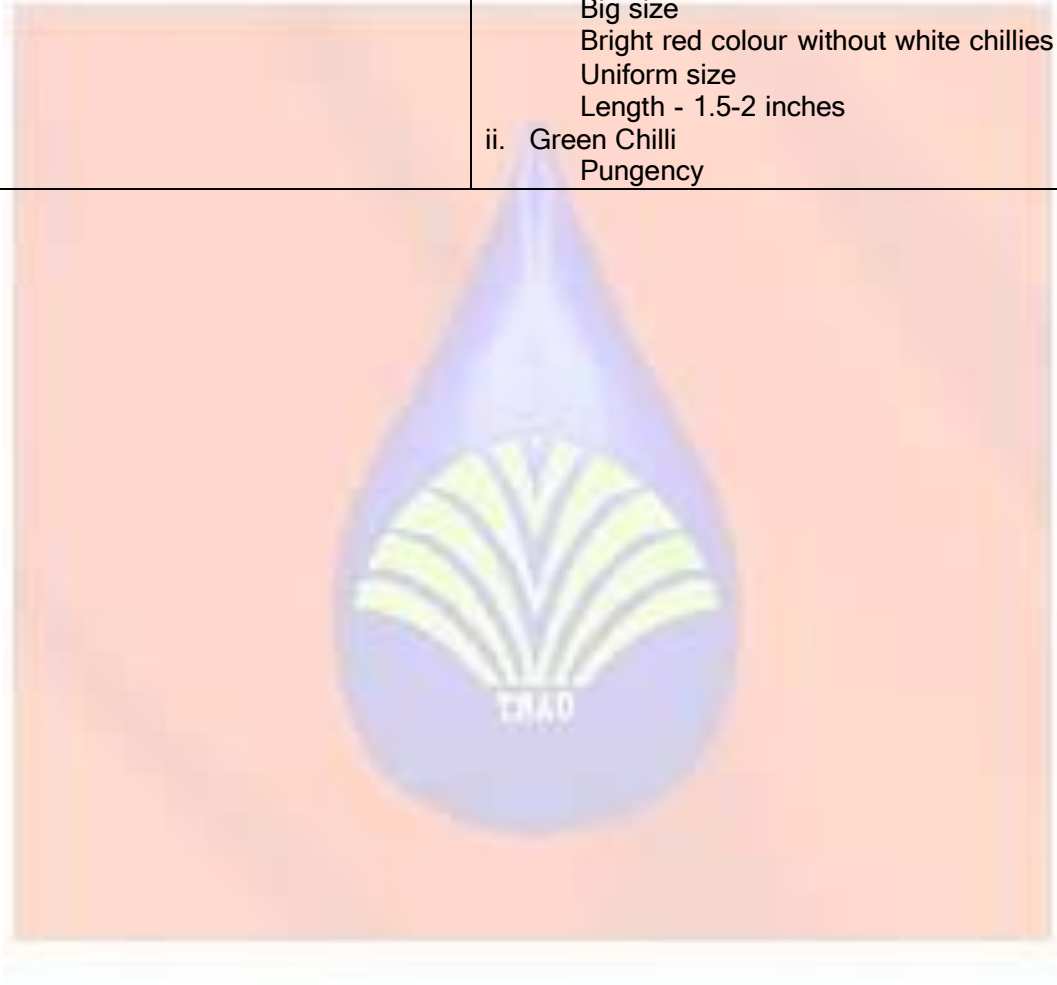
#### Yield

Varieties : 2 - 3 t/ha of dry pods or 10 - 15 t/ha of green chillies.

Hybrids : 25 t / ha of green chillies.

### Market information

Crop Growing districts	Ramanathapuram (samba), Thoothukudi (gundu), Sivagangai (samba), Virudhunagar (samba), Tirunelveli (samba)
Major markets in Tamil Nadu	Virudhunagar, Chennai, Ramanad, Paramkudi, Thoothukudi
Grade Specification	<p>i. Dry Chilli</p> <p>Well dried -12 % moisture</p> <p>Big size</p> <p>Bright red colour without white chillies</p> <p>Uniform size</p> <p>Length - 1.5-2 inches</p> <p>ii. Green Chilli</p> <p>Pungency</p>



## **Capsicum (Sweet pepper / Bell pepper): *Capsicum annuum* ; Solanaceae**

**Varieties** : Arka Basant, Arka Gaurav, Arka Mohini, Green Gold, Bharath.

**Soil** : Well drained loamy soil rich in organic matter.

**Season of sowing** : September - February

### **Seed rate**

**Varieties** : 1.25 kg/ha

**Hybrids** : 200 g / ha

**Nursery** : 3 cents /ha

Treat the seeds with of Carbendazim @ 2 g /kg of seed and sow in lines across the bed at a spacing of 2.5 cm and then cover with top soil and then paddy straw. Watering with rose can has to be done daily. On 20<sup>th</sup> day of sowing, 300g of carbofuran 3G granules have to be applied in between the seedling lines across the bed, the soil has to be stirred and then the beds are irrigated.

### **Protected nursery**

- ❖ Prepare the nursery area of 3 cents with slanting slope of 2 % for the seedling production to cover 1 ha.
- ❖ Cover the nursery area with 50 % shade net and cover the sides using 40/50 mesh insect proof nylon net.
- ❖ Form raised beds of 1 m width and convenient length and place HDPV pipes at 2m interval for further protection with polythene sheets during rainy months.
- ❖ Mix sterilized cocopeat @ 300 kg with 5 kg neem cake along with *Azospirillum* and phosphobacteria each @ 1 kg. Approximately 1.2 kg of cocopeat is required for filling one protray. 238 protrays (98 cells) are required for the production of 23,334 seedlings, which are required for one hectare adopting a spacing of 90 x 60 x 60 cm in a paired row system.
- ❖ Sow the treated seed in protrays @ 1 seed per cell.
- ❖ Cover the seed with cocopeat and keep the trays one above the other and cover with a polythene sheet till germination starts.
- ❖ After 6 days, place the protrays with germinated seeds individually on the raised beds inside the shade net.
- ❖ Water with rose-can everyday and drench with 19:19:19 @ 0.5% (5g/l) at 18 days after sowing.

### **Preparation of field**

Plough the field to a fine tilth. Form ridges and furrows 45 or 60 cm apart. Transplant 40-45 days old seedlings at 30 cm spacing.

### **Irrigation**

Irrigation at weekly or 10 days interval.

### Layout and planting for drip irrigation and fertigation

- ❖ Apply FYM @ 25 t / ha as basal before last ploughing.
- ❖ Apply 2 kg/ha of *Azospirillum* and 2 kg/ha of Phosphobacteria by mixing with 20 kg of FYM.
- ❖ Apply 75 % total recommended dose of super phosphate ie 703 kg / ha as basal.
- ❖ Install the drip irrigation with main and sub main pipes and place lateral tubes at an interval of 1.5 m.
- ❖ Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.
- ❖ Form raised beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of the each bed.
- ❖ Before planting, wet the beds using drip system for 8-12 hrs.
- ❖ Planting to be done at a spacing of 90 x 60 x 60 cm in the paired row system, using ropes marked at 60 cm spacing.
- ❖ Spray Pendimethalin 1.0 kg a.i. /ha or Fluchloralin 1.0 kg a.i./ha as pre-emergence herbicide at 3<sup>rd</sup> day after planting.
- ❖ Gap filling to be done at 7<sup>th</sup> day after transplanting.

### Application of fertilizers

Apply FYM 25 t/ha and NPK 40:60:30 kg /ha as basal and 40 kg N/ha each on 30, 60 and 90 days of planting as top dressing.

### Fertigation schedule for capsicum F1 Hybrid

Recommended dose: 250:150:150 kg / ha

Stage	Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)	Nutrient supplied			% requirement		
					N	P	K	N	P	K
1.	Transplanting to plant establishment stage	10	19:19:19 MN 13:0:45 Urea	39.47	7.50	7.50	7.50	10.00	5.00	10.00
				16.66	2.16	-	7.50			
				33.28	15.30	-	-			
				Subtotal	24.96	7.50	15.00			
2.	Vegetative stage	30	12:61:0 13:0:45 Urea	24.60	2.95	15.00	-	30.00	10.00	20.00
				133.33	17.33	-	60.00			
				173.00	79.58	-	-			
				Subtotal	99.86	15.00	60.00			
3.	Flower initiation to first picking	30	19:19:19 13:0:45 Urea	39.47	7.50	7.50	7.50	20.00	5.00	20.00
				83.33	10.83	-	37.50			
				122.97	56.57	-	-			
				Subtotal	74.90	7.50	45.00			
4.	Harvesting stage	95	12:61:0 13:0:45 Urea	12.30	1.48	7.50	-	40.00	5.00	50.00
				66.66	8.67	-	30.00			
				86.51	39.79	-	-			
				Subtotal	49.94	7.50	30.00			
	Total	165			249.66 (or) 250.00	37.50	150.00	100.00	25.00	100.00

75% RD of Phosphorous applied as super phosphate = 703 kg / ha

- |    |          |   |            |
|----|----------|---|------------|
| 1. | 19:19:19 | = | 79 kg /ha  |
| 2. | 13:0:45  | = | 300 kg /ha |
| 3. | 12:61:0  | = | 37 kg /ha  |
| 4  | Urea     | = | 416 kg /ha |

#### **Weed control**

On 30<sup>th</sup> day, hoeing and weeding has to be done once and the plants are earthed up.

#### **Growth regulator**

Spray 1.25 ppm Triaccontanol (12.5 mg /10 l of water) on 20<sup>th</sup>, 40<sup>th</sup>, 60<sup>th</sup> and 80<sup>th</sup> day after transplanting. Spray NAA 10 ppm (10 mg/l of water) on 60 and 90 days after planting.

#### **Diseases**

**Powdery mildew:** Spray wettable sulphur @ 2g /l

**Dieback and fruit rot:** Spray Mancozeb @ 2g /l

#### **Harvest and yield**

Harvest fully matured green fruits before ripening. Yield: 15 tonnes/ha in 150-160 days.

Trade Mark of TNAU



**Paprika: *Capsicum annuum* var. *grossum*; Solanaceae**

**Varieties** : KTPL-19

**Soil**

Well-drained sandy loam or clay saline free soil is preferable. It can be grown on any fertile well-drained soil suitable for chillies cultivation with pH 6.5 - 7.0.

**Season of sowing** : June - July.

**Seed rate** : 500 g/ha.

**Spacing** : 60 x 45 cm

**Nursery**

Prepare 10 - 12 beds of 7 m long 1.2 m wide and 15 cm height and sow the seeds in rows 10 cm apart on 0.5 cm deep. Apply 15 - 20 kg well decomposed compost and 500 g of 15:15:15 NPK complex fertiliser to each bed 15 to 20 days before sowing.

**Transplanting**

Healthy seedlings may be transplanted at a spacing of 45 cm apart.

**Application of fertilizers**

Apply FYM 20 - 25 tonnes / ha, 60, 100 and 60 kg NPK / ha as basal, 20 kg N and 20 kg K three weeks after transplanting and 40 kg N and 40 kg K / ha six weeks after transplanting as top dressing.

**Diseases**

**Anthracnose:** Spray Mancozeb 2 g/l.

**Fruit rot:** Spray Copper oxychloride @ 2.5 g/l.

**Powdery mildew:** Spray Wettable sulphur @ 0.3%.

**Yield:** 25 - 35 t/ha.



## **Pumpkin: *Cucurbita moschata* Poir.; Cucurbitaceae**

**Varieties:** CO 1, CO 2, Arka Suryamuki and Arka Chandan.

### **Soil**

Sandy loam rich in organic matter and with good drainage. The pH range from 6.5-7.5 is found ideal.

**Season and sowing:** June- July and December- January.

Soak the seeds in double the quantity of water for 30 minutes and incubate for 6 days. Sow the seeds (3 seeds/pit) treated with *Azospirillum* just before sowing and thin the seedlings to two per pit after 15 days.

**Seed rate:** 1.0 kg /ha.

**Spacing:** 2 m x 2 m. Pit size 30 cm x 30 cm x 30 cm.

### **Application of fertilizers**

Apply 10 kg of FYM (20 t/ha) and 100 g of NPK 6:12:12 mixture as basal and 10 g of N per pit after 30 days of planting. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha such and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

### **After cultivation**

Hoe and weed thrice. Spray Ethrel 250 ppm (2.5 ml per 10 l of water) four times at weekly intervals commencing from 10 to 15 days after sowing.

### **Quality seedling production**

#### **Nursery raising**

In hi-tech horticulture, use 12 days old healthy seedlings obtained from shade net houses for planting. Raise the seedlings in protrays having 98 cells. Use well decomposed cocopeat as medium. Sow one seed per cell. Water regularly twice a day.

#### **Fertigation**

Apply a dose of 60:30:30 kg NPK/ha throughout the cropping period through split application. Apply 75% of the phosphorus as superphosphate as basal dose.

### **Pests and diseases**

**Beetles and caterpillars:** Spray Dichlorvos 76% EC @ 6.5 ml/10 l or Trichlorofen 50% EC @ 1.0 ml/lit.

#### **Fruit fly**

- 1) Collect the damaged fruits and destroy.
- 2) The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
- 3) Plough the field to expose the pupae.
- 4) Use polythene bags fish meal trap with 5 g of wet fish meal + 1 ml dichlorvos in absorbent cotton. 50 traps are required per ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.
- 5).Neem oil @ 3.0 % as foliar spray as need based

***Do not use, copper and sulphur dust. These are phytotoxic***

#### **Diseases**

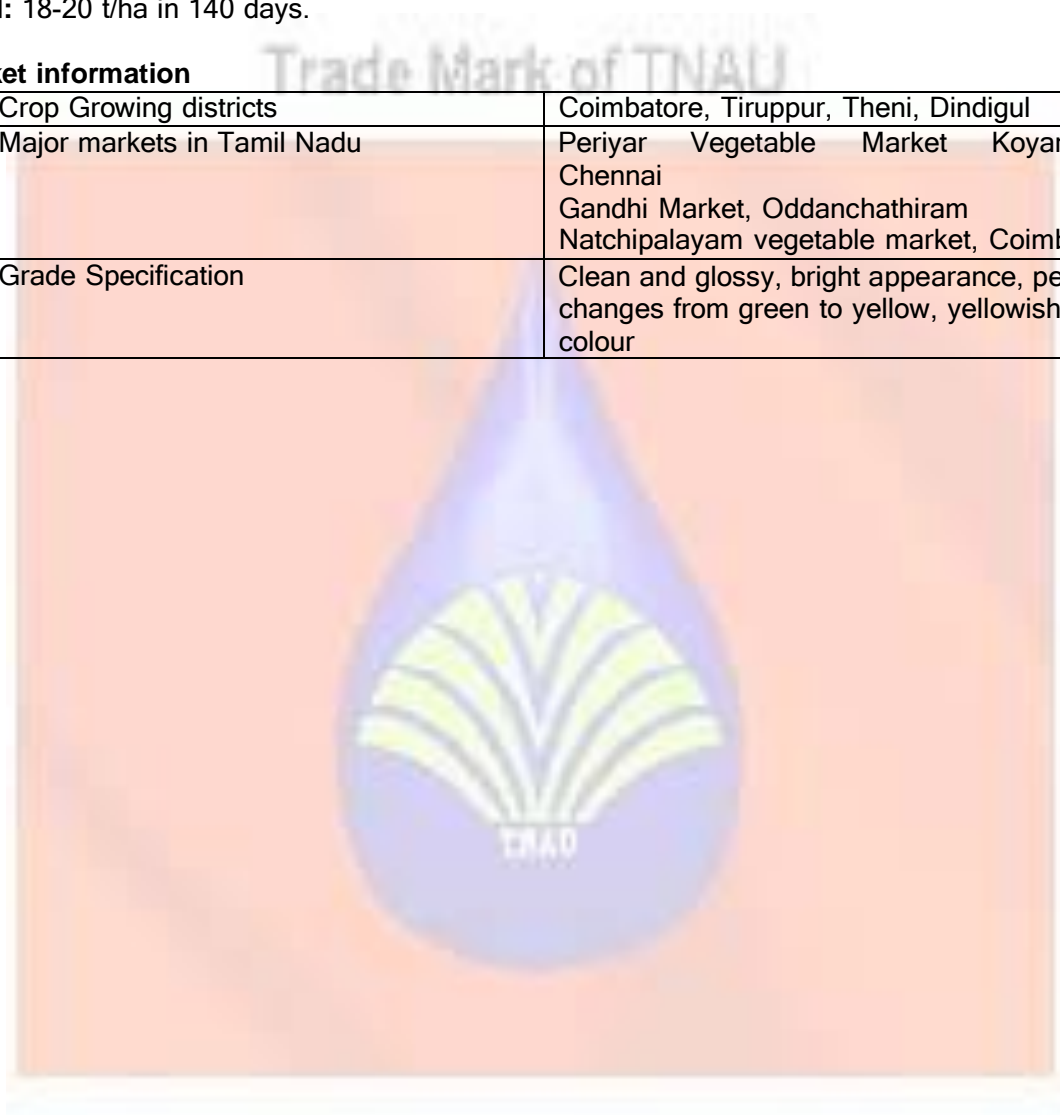
**Powdery mildew:** Spray Dinocap 1 ml/l or Carbendazim 0.5 g/l.

**Downy mildew:** Spray Mancozeb or Chlorothalonil 2 g/l twice at 10 days interval.

**Yield:** 18-20 t/ha in 140 days.

#### **Market information**

Crop Growing districts	Coimbatore, Tiruppur, Theni, Dindigul
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	Clean and glossy, bright appearance, peel changes from green to yellow, yellowish flesh colour



## **Snake gourd: *Trichosanthes cucumerina*. L. Cucurbitaceae**

**Varieties:** CO1, CO 2, PKM 1, PLR 1 and PLR 2.

### **Soil**

Sandy loam rich in organic matter with good drainage and a pH range of 6.5-7.5.

**Season and sowing:** July and January.

Sow the seeds (3 seeds/pit) treated with *Trichoderma viride* @ 4 g/kg or *Pseudomonas fluorescens* @ 10 g/kg or carbendazim @ 2 g/kg and thin the seedlings to two per pit after 15 days.

**Seed rate:** 1.5 kg/ha.

### **Preparation of field**

Plough the field to fine tilth. Dig pits of size 30 cm x 30 cm x 30 cm at 2.5 x 2 m spacing and form basins.

### **Irrigation**

Irrigate the basins before dibbling the seeds and thereafter once in a week.

### **Application of fertilizers**

Apply 10 kg of FYM, 100 g of NPK 6:12:12 mixture as basal dose per pit and N @ 10 g pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

### **After cultivation**

Hoe and weed thrice. Provide stakes for the plants to reach the pandal (2 m). Spray Ethrel 100 ppm (1 ml in 10 l of water) four times starting from 10 to 15 days after sowing at weekly intervals.

### **Quality seedling production**

#### **Nursery raising**

Sow the snake gourd seeds in pro trays containing well decomposed cocopeat medium. Sow only one seed per cell. Keep the trays under shadenet house. Water regularly with the help of rose can. Transplant about 12 days old seedlings to main field.

#### **Planting**

Spread the lateral tubes on the raised beds of 120cm wide at 150cm spacing. Irrigate the beds by operating the drip system continuously for 8-12 hrs. Plant the seedlings in the holes made at 60cm spacing.

#### **Fertigation**

Apply a dose of 75:100:100 kg NPK/ha throughout the cropping period through split application. Apply 75% of the phosphorus as superphosphate as basal dose.

## Plant protection

### Pests

**Leaf beetles and leaf caterpillars:** Spray Dichlorvos 76% EC 6.5 ml/10 lit or Trichlorofon 50% EC 1.0 ml/l.

### Fruit fly

- Collect the damaged fruits and destroy.
- The fly population is low in hot day conditions and it is peak in rainy season. Hence, the sowing time may be adjusted accordingly.
- Expose the pupae by ploughing.
- Use 20 x 15 cm poly bags fish meal traps with 5 g of fish meal + 1 ml of dichlorvos in cotton @ 50 traps/ha. Fish meal and cotton are to be removed once in 20 and 7 days respectively.
- *Neem oil* @ 3.0 % as foliar spray as need based
- For management of Aphid vector, spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apsa etc., for better adhesion and coverage.

***Do not use copper and sulphur dust. These are phytotoxic.*** Diseases

**Powdery mildew:** Spray Dinocap 1 ml/l or Carbendazim 0.5 g/l.

**Downy mildew:** Spray Mancozeb or Chlorothalonil 2 g/l twice at 10 days interval.

**Yield:** 18 t/ha in 135 - 145 days.

### Market information

Crop Growing districts	Cuddalore, Coimbatore, Dindigul
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

**Ribbed gourd: *Luffa acutangula* Roxb; Cucurbitaceae**

**Varieties:** CO 1, CO 2 and PKM 1.

**Soil**

Sandy loam rich in organic matter with good drainage and a pH range from 6.5-7.5.

**Season of sowing**

July and January.

**Seed rate**

1.5 kg/ha. Sow the seeds (3 seeds/pit) treated with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* @ 10g/kg of seeds and thin the seedlings to two per pit after 15 days.

**Preparation of field**

Plough the field to fine tilth. Dig pits of 30 cm x 30 cm x 30 cm size at 2.5 x 2 m spacing and form basins.

**Irrigation**

Irrigate the basins before dibbling the seeds and thereafter once a week.

**Application of fertilizers**

Apply 10 kg of FYM, 100 g of NPK 6:12:12 mixture as basal per pit and N @ 10 g per pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @2 kg/ha and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

**Drip irrigation**

Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5 m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

**Sowing**

Dig pits of size 45 x 45 x 45 cm at spacing of 2 m in row spaced at 1.5 m. Sow three seeds in each pit. After germination, thin to 2 healthy seedlings. Instead of direct sowing, the seeds can be sown in poly bags @ 2 seeds / bag and 15 days after germination, they can be planted @ 2 seedlings per pit.

**Fertigation**

Apply a dose of 250:100:100 kg NPK/ha throughout the cropping period through split application.

**Fertigation Schedule- Ribbed gourd (Hybrid)**  
**Recommended dose: 250:100:100 Kg/ha**

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	12-61-0 13-0-45 Urea	32.79 22.00 39.49	3.93 2.87 18.20	5.00 - -	- 10.00 -	10.00	5.00	10.00
			<b>Subtotal</b>		<b>25.00</b>	<b>5.00</b>	<b>10.00</b>			
2.	Vegetative stage	30	19:19:19 + MN Urea	157.89 97.67	29.99 45.00 -	7.50 - -	- 29.99 -	30.00	7.50	30.00
			<b>Subtotal</b>		<b>74.99</b>	<b>7.50</b>	<b>29.99</b>			
3.	Flower initiation to first picking	20	12-61-0 13-0-45 Urea	49.17 44.00 137.52	5.91 5.72 63.84	7.50 - -	- 20.00 -	30.00	7.50	20.00
			<b>Subtotal</b>		<b>75.47</b>	<b>7.50</b>	<b>20.00</b>			
4.	Harvesting stage	60	12-16-0 13-0-45 Urea	32.79 88.00 129.39	3.93 11.44 59.63	5.00 - -	- 40.00 -	30.00	5.00	40.00
	<b>Total duration</b>	<b>120 days</b>	<b>Subtotal</b>		<b>75.00</b>	<b>5.00</b>	<b>40.00</b>			
<b>Total</b>					<b>250.46 (or) 250.00</b>	<b>25.00</b>	<b>99.99 (or) 100.00</b>	<b>100</b>	<b>25</b>	<b>100</b>

**\*75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.**

1. 19:19:19 = 158 kg/ha
2. 13:0:45 = 154 kg/ha
3. 12:61:0 = 115 kg/ha
4. Urea = 405 kg/ha

**After cultivation**

Hoe and weed thrice and provide support for the plants to reach the pandal erected at a height of 2 m. Spray Ethrel 250 ppm (2.5 ml/10 lit. of water) four times commencing from 15th day of sowing at weekly interval to increase yield.

**Plant protection**

**Pests**

**Beetles, fruit flies and caterpillars:** Spray Dichlorvos 76% EC 6.5 ml/10 lit or Trichlorofon 50% EC 1.0 ml/l

***Do not use copper and sulphur dust, which are phytotoxic.***

**Diseases**

**Powdery mildew :** Spray Dinocap 1 ml/l. or Carbendazim 0.5 g/l.

**Downy mildew:** Spray Mancozeb or Chlorothalonil 2 g/l. twice at 10 days interval.

**Yield:** 14 - 15 t/ha in 125 days.

**Market information**



Crop Growing districts	Erode, Coimbatore, Tiruppur
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai, Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

## Trade Mark of TNAU



## **Bottle gourd: *Lagenaria siceraria* (Mol) Standl; Cucurbitaceae**

### **Varieties**

Pusa Summer Prolific Long, Pusa Summer Prolific Round, Pusa Manjari, Pusa Megdoot and Arka Bahar.

### **Soil**

Sandy loams rich in organic matter with good drainage and a pH range from 6.5 to 7.5.

### **Season and sowing**

July and January. Sow the seeds (3 seeds/pit) treated with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* 10 g or carbendazim 2 g/kg of seeds and thin the seedlings to two per pit after 15 days.

### **Seed rate**

1.5 kg/ha

### **Preparation of field**

Plough the field to fine tilth. Dig pits of 30 cm x 30 cm x 30 cm size at 2.5 x 2 m spacing.

### **Irrigation**

Irrigate the field before dibbling the seeds and thereafter once a week.

### **Application of fertilizers**

Apply 10 kg of FYM (20 t/ha) and 100 g of NPK 6:12:12 mixture as basal and 10 g of N per pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* 2 kg/ha and *Pseudomonas* 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

### **Drip irrigation**

Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers at an interval of 60 cm and 50 cm spacing with 4LPH and 3.5LPH capacities respectively.

### **Field preparation**

Form raised beds of 120cm width and place laterals in the centre of bed.

### **Nursery raising**

In hi-tech horticulture, plant 15 days old healthy seedlings raised in shade net houses. Raise the seedlings in protrays having 98 cells or in polythene bags. Transplant about 15 days old seedlings in the main field.

### **Fertigation**

Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application.

**After cultivation:** Hoe and weed thrice.

## Plant protection

### Pests

**Mites:** Spray dicofol 18.5 % SC @ 2.5 ml per litre of water

**Aphid:** Spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apha etc., for better adhesion and coverage.

### Diseases

**Powdery mildew:** Spray Dinocap 1 ml/l. or Carbendazim 0.5 g/l or Tridemorph 1 ml/l.

**Downy mildew:** Spray Mancozeb or Chlorothalonil 2 g/l. twice at 10 days interval.

**Yield:** 15 - 20 t/ha in 135 days.

### Market information

Crop Growing districts	Dindigul, Thiruvallur, Coimbatore, Thoothukudi
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

## Fertigation Schedule-Bottle gourd (Hybrid)

Recommended Dose: 200:100:100 Kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				<b>Subtotal</b>	<b>19.78</b>	<b>5.00</b>	<b>9.95</b>			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.50 - -	- 29.70 -	30.00	7.50	30.00
				<b>Subtotal</b>	<b>60.19</b>	<b>7.50</b>	<b>29.70</b>			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.50 - -	- 19.80 -	30.00	7.50	20.00
				<b>Subtotal</b>	<b>60.09</b>	<b>7.50</b>	<b>19.80</b>			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	<b>Total duration</b>	<b>115 days</b>		<b>Subtotal</b>	<b>60.00</b>	<b>5.00</b>	<b>40.10</b>			
<b>Total</b>					<b>200.06</b>	<b>24.98 (or) 25.00</b>	<b>99.35 (or) 100.00</b>	<b>100</b>	<b>25</b>	<b>100</b>

\*75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351 kg/ha

## **Bitter gourd; *Momordica charantia* L.; Cucurbitaceae**

**Varieties:** CO 1, MDU 1, Arka Harit, VK1, Priya and Preethi.

**Hybrids :** COBgoH1

### **Soil**

Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

### **Season and sowing**

July and January. Sow the seeds (3 seeds/pit) treated with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* @ 10 g or carbendazim @ 2 g/kg of seeds and thin the seedlings to two per pit after 15 days.

### **Seed rate**

1.8 kg/ha.

### **Preparation of field**

Plough the field to fine tilth. Dig pits of 30 cm x 30 cm x 30 cm size at 2 x 1.5 m spacing and form basins.

### **Irrigation**

Irrigate the basins before dibbling the seeds and thereafter once in a week.

### **Application of fertilizers**

Apply 10 kg of FYM (20 t/ha) and 100 g of NPK 6:12:12 mixture per pit as basal and 10 g of N per pit 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

### **Quality seedling production**

Bitter gourd is a direct sown vegetable but polythene bag nursery is more advantageous to get early marketing and to avoid more gap filling. Use 200 gauge poly bags of 10 cm diameter x 10 cm height for sowing the seeds. Transplant about 15 days old seedlings to the main field.

### **Drip irrigation**

Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4LPH and 3.5 LPH capacities respectively.

### **Field preparation**

Form the raised beds of 120cm width (120 cm) and spread the lateral tubes in the centre of each bed. Irrigation is done in the beds by operating the drip system continuously for 8-12 hrs. Spray pre emergence herbicide like Pendimethalin @ 1 Kg a.i/ha just before planting. Planting or sowing is done at the holes made at 2 m distance.

### **Fertigation**

Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application.

**After cultivation**

Hoe and weed thrice. Provide stakes for the plants to reach the pandal (2 m). Spray Ethrel 100 ppm (1 ml dissolved in 10 l of water) four times from 15th day after sowing at weekly intervals.

**Plant protection****Pests**

**Mites:** Spray dicofol 18.5 % SC @ 2.5 ml per litre of water

**Aphid:** Spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apha etc., for better adhesion and coverage.

**Diseases**

**Powdery mildew:** Spray Dinocap 1ml/l or Carbendazim 0.5 g/l.

**Downy mildew:** Spray Mancozeb or Chlorothalonil @ 2 g/l twice at 10 days interval.

**Yield**

Varieties : 14 t/ha in 140 - 150 days.

Hybrids : 40 t/ha in 180 days

**Market information**

Crop Growing districts	Coimbatore, Dindigul, Cuddalore, Thoothukudi, Tiruppur
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	20-25 cm long green fruits with short neck and tubercles are preferred



### Fertigation Schedule- Bitter gourd (Hybrid)

Recommended dose: 200:100:100 kg/ha

Sl. No	Crop Stage	Duration in Days	Fertilizer grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				<b>Subtotal</b>	<b>19.78</b>	<b>5.00</b>	<b>9.95</b>			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.49 - -	- 29.70 -	30.00	7.50	30.00
				<b>Subtotal</b>	<b>60.19</b>	<b>7.49</b>	<b>29.70</b>			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.49 - -	- 19.80 -	30.00	7.50	20.00
				<b>Subtotal</b>	<b>60.09</b>	<b>7.49</b>	<b>19.80</b>			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	<b>Total duration</b>	<b>115 days</b>		<b>Subtotal</b>	<b>60.00</b>	<b>5.00</b>	<b>40.10</b>			
<b>Total</b>					<b>200.06</b>	<b>24.98 (or) 25.00</b>	<b>99.35 (or) 100.00</b>	<b>100</b>	<b>25</b>	<b>100</b>

\*75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351 kg/ha



## **Ash gourd: *Benincasa hispida* Cogn; Cucurbitaceae**

### **Varieties**

CO 1 and CO 2.

### **Soil**

A deep loamy soil with pH range of 6.5-7.5 is suitable.

### **Season and sowing**

July and January. Three seeds are sown in each pit. The seeds are treated with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* @ 10 g or carbendazim @ 2 g/kg of seeds and after germination, the seedlings are thinned to two per pit.

### **Seed rate**

2.5 kg/ha. Soak the seeds in double the quantity of water for 30 minutes and incubate for 6 days.

### **Preparation of field**

Plough the field 3 – 4 times. Dig pits of 30 cm x 30 cm x 30 cm at a spacing of 2 x 1.5 m and form basins.

### **Irrigation**

Irrigate the basins before dibbling the seeds and thereafter once a week.

### **Application of fertilizers**

Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing. Apply 10 kg FYM and 100 g of 6:12:12 NPK mixture/pit as basal and 10 g N/ pit at 30 days after sowing.

### **After cultivation**

Hoe and weed thrice. Spray Ethrel 250 ppm (2.5 ml/10 lit of water) four times at weekly intervals commencing from 15th day after sowing.

### **Quality seedling production:**

#### **Nursery raising**

In hi-tech horticulture, use 12 days old healthy seedlings obtained from shade net houses for planting. Raise the seedlings in protrays having 98 cells. Use well decomposed cocopeat is used as medium. Sow one seed per cell. Water regularly twice a day. Transplant about 12 days old seedlings in the main field

#### **Fertigation**

Apply 60:30:30 kg of NPK/ha throughout the cropping period through split application. 75% of phosphorus, is applied through superphosphate as basal dose.

## Plant protection

### Pests

#### Fruit fly

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use 20 x 15 cm polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.
5. *Neem oil* @ 3.0 % as foliar spray as need based

**Aphid:** Spray Imidachloprid @ 0.5 ml/lit along with sufficient quantity of stickers like Teepol, triton X100, apha etc., for better adhesion and coverage.

***Do not use copper and sulphur dust, as these are phytotoxic.***

### Diseases

#### Powdery mildew

Spray Dinocap 1 ml/l or Carbendazim 0.5 gm/l.

**Downy mildew:** Spray Mancozeb or Chlorothalonil 2 g/l twice at 10 days interval.

**Yield:** 20 t/ha in 140 days.

### Market information

Crop Growing districts	Erode, Coimbatore, Villupuram
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Natchipalayam vegetable market, Coimbatore
Preferred Varieties and hybrids	Co 1 and Co 2

### Fertigation Schedule- Ash gourd (Hybrid)

Recommended Dose: 200:100:100 kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				<b>Sub total</b>	<b>19.78</b>	<b>5.00</b>	<b>9.95</b>			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.50 - -	- 29.70 -	30.00	7.50	30.00
				<b>Sub total</b>	<b>60.19</b>	<b>7.50</b>	<b>29.70</b>			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.50 - -	- 19.80 -	30.00	7.50	20.00
				<b>Sub total</b>	<b>60.09</b>	<b>7.50</b>	<b>19.80</b>			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.0	40.00
	<b>Total duration</b>	<b>115 days</b>		<b>Sub total</b>	<b>60.00</b>	<b>5.00</b>	<b>40.10</b>			
<b>Total</b>					<b>200.06</b>	<b>25.00</b>	<b>100.00</b>	<b>100</b>	<b>25</b>	<b>100</b>

\*75% RD of Phosphorus applied as superphosphate = 469 Kg/ha.

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351 kg/ha



## **Cucumber: *Cucumis sativus* L.; Cucurbitaceae**

**Varieties:** Japanese Long Green, Straight Eight and Poinsette.

**Soil:** Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

**Preparation of field:** Plough the field four times. Form long channels at 1.5 m apart.

**Season and sowing:** Sow the seeds during June or January to April at 2.5 kg/ha after treating with *Trichoderma viride* 4 g or *Pseudomonas fluorescens* 10 g or carbendazim 2g/kg on one side of channel giving a spacing of 0.6 m between hills. Thin the seedlings to two per hill.

**Irrigation:** Irrigate the field before dibbling the seeds and thereafter once in a week.

**Application of fertilizers:** Apply FYM 40 t/ha as basal and 35 kg of N/ha at 30 days after sowing. Apply Azospirillum and Phosphobacteria 2 kg/ha and Pseudomonas 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

**Drip irrigation:** Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

**Field preparation:** Form raised beds of 120 cm width at an interval of 30 cm and the laterals are placed at the centre of each bed.

**Sowing:** Sow the seeds at an interval of 60 cm distance at the centre of the bed along the laterals. Sow the seeds in polybags @ one per bag for gap filling. Spray pre emergence weedicide like fluchloralin 1 kg a.i. or metalachlor 0.75 kg a.i./ha on third day of sowing.

**Fertigation:** Apply a dose of 150:75:75 kg NPK/ha throughout the cropping period through split application for F<sub>1</sub> hybrid. In respect of phosphorous, 75% has to be applied as a basal dose.

**After cultivation:** Hoe and weed twice or thrice.

### **Plant protection: Pests**

#### **Fruit fly**

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use 20 x 15 cm polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.
5. *Neem oil* @ 3.0 % as foliar spray as need based

**Do not use copper and sulphur dust, as these are phytotoxic.**

**Yield:** 8 - 10 t/ha in 80 to 90 days for salad.

### **Market information**

Crop Growing districts	Kanyakumari, Dindigul, Tirunelveli, Theni
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

**Fertigation Schedule - Cucumber (Hybrid)**  
**Recommended Dose: 150:75:75 Kg/ha**

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	19.72	3.75	3.75	3.75	10.00	5.00	10.00
				8.24	1.07	-	3.75			
				22.11	10.19	-	-			
				<b>Subtotal</b>	<b>15.01</b>	<b>3.75</b>	<b>7.50</b>			
2.	Vegetative stage	20	12-61-0 13-0-45 Urea	9.21	1.09	5.63	-	30.00	7.50	30.00
				49.49	-	-	22.49			
				95.27	43.91	-	-			
				<b>Subtotal</b>	<b>45.00</b>	<b>5.63</b>	<b>22.49</b>			
3.	Flower initiation to first picking	20	19:19:19 + MN 13-0-45 Urea	29.61	5.62	5.63	5.63	30.00	7.50	20.00
				20.61	2.62	-	9.37			
				80.00	36.71	-	-			
				<b>Subtotal</b>	<b>45.00</b>	<b>5.63</b>	<b>15.00</b>			
4.	Harvesting stage	40	19:19:19 + MN 13-0-45 Urea	6.13	0.73	3.75	-	30.00	5.00	40.00
				66.00	8.57	-	30.00			
				77.47	35.69	-	-			
	<b>Total duration</b>	<b>90 days</b>		<b>Subtotal</b>	<b>44.99</b>	<b>3.75</b>	<b>30.00</b>			
<b>Total</b>					<b>150.00</b>	<b>18.75</b>	<b>75.00</b>	<b>100</b>	<b>25</b>	<b>100</b>

**\*75% RD of Phosphorus applied as superphosphate = 352 Kg/ha**

1. 19:19:19 = 55 kg/ha
2. 13:0:45 = 144 kg/ha
3. 12:61:0 = 9 kg/ha
4. Urea = 275 kg/ha





## **Gherkin: *Cucumis sativus* var. *anguria*; Cucurbitaceae**

### **Hybrids.**

**Soil:** Well-drained sandy loam with a pH range of 6.0 to 6.8 is optimum.

**Seed rate:** 800 g per hectare.

**Sowing:** Sow the seeds at 30 cm spacing on sides of the ridges with 2 seeds per hill after treating with *Trichoderma viride* @ 4 g or *Pseudomonas* @ 10 g or carbendizim @ 2 g/kg of seeds.

**Preparatory cultivation:** Apply 25 t/ha of FYM. Prepare ridges and furrows one metre apart.

**Manuring:** Apply N - 150 kg, P - 75 kg and K - 100 kg/ha in 3 equal splits *i.e.*, basal, three and five weeks after sowing.

**After cultivation:** Earth up the plants 25 days after sowing. Provide support to plants as and when vines start trailing.

**Drip irrigation:** Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

**Field preparation:** Raise beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of each bed.

**Fertigation:** Apply the recommended dose of fertilizers viz., 150:75:100 Kg NPK / ha fertigate on every third day after sowing.

### **Plant protection**

#### **Pest**

**Minor pest:** To control leaf miner, white fly, aphids and thrips spray Dimethoate 1.5 ml/l or Malathion 1.5 ml/l.

#### **Diseases**

Spray Carbendazim 0.05 % (0.5 g/l) to control diseases.

**Harvest:** The crop is ready for harvest in 30-35 days. As the tender immature fruits are meant for canning the price of the produce is decided by the stage of maturity. Smallest fruit (stage 1) which will weigh approximately 4.0g (250 fruits per kg) will fetch the maximum price followed by stage 2 and stage 3. To maintain the grade the harvesting of fruits should be done every day. A day's break would end up with outsized or overgrown gherkin means loss to farmer.

Avoid sharp sun and high temperature while harvesting. For this picking of fruits must be none in the very early morning or late evening. Harvest the fruits by retaining the stalk on the plant. Harvested fruits must be collected under shade. Flower head has to be removed from fruit. Water should not be sprinkled on harvested fruits at any stage. Even if there is surface water during harvest it should be dried by aeration. For collection of fruits jute bags alone have to be used and plastic bags should be totally avoided. The harvested produce should be transported to the factory on the same day before dusk. Leaving the gherkin unprocessed overnight would result in poor quality produce.

**Yield:** 10 - 12 tonnes/ha in 90 days.

## **Watermelon: *Citrullus lanatus* (Thumb) Matsum and Nakai; Cucurbitaceae**

**Varieties:** Sugar Baby and Arka Manik.

**Hybrids:** Arka Jyoti and Pusa Bedana.

**Soil:** Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

**Season and sowing:** Treat the seeds with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* 10 g or carbendazim 2g/kg of seed. Sow the seeds during November-December @ 3.5 kg/ha on one side of the channel with a spacing of 0.9 m between hills. Thin the seedlings 2 per hill 15 days after sowing.

**Preparation of field:** Plough the field to a fine tilth and form long channels 2.5 m apart.

**Irrigation:** Irrigate the field before dibbling the seeds and thereafter once a week.

**Application of fertilizers:** Apply FYM 20 t/ha, P 55 kg and K 55 kg as basal and N 55 kg/ha 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake 100 kg before last ploughing.

**Nursery preparation:** Nursery for watermelon can be prepared either with polythene bags of 200 gauge, 10 cm diameter and 15 cm height size or through protrays under protected nursery. In polybag nursery, fill the bags with 1:1:1 ratio of red soil, sand and farmyard manure mixture. Use protrays, each having 98 cells for raising seedlings. Transplant about 12 days old seedlings in the main field.

**Drip irrigation:** Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5 m. Place the drippers in lateral tubes at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

**Field preparation:** Raise beds of 1.2 m width and 30cm height for sowing.

**Planting:** Spread the lateral tubes in the centre of each bed. Irrigate the beds by operating the drip system continuously for 8-12 hrs. Spray pre-emergence weedicide (Pendimethalin @ 1 kg a.i/ha) just before planting. Plant the seedlings in the holes made at 60 cm distance.

**Fertigation :** Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application

**After cultivation:** Spray ethrel 250 ppm (2.5 ml/10 l of water) 4 times at weekly intervals commencing from 15 days after sowing. Hoe and weed thrice.

### **Plant protection**

#### **Pests**

##### **Fruit fly**

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.

4. Use 20 x 15 cm polythene bags, fish meal trap with 5 g of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.

5. *Neem oil @ 3.0 %* as foliar spray as need based

***Do not use copper and sulphur dust, as these are phytotoxic***

**Yield:** 25 - 30 t/ha in 120 days.

#### Market information

Crop Growing districts	Kancheepuram, Villupuram, Thiruvallur
Major markets in Tamil Nadu	Coimbatore, Chennai
Preferred Varieties and hybrids	Mithila, Suganthi, Kiran, Simran, Vishal
Grade Specification	Symmetrical and uniform in appearance. The surface should be waxy and bright in appearance devoid of scars, sunburn, transit abrasions or other surface defects.



**Fertigation Schedule**  
**Watermelon**

**Recommended Dose: 200:100:100 Kg/ha**

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.00	10.00
				<b>Subtotal</b>	<b>19.78</b>	<b>5.00</b>	<b>9.95</b>			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.49 - -	- 29.70 -	30.00	7.50	30.00
				<b>Subtotal</b>	<b>60.19</b>	<b>7.49</b>	<b>29.70</b>			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.49 - -	- 19.80 -	30.00	7.50	20.00
				<b>Subtotal</b>	<b>60.09</b>	<b>7.49</b>	<b>19.80</b>			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	<b>Total duration</b>	<b>115 days</b>		<b>Subtotal</b>	<b>60.00</b>	<b>5.00</b>	<b>40.10</b>			
<b>Total</b>					<b>200.06</b>	<b>24.98 (or) 25.00</b>	<b>99.35 (or) 100.00</b>	<b>100</b>	<b>25</b>	<b>100</b>

**\*75% RD of Phosphorus applied as superphosphate = 469kg/ha.**

1. 19:19:19 = 53 kg/ha
2. 13:0:45 = 199kg/ha
3. 12:61:0 = 25 kg/ha
4. Urea = 351kg/ha



## **Muskmelon: *Cucumis melo* L; Cucurbitaceae**

**Varieties:** Pusa Sharbati, Hara Madhu, Durgapura Madhu, Arka Rajhans and Arka Jeet.

**Soil:** Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

**Season of sowing:** November to February. Sow the seeds @ 3.0 kg/ha after treating with *Trichoderma viride* @ 4g or *Pseudomonas fluorescens* @ 10 g or carbendazim @ 2g/kg of seed on one side of the channel giving a spacing of 0.6 m between hills. Thin the seedlings after 15 days, to maintain two per hill.

**Preparation of field:** Plough the field to a fine tilth and form long channels at 2.5 m apart.

**Irrigation:** Irrigate the field before dibbling the seeds and thereafter once in a week.

**Application of fertilizers:** Apply FYM 20 t/ha, NPK 40:60:30 kg/ha as basal and N @ 40 kg/ha 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake 100 kg before last ploughing.

**Nursery preparation:** Nursery for muskmelon can be prepared either with polythene bags of 200 gauge, 10 diameter and 15 cm height size or through protrays under protected nursery. Use protrays, each having 98 cells for raising seedlings. Transplant about 12 days old seedlings in the main field.

**Drip irrigation:** Install drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5m. Place the drippers in lateral tubes are at an interval of 60 cm and 50 cm spacing with 4 LPH and 3.5 LPH capacities respectively.

**Sowing:** Around 250 protrays are required for the production of 23,334 (22,223 + 5%) seedlings, which are required for one hectare at spacing of 1.5 m x 30 cm in a raised bed single row system. Raise beds of 120 cm width at an interval of 30 cm and place the laterals at the centre of each bed. Direct sowing or transplanting is done at a spacing of 1.5 m along the laterals and 30 cm interval in the raised bed single row system, using ropes marked at 30 cm spacing.

**Fertigation :** Apply a dose of 200:100:100 kg NPK/ha throughout the cropping period through split application.

**After cultivation:** Hoe and weed thrice.

### **Plant protection**

#### **Pests**

1. Collect the affected fruits and destroy.
2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
3. Expose the pupae by ploughing.
4. Use 20 x 15 cm polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.
5. *Neem oil* @ 3.0 % as foliar spray as need based

**Do not use copper and sulphur dust, as these are phytotoxic.**

**White fly:** Spray neem seed kernel extract 5 %.

**Yield:** 20 t/ha in 120 days.

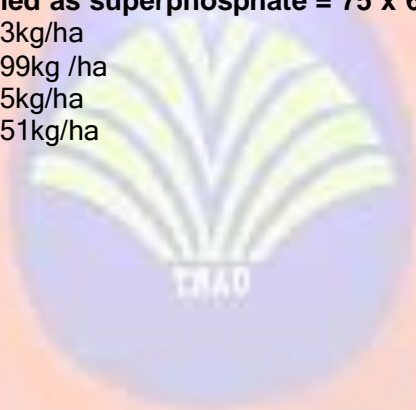
# Fertigation schedule-Muskmelon

Recommended dose: 200:100:100 Kg/ha

Sl. No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (Kg/ha)	Nutrient Supplied			% Requirement		
					N	P	K	N	P	K
1.	Crop establishment stage	10	19:19:19 + MN 13-0-45 Urea	26.81 11.00 29.03	5.00 1.43 13.35	5.00 - -	5.00 4.95 -	10.00	5.0	10.00
				<b>Sub total</b>	<b>19.78</b>	<b>5.00</b>	<b>9.95</b>			
2.	Vegetative stage	30	12-61-0 13-0-45 Urea	12.28 66.00 109.00	1.47 8.58 50.14	7.49 - -	- 29.70 -	30.00	7.50	30.00
				<b>Sub total</b>	<b>60.19</b>	<b>7.49</b>	<b>29.70</b>			
3.	Flower initiation to first picking	30	12-61-0 13-0-45 Urea	12.28 44.00 115.00	1.47 5.72 52.90	7.49 - -	- 19.80 -	30.00	7.50	20.00
				<b>Sub total</b>	<b>60.09</b>	<b>7.49</b>	<b>19.80</b>			
4.	Harvesting stage	45	19:19:19 + MN 13-0-45 Urea	26.31 78.00 97.52	5.00 10.14 44.86	5.00 - -	5.00 35.10 -	30.00	5.00	40.00
	<b>Total duration</b>	<b>115 days</b>		<b>Sub total</b>	<b>60.00</b>	<b>5.00</b>	<b>40.10</b>			
<b>Total</b>					<b>200.06</b>	<b>24.98 (or) 25.00</b>	<b>99.35 (or) 100.00</b>	<b>100</b>	<b>25</b>	<b>100</b>

\*75% RD of Phosphorus applied as superphosphate =  $75 \times 6.25 = 469 \text{ kg/ha}$ .

1. 19:19:19 = 53kg/ha
2. 13:0:45 = 199kg /ha
3. 12:61:0 = 25kg/ha
4. Urea = 351kg/ha





**Tinda: *Citrullus vulgaris* var. *fistulosus*; Schrad Cucurbitaceae**

**Varieties:** Annamalai and Arka Tinda.

**Soil:** Sandy loam rich in organic matter with good drainage and pH range of 6.5-7.5.

**Season of sowing:** January-February Sow the seeds on one side of the channel

**Seed and rate:** 3.5 kg/ha. Treat the seeds with *Trichoderma viride* @ 4g or *Pseudomonas fluorescens* 10 g or carbendazim 2g/kg of seed. Thin the seedlings after 15 days to maintain two per pit at 0.9 m spacing.

**Preparation of field:** Plough the field to fine tilth and form long channels at 1.5m apart.

**Irrigation:** Irrigate the field before dibbling the seeds and thereafter once a week.

**Application of fertilizers:** Apply FYM 10 t/ha, N 20 kg/ha as basal and N 20 kg/ha 30 days after sowing. Apply *Azospirillum* and *Phosphobacteria* @ 2 kg/ha and *Pseudomonas* @ 2.5 kg/ha along with FYM 50 kg and neem cake @ 100 kg before last ploughing.

**After cultivation:** Hoe and weed thrice.

**Plant protection**

**Pest**

**Beetles:** Spray malathion 50 EC 1 ml/l at weekly intervals.

1. Collect the affected fruits and destroy.
  2. The fly population is low in hot day conditions and it is peak in rainy season. Hence adjust the sowing time accordingly.
  3. Expose the pupae by ploughing.
  4. Use 20 x 15 cm polythene bags, fish meal trap with 5 gm of wet fish meal and 1 g of dichlorvos in cotton, 50 traps are required per hectare. Fish meal and dichlorvos impregnated cotton are to be renewed once in 20 and 7 days respectively.
  5. *Neem oil* @ 3.0 % as foliar spray as need based
- Do not use copper and sulphur dust, as these are phytotoxic.*

**White fly:** Spray Neem Seed Kernal Extract 5 %.

**Yield:** 10 t/ha in 90 days.

## **Chow chow: *Sechium edule*; *Cucurbitaceae***

**Varieties:** Green fruited and White fruited.

**Soil and climate:** Requires well drained acidic soil with a pH of 5.5 - 6.5 and thrives best in a temperature range of 18 – 22°C and at an altitude of 1200 - 1500m. In plains, it comes up well during winter season.

**Preparation of field:** Dig pits of 45 cm x 45 cm x 45 cm at a spacing of 2.4 x 1.8 m. Fill up the pits with 10 kg of FYM, 250 g of urea, 500 g of superphosphate and 500 g of muriate of potash.

### **Season and sowing**

**Hills:** April - May. Fully matured and sprouted fruits collected from high yielding vines are planted in pits @ 2 -3 per pit.

**After cultivation:** Hoeing and weeding are done as and when necessary. At initiation of vine growth, stake the plants. Provide pandal at a height of 2m. Prune the plants to ground level during winter from second year after planting. In hills, pruning period is January. Apply 250 g of urea to each vine after pruning and at the time of flowering.

### **Plant protection**

#### **Pests**

For scales, mealy bugs and aphids, spray Dimethoate 30 EC @ 1 ml/l.

#### **Fruit fly**

- 1) Collect the damaged fruits and destroy.
- 2) The fly population low in hot day condition and it is peak in rainy season. Hence adjust the sowing time accordingly.
- 3) Plough the field to expose the pupae.
- 4) Use 20 x 15 cm polythene bags fish meal trap with 5 g of wet fish meal + 1 ml. dichlorvos in cotton. 50 traps are required/ha, fish meal + dichlorvos soaked cotton are to be renewed once in 20 and 7 days respectively.
- 5) *Neem oil* @ 3.0 % as foliar spray as need based

#### **Diseases**

**Mosaic:** Spray dimethoate 30 EC @ 1.5 ml/lit or methyl demeton 25 EC @ 1.5 ml/lit. thrice at fortnightly intervals

**Yield:** 25 - 35 tonnes/ha.

**Cluster beans: *Cyamopsis tetragonoloba* L; Fabaceae**

**Varieties:** Pusa Mausmi, Pusa Sadabahar and Pusa Naubahar.

**Soil:** Well drained sandy loam with pH range of 7.5-8.0. The crop tolerates salinity.

**Season and sowing:** June - July and October - November. Dibble the seeds on the sides of the ridges 15 cm apart.

**Seed rate:** 10 kg per ha.

**Seed treatment:** Treat the seeds with Rhizobial culture @ 600 g/ha using rice gruel as binder. Dry the treated seeds in shade for 15 – 30 minutes before sowing.

**Preparation of field:** Plough the field to fine tilth and form ridges and furrows 45 cm apart.

**Irrigation:** Irrigate the field immediately after sowing then at weekly intervals.

**Application of fertilizers:** Apply FYM 25 t, *Azospirillum* @ 2 kg and *Phosphobacteria* @ 2 kg /ha, N 25, P 50 and K 25 kg/ha as basal and 25 kg N/ha 30 days after sowing.

**Plant protection**

**Pests**

**Leaf hoppers, aphids, and glasshouse whitefly**

Spray methyl demeton 25 EC or dimethoate 30 EC @ 1 ml/lit.

**Ash weevils**

Spray phosalone 35 EC @ 1.5 ml/lit.

**Diseases**

**Leaf spot:** Spray Mancozeb @ 2 g/l.

**Powdery mildew:** Spray Wettable sulphur @ 2 g/l or dust Sulphur @ 25 kg/ha. Repeat it at 15 days interval.

**Yield:** 5 - 7 t/ha in 90 days.

**Market information**

Crop growing districts	Dindigul, Coimbatore, Namakkal
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore

**Vegetable Cowpea: *Vigna unguiculata* (L) Walp.; Fabaceae**

**Varieties:** CO 2, VBN 2, Pusa Komal and PKM 1

**Soil:** Well drained soil with high organic matter.

**Season:** June - July (Rainfed), February - March (irrigated).

**Seed rate:** 20 kg/ha.

Treat the seeds with 600 g of *Rhizobium* bacterial culture before sowing as in cluster beans. Dibble the seeds on both sides of the ridges or in lines in the beds.

**Preparation of field:** Plough the field to fine tilth. Form ridges and furrows at 45 cm apart or beds of convenient size.

**Spacing:** 45 x 15 cm and 60 x 30 cm.

**Irrigation:** Give irrigation immediately after sowing and on 3rd day, thereafter once a week.

**Application of fertilizers:** Apply FYM 25 t, *Azospirillum* @ 2 kg and *Phosphobacteria* @ 2 kg /ha, and N 25 kg and P 50 kg/ha for irrigated crop. Apply FYM at 12.5 t/ha and N 12.5 kg and P 25 kg/ha for rainfed crop. Fertilizers can be applied in several split doses at fortnightly intervals.

**Pinching :** Before flowering, the tendrils should be pinched thrice for getting bushy plants.

**After cultivation:** Give one hoeing and weeding on 25th day after sowing.

**Plant protection**

**Pests**

**Aphids:** Spray Dimethoate 30 EC 1 ml/l or Methyl demeton 25 EC 1 ml/l.

**Diseases**

**Powdery mildew:** Dust sulphur 25 kg/ha or spray Wettable sulphur 2 g/l.

**Yield:** 25t/ha in a crop duration of 75 to 90 days.

**Lab lab or Dolichos bean: *Lab lab purpureus* var. *typicus*; Fabaceae**

**Varieties - Bush types**

CO 6, CO 7, CO 8, CO 9, CO 10, CO 11, CO 12, CO 13, COGB 14, Arka Jay and Arka Vijay.

**Pandal types:** CO 1, CO 2, CO 3, CO 4, CO 5 and Pusa Early Prolific.

**Soil:** Well drained loamy soil with pH range of 6.5-8.5.

**Rhizobial treatment:** Treat the seeds with three packets (600 g) of rhizobial culture per ha using rice gruel as binder. Dry the treated seeds in shade for 15 – 30 minutes before sowing.

**Season:** Bush type - Throughout year;

Pandal type - July – August.

**Seed rate and sowing:** 25 kg/ha for Bush type and 5 kg/ha for pandal type. Dibble single seed 30 cm apart on one side of the ridge formed at a spacing of 60 cm for bush type. For pandal type, 2 - 3 seeds/pit at 2 x 3 m spacing. Spacing for CO 1 Dolichos bean is 1 x 1 m.

**Preparation of field:** Plough the land to a fine tilth. Form ridges and furrows 60 cm apart for bush types. Dig pits of 30 cm x 30 cm x 30 cm at required spacing and fill it up with FYM and soil for pandal type.

**Irrigation:** Immediately after sowing and on 3rd day, thereafter once a week.

**After cultivation:** Hoe and weed thrice. Provide stakes to reach pandal of 2 m height and train the vines on pandal.

**Application of fertilizers**

**(a) Basal dressing for bush type**

Manures and fertilizers	Irrigated	Dry
FYM	12.5 t/ha	12.5 t/ha
N	25 kg/ha	12.5 kg/ha
P	50 kg/ha	25 kg/ha
K	-	-

**b) For pandal type**

Apply 10 kg FYM per pit (20 t/ha), 100 g of NPK 6:12:12 mixture as basal and 10 g N per pit after 30 days. Apply 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of sowing.

## Plant protection

### Pests

**Pod borer:** Spray Carbaryl 50 WP thrice at fortnightly intervals @ of 2 g/l. Dust Carbaryl 10 D @ 25 kg/ha.

**Sucking pests:** Spray Malathion 50 EC @ 1 ml/l or Dimethoate 30 EC @ 1 ml/l or Methyl demeton 25 EC @ 1 ml/l or Fenthion 1000 EC @ 1 ml/l at 15 days interval to control aphids and other sucking insects.

### Diseases

#### **Powdery mildew**

Spray Wettable sulphur @ 2 g/l or Carbendazim @ 0.5 g/ litre.

#### **Yield**

**Pandal type :** 12 - 13 t/ha

**Bush type :** 8 - 10 t/ha

### Market information

Crop growing districts	Dindigul, Erode, Salem, Theni
Major markets in Tamil Nadu	Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore



**French bean: *Phaseolus vulgaris* L; Fabaceae**

**Bush type varieties**

**Hills:** YCD 1, Ooty 2 and Premier.

**Plains:** Arka Komal, (Sel.9) and Premier.

**Soil:** Well drained loamy soils with pH range of 5.5-6.0.

**Season**

**Hills** : February - March

**Plains** : October - November

**Sowing:** Treat the seeds with *Trichoderma viride* @ 4 g/kg or Thiram or Carbendazim @ 2 g/kg of seed 24 hours before sowing to control fungal diseases. If the crop is raised for the first time, it should be treated with *Rhizobium* as in cluster beans. In hills, sow the seeds in lines or in beds. In plains, sow the seeds on the sides of the ridges.

**Seed rate and spacing**

**Hills:** 80 kg/ha (2 seeds/hill) 30 x 15 cm.

**Plains:** 50 kg/ha (2 seeds/hill) 45 x 30 cm.

**Preparation of field**

**Hills:** Dig the soil thoroughly and incorporate FYM. Form beds of convenient size.

**Plains:** After two ploughings form ridges and furrows.

**Irrigation:** Immediately after sowing, third day and thereafter once a week.

**Application of fertilizers:** Apply FYM 25 t/ha at the last ploughing. N at 90 and P at 125 kg/ha should be applied on one side of the ridges. For rainfed conditions of Shevaroy hills, apply as a basal dose of 62.5 kg/ha of Phosphorus as superphosphate and with another half of 62.5 kg/ha Phosphorus as FYM enriched super phosphate.

**After cultivation:** Weeding should be given 20 – 25 days and 40 – 45 days after sowing. The crop should be earthed up after each weeding.

**Plant protection**

**Pests**

**Whitefly:** Place 20 yellow sticky traps coated with castor oil in polythene sheet to attract the white flies.

**Leaf hoppers, aphids, and glasshouse whitefly**

Spray methyl demeton 25 EC or dimethoate 30 EC @ 1 ml/lit.

**Ash weevils**

Spray phosalone 35 EC @ 1.5 ml/lit.

**Pod borer:** Spray Carbaryl 50 WP thrice at fortnightly intervals at @ 2 g/l. Dust Carbaryl 10 D @ 25 kg/ha.

#### **Diseases**

**Powdery mildew:** Spray Wettable sulphur @ 2 g/l or dust sulphur @ 25 kg/ha.

**Rust:** Dust Sulphur at 25 kg/ha.

**Anthracnose:** Spray Mancozeb @ 2 g/l or Carbendazim @ 1 g/l or Chlorothalonil @ 2 g/l.

**Leaf spot:** Spray Mancozeb @ 2 g/l.

**Root rot:** Drench Carbendazim @ 1 g/l.

**Mosaic :** Select disease free planting materials. Spray Dimethoate 30 EC @ 2 ml/l or Methyl Demeton @ 25 EC 2 ml/l thrice at fortnightly intervals.

**Yield:** 8 - 10 t/ha of green pods in 90 - 100 days.

#### **Pole type**

**Varieties:** TKD 1, KKL-I, Ooty 1, Murungai beans.

**Soil:** Well drained loamy soils with pH range of 5.5-6.0.

#### **Season and sowing**

**Hills:** February - March and July - August.

**Preparation of field:** Prepare the land to fine tilth. Sow the seeds at a spacing of 20 cm between plants in double rows of 30 cm apart with a distance of 1.5 metre between each pair of rows.

**Seed rate:** 50 - 55 kg/ha. Treat the seeds with *Rhizobium* @ (4 packets/ha).

**Irrigation:** Immediately after sowing, on 3rd day and thereafter once in a week.

**Application of fertilizers:** FYM 25 t/ha, 90 kg each of NPK as basal and 45 kg each 20 days after sowing.

**After cultivation:** First weeding and staking 20 days after sowing.

#### **Plant protection**

##### **Pests**

**Whitefly:** Place 20 yellow sticky traps coated with castor oil in polythene sheet to attract the white flies.

##### **Leaf hoppers, aphids, and glasshouse whitefly**

Spray Methyl demeton @ 25 EC or Dimethoate 30 EC @ 1 ml/l.

**Ash weevils**

Spray Phosalone 35 EC @ 1.5 ml/l.

**Diseases**

**Mosaic:** Remove the affected plants and spray systemic insecticides to control insect vectors.

**Powdery mildew:** Spray Wettable sulphur @ 2 g/l or dust sulphur @ 25 kg/ha.

**Rust:** Dust sulphur @ 25 kg/ha.

**Anthrachnose:** Spray Mancozeb @ 2 g/l. Remove the affected plants and pods.

**Yield:** Green pods 8 - 10 t/ha in 90 to 110 days.



**Broad beans: *Vicia faba* L; Fabaceae**

**Varieties:** SWS 1 (Suttan White Seeded), BR 1 (Bihar Black Seeded) and BR 2 (Bihar Yellow Seeded).

**Soil:** Thrives in almost all soils with a pH range of 6.5-7.5 in hills only.

**Season and sowing:** Sow the seeds during July – August and November - December at 25 kg/ha at 45 x 15 cm spacing.

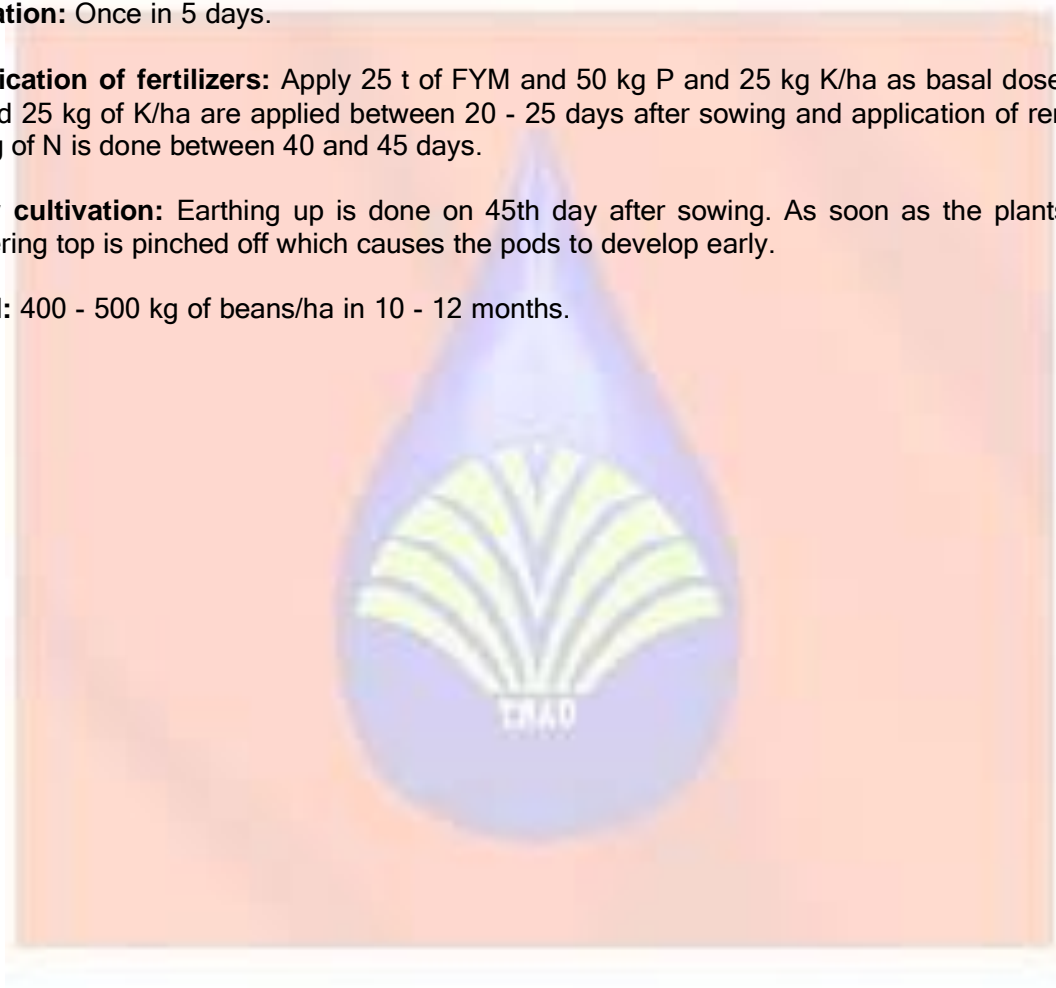
**Preparation of field:** Plough the land to a fine tilth, level and form beds.

**Irrigation:** Once in 5 days.

**Application of fertilizers:** Apply 25 t of FYM and 50 kg P and 25 kg K/ha as basal dose. 25 kg N and 25 kg of K/ha are applied between 20 - 25 days after sowing and application of remaining 25 kg of N is done between 40 and 45 days.

**After cultivation:** Earthing up is done on 45th day after sowing. As soon as the plants grow, flowering top is pinched off which causes the pods to develop early.

**Yield:** 400 - 500 kg of beans/ha in 10 - 12 months.



## **Peas: *Pisum sativum* L.; Fabaceae**

**Varieties:** Ooty 1, Bonneville, Arkel, Azad.

**Soil:** Well drained loamy soil with optimum pH range of 6-7.5.

**Season and sowing:** Sow the seeds during February - March and October - November in plains. Treat the seeds with *Trichoderma* @ 4 g/kg or Thiram or Captan @ 2 g/kg of seeds to avoid seed borne diseases. Treat the seeds with *Rhizobium* culture @ of 2 kg and apply 2 kg *Phosphobacteria* as soil application just before sowing.

**Preparation of field:** Dig the land thoroughly to fine tilth.

**Spacing:** 45 x 10 cm.

**Seed rate:** 100 kg/ha.

**Irrigation:** Once in a week.

**Application of fertilizers:** Apply FYM @ 20 t/ha and 60 kg N, 80 kg P and 70 kg K/ha as basal and 60 kg N/ha 30 days after sowing.

**After cultivation:** Weeding should be done 15 days after sowing. Subsequent weedings as and when necessary. Stake the plants on 30th day of sowing.

### **Harvest**

Harvest can be done on 75 days after sowing. High temperature during harvest affects the quality of peas.

### **Plant protection**

#### **Pests**

**Pod borer:** Spray Carbaryl 50 WP thrice at fortnightly intervals @ 2 g/lit. Dust with Carbaryl 10 D at the rate of 25 kg/ha.

**Aphids:** Spray Methyl demeton 25 EC or Dimethoate 30 EC or Phosphamidon 40 SL @ 1 ml/l of water.

#### **Diseases**

**Powdery mildew:** Spray wettable sulphur @ 2 g/l or Dinocap @ 1 ml/l or Tridemorph @ 0.5 ml/l or dust sulphur @ 25 kg/ha three rounds at 15 days interval.

**Yield:** 8 -12 t/ha

#### **Market information**

Crop growing districts	Nilgiris, Dindigul
Major markets in Tamil Nadu	Mettupalayam, Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Grade Specification	The edible-pods should be uniformly bright green (light to deep green but not yellowgreen), fully turgid, clean, and free from damage.

## **Annual moringa: *Moringa oleifera* L.; Moringaceae**

**Varieties:** PKM 1 and PKM 2.

**Soil:** Comes up well in a wide range of soil. A deep sandy loam soil with a pH of 6.5 – 8 is ideal.

**Season:** July - October.

**Seed rate:** 500 g/ha

Sow two seeds per pit at a depth of 2.5-3.0 cm. The seeds can also be sown in polybags containing pot mixture and transplanted after 35 -40 days of sowing.

**Preparatory cultivation:** Dig pits of size 45 cm x 45 cm x 45 cm with a spacing of 2.0-2.5 m either way. Apply 15 kg of compost or FYM/pit after mixing with top soil.

### **High density planting and fertigation in moringa PKM 1**

High density planting at 1.5 X 1.0 m spacing with two plants/hill and plant population 13,333 / ha along with the application of fertilizer dose of 135: 23 :45 g of NPK/pit (150%) through drip increases the yield of moringa. In this phosphorus should be applied basally as soil application. N and K can be applied in the form of urea and muriate of potash through drip.

- For PKM-2, the closest spacing of 1.2 x 1.2 m is ideal to obtain the highest yield of 138 t/ha. The pinching of main shoots on 80<sup>th</sup> day after sowing will also help register the highest yield of fruits.

**After cultivation:** Gap filling may be done within a month. Pinch off the seedlings when they are about 75 cm in height to facilitate more branching. Short duration vegetables like cowpea, bhendi and tomato can be grown as intercrop.

- For perennial moringa, medium pruning of shoots at 70 cm from the tip has to be followed to regulate flowering and obtain the highest yield of 37 kg/ tree.

**Manuring:** A fertilizer dose of 45:15:30 g of NPK/pit may be applied 3 months after sowing. Apply 45 g of N/pit after 6 months when the crop is in bearing.

**Irrigation:** Irrigate before sowing, on 3rd day after sowing and subsequently at 10 to 15 days interval according to soil type.

### **Plant protection**

#### **Pests**

##### **Moringa pod fly management**

Soil application of Thiamethoxam 25 WG @ 200g a.i. / ha on 150, 180 and 210 days after planting; placement of fermented tomato fruit trap @ 25 / ha; and need based foliar spray of Spinosad 45 SC @ 56g a.i. / ha followed by Profenophos 50 EC@ 250g a.i. / ha

**Bud worm, leaf caterpillar and leaf webber:** Dust Carbaryl 10 D @ 25 kg/ha or spray Carbaryl 50 WP @ 2 g/l.

##### **Hairy caterpillar**

Use flame torch when the caterpillars settle on the tree trunk



**Ratoon crop:**

Cut back the trees at 90 cm from ground level after the harvest is over. In another 4 – 5 months, plants will again come for harvest. Two ratoon crops can be taken. Apply the fertilizer dose of 45:15:30 g NPK/plant, within a week after cutting back along with 25 kg of FYM or compost every time.

**Yield:** 50 - 55 tonnes of pods/ha (220 pods/tree/year).

**Market information**

Crop growing districts	Dindigul, Thoothukudi, Theni, Karur, Tiruppur
Major markets in Tamil Nadu	Dindigul, Periyar Vegetable Market Koyambedu, Chennai Gandhi Market, Oddanchathiram Natchipalayam vegetable market, Coimbatore
Preferred Varieties and hybrids	PKM 1, PKM 2 and KM 1

Trade Mark of TNAU



**Baby corn: *Zea mays*; Poaceae**

**Variety:** COBC 1

**Soil:** All maize growing soils with a pH range of 6-7.

**Season**

Irrigated : Throughout the year.

Rainfed : June - July and September - October.

**Seed rate:** 25 kg/ha.

Trade Mark of TNAU

**Preparation of field:** Plough the field to fine tilth. Form ridges and furrows at a spacing of 45 cm and sow the seeds at a spacing of 25cm on one side of the ridge.

**Irrigation:** First irrigation after sowing, second on third day and thereafter once in ten days.

**Application of fertilizers:** Apply FYM 12.5 t/ha, NPK 75, 60, 20 kg/ha as basal, 75 kg N and 20 kg K top dressed on 25th day after sowing.

**After cultivation**

First weeding : 15 days after sowing.

Earthing up and top dressing : 25 days after sowing.

De-tasseling (removal of male flowers) : 40 - 45 days before pollen shedding

**Plant protection**

Basal application: Carbofuran 3 G 10 kg/ha is to be applied and incorporated.

**Yield**

Tender cob (baby corn) : 6660 kg/ha

Green fodder : 32.2 t/ha



## Chapter B

### Cole Vegetables

**Cabbage:** *Brassica oleracea var. capitata*; Brassicaceae

#### Varieties

**Hills:** Quisto.

**Plains:** Golden Acre and Maha Rani.

**Soil:** It is grown in varied types of soils ranging from sandy loam to clay. It requires a pH range of 5.5 to 6.5.

#### Season of sowing

**Hills:** January - February, July - August and September - October.

**Plains:** August - November.

**Seed rate:** 650 g/ha.

**Nursery:** 100 sq.m nursery area/ha. Apply FYM at 300 kg and 10 kg of No.5 mixture (9:9:9) along with 50 g of sodium molybdate and 100 g of borax. Sow the seeds in rows drawn at 10 cm spacing in raised seed beds after drenching it with Copper oxychloride (2.5 g/l). Seedlings will be ready for transplanting in 40-45 days after sowing. Avoid land infected with 'club root disease'.

#### Protected nursery

Raise the seedlings in shade net house. A nursery area of 5 cents with a slanting slope of 2% is required for the production of seedlings for 1 ha. Cover the nursery area with 50 per cent shade net and the sides with 40/50 mesh insect proof nylon net. Form the raised beds of 1m width and convenient length inside the nursery and above the beds, the protrays are placed.

#### Protray

The Protrays of 98 cells are ideal for cabbage seedling production. Around 600 protrays are required for the production of 28.333 seedlings required for one hectare at spacing of 60x45x45 cm in three row planting

#### Growing medium

The sterilized cocopeat @ 720kg / ha is mixed with 10kg of neem cake and Azospirillum and Phosphobacteria each @ 1kg. About 1.25 kg of the cocopeat medium is required for each tray.

#### Seed treatment

250 g of hybrid cabbage seed is required for the production of seedlings for 1 ha. Treat the seeds in hot water @ 50°C for 30 minutes. 25g of Azospirillum is required for the seed treatment of 250g cabbage seeds.

### **Sowing**

Sow the seeds in protrays @ 1 seed per cell. Cover the seeds with cocopeat and keep the tray one over the other (8-10Nos) and covered with polythene sheet for 5 days or till germination starts. After 5 days when the seeds are germinated arrange the protrays on the raised beds inside the shade net nursery. Water the tray by rose can everyday (twice / day) upto seed germination. Drench with 19:19:19 + MN @ 0.5 % (5g/lit) solution using rose can or spray micro nutrient of 0.5 % at 18 days after sowing. The cabbage seedlings are ready for transplanting in 25 days

**Preparation of field:** Bring the soil to a fine tilth. Pits should be taken up at a spacing of 40 cm either way in Hills. Ridges and furrows are formed at 45 cm apart in plains.

### **Spacing**

Hills : 40 x 40 cm  
Plains : 45 x 30 cm

**Irrigation:** Provide continuous supply of moisture.

### **Drip irrigation**

Install drip system with main and sub-main and place the inline laterals at the interval of 1.5. Place the drippers at the interval of 60 cm for 4 LPH or 50 cm for 3.5 LPH in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

### **Application of fertilizers**

**Hills:** Apply 30 t/ha FYM, 90 kg N, 90 kg P and 90 kg K as basal and 45:45:45 kg NPK/ha 30 to 45 days after planting. Apply departmental micronutrient mixture (borax & molybdenum) @ 2 kg per ha as basal dressing.

**Plains:** Apply 20 t/ha of FYM. 50 kg N, 125 kg P and 25 kg K/ha along with 2 kg *Azospirillum* as basal and 50 kg N after one month of planting and earth up.

### **Fertigation**

**Fertigation requirement** for F1 hybrid: 200: 125:150 kg of NPK / ha. Apply once in three days throughout the cropping period.

**Spacing :** 60x 45x45cm in paired row system

### Fertigation schedule

Recommended Dose: 200:125:150 kg/ha

Sl.No.	Crop Stage	Duration in days	Fertilizer grade	Total fertilizers	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Transplanting to plant establishment	10	19:19:19+ MN 13-0.45 Urea	32.87 19.42 24.36	6.25 2.52 11.21	6.25 - -	6.25 8.74 -	10.00	5.00	10.00
				Sub total	19.98	6.25	14.99			
2	Head initiation stage	30	12-61-0 13-0-45 Urea	20.37 133.20 130.74	2.44 17.32 60.14	12.50 - -	- 59.94 -	30.00	10.00	30.00
				Sub total	79.90	12.50	59.54			
3	Head initiation to development stage	30	19:19:19+ MN 13-0.45 Urea	32.87 86.02 92.37	6.25 11.18 42.49	6.25 - -	6.25 38.71 -	20.00	5.00	20.00
				Sub total	59.92	6.25	44.96			
4	Harvesting stage	35	12-61-0 13-0-45 Urea	10.18 66.60 65.38	1.22 8.66 30.07	6.25 - -	- 29.97 -	40.00	5.00	40.00
	Total duration	105		Sub total	39.95	6.25	29.97	100.00	25.00	100.00
				Total	199.75 (or) 200.00	31.25	149.85 (or) 150.00			

75% RD of Phosphorus applied as superphosphate in plains and rock phosphate in hills (589 kg/ha)

1. 19:19:19 = 66 kg / ha
2. 13:0:45 = 305 kg / ha
3. 12:61:0 = 31 kg / ha
4. Urea = 313 kg / ha

**After cultivation:** Deep hoeing should be avoided, as the Cabbage roots are surface feeders.

### Plant protection

#### Pests

#### Aphids:

Install yellow sticky trap @12 no/ha to monitor "macropterous" adults (winged adult).

Spray neem oil 3 % with 0.5 ml Teepol/lit or any one of the following insecticide

Insecticide	Dose
Azadirachtin 0.03% WSP (300 ppm)	5.0 g/lit.
Dimethoate 30 % EC	6.0 ml/10 lit.
Malathion 50 % EC	1.5 ml/lit.
Phosalone 35 % EC	1.5 ml/lit.
Quinalphos 25 % EC	1.0 ml/lit.

#### Diamond backmoth

1. Grow mustard as intercrop at 20:1 ratio to attract diamond back moths for oviposition.

Periodically spray the mustard crop with insecticide to avoid the dispersal of the larvae.

2. Install pheromone traps @ 12/ha.
3. Spray cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* @ 2 g/lit at primordial stage (ETL 2 larvae/plant).
4. Release parasite *Diadegma semiclausum* @ 50,000/ha, 60 days after planting.
5. Spray NSKE 5 % after primordial stage or any one of the following insecticide

Insecticide	Dose
Azadirachtin 0.03% WSP (300 ppm)	5.0 g/lit.
<i>Bacillus thuringiensis</i> var <i>kurstaki</i> 5 % WP	1.0 g/lit.
Chlorantraniliprole 18.5 % SC	1.0 ml/10 lit.
Chlorfenapyr 10 % SC	1.5 ml/lit.
Chlorpyrifos 20 % EC	2.0 ml/lit.
Diafenthiuron 50 % WP	8.0 g/10 lit.
Emamectin benzoate 5 % SG	4 g/10 lit.
Fipronil 5 % SC	1.6 ml/lit.
Flubendiamide 20 WDG	2.5 g/10 lit.
Flufenoxuron 10 % DC	4 ml/10 lit.
Indoxacarb 14.5 % SC	3.5 ml/10 lit.
Indoxacarb 15.8 % SC	2.7 ml/10 lit.
Lufenuron 5.4 % EC	1.2 ml/ lit.
Metaflumizone 22 % SC	1.5 ml/lit.
Novaluron 10 % EC	7.5 ml/10 lit.
Pyridalyl 10 % EC	1.0 ml/lit.
Spinosad 2.5 % SC	1.2 ml/lit.
Thiodicarb 75 % WP	1.5 g/lit.
Trichlorofon 50 % EC	1.0 ml/ lit.

## Diseases

### Club root:

### Biological control

Seed treatment with *Pseudomonas fluorescens* at 10 g/ kg of seeds, followed by seedling dip @ 5g/ l and soil application @ 2.5 kg/ha along with 50 kg FYM before planting

### Chemical control

Dip the seedlings in Carbendazim solution 2 g/l for 20 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/l of water. Follow crop rotation. Crucifers should be avoided for three years.

**Leaf spots:** Spray Mancozeb at 2 g/l or Carbendazim 1 g/l.

**Leaf Blight:** Spray Mancozeb @ 2.5 g/ l.

**Ring spot:** Spray Mancozeb 2 g/l or Carbendzim 1 g/l or Copper oxychloride 2.5 g/lit.

**Downy mildew:** Spray combination of Metalaxyl + Mancozeb 2 g/l 3 sprays at 10 days interval.

**Black rot:** Dip the seeds in 100 ppm Streptocycline for 30 minutes. Two sprays with 2 g/l Copper oxychloride + Streptomycin 100 ppm after planting and head formation.



**Yield**

**Hills** : 70 - 80 t/ha in 150 days.

**Plains** : 25 - 35 t/ha in 120 days.

**Market information**

Crop Growing districts	Nilgris, Krishnagiri, Theni, Erode
Major markets in Tamil Nadu	Mettupalayam, Ottanchathiram, Hosur and Dindigul
Grade Specification	Size and Weight



## **Cauliflower: *Brassica oleracea var. botrytis*; Brassicaceae**

### **Varieties**

**Hills:** Ooty 1, Pusa Dapoli.

**Plains:** Early Synthetic, Pawas, NS131.

**Climate and Soil:** It requires cool moist climate. Deep loamy soils are good with high organic matter and good drainage. It can be grown in a pH range of 5.5 to 6.6.

**Season and sowing:** The early varieties may tolerate higher temperature and long days. This can be grown in plains during September to February. Late Varieties Snowball types can be grown in hills.

**Nursery:** 100 sq.m nursery area/ha. Apply FYM at 300 kg and 10 kg of No.5 mixture (9:9:9) along with 50 g of sodium molybdate and 100 g of borax. Sow the seeds at 10 cm between rows in raised seed beds after drenching with Copper oxychloride (2.5 g/l). Transplant 30 to 40 days old seedlings at a spacing of 45 cm. Avoid land infected with 'club root disease'.

**Seed rate:** 375 g/ha.

Sow the seeds in raised beds and transplant 25 days (early varieties), 45 days (late varieties) old seedlings at 45 cm apart

### **Protected nursery**

Raise the seedlings in shade net house. A nursery area of 5 cents with slanting slope of 2% is required for the production of seedlings for 1 ha. Cover the nursery area with 50 per cent shade net and the sides with 40/50 mesh insect proof nylon net. Form the raised beds of 1m width and convenient length inside the nursery and above the beds, place the protrays.

### **Protray**

The Protrays of 98 cells are ideal for cauliflower seedling production. Around 600 protrays are required for of 28,333 seedlings required for one hectare at a spacing of 60 x 45 x 45 cm in three row planting

### **Growing medium**

The sterilized cocopeat @ 720kg / ha is mixed with 10kg of neem cake and Azospirillum and Phosphobacteria each @ 1kg. About 1.25 kg of the cocopeat medium is required for each tray.

### **Seed treatment**

250 g of hybrid cauliflower seed is required for the production of seedlings for 1 ha. Treat the seeds in hot water @ 50°C for 30 minutes. 25g of Azospirillum is required for the seed treatment of 250g cauliflower seeds.

### **Sowing**

Sow the seeds in protrays @ 1 seed per cell. Cover the seeds with cocopeat, keep the tray one over the other (8-10Nos) and cover with polythene sheet for 5 days or till germination starts. After 5 days when the seeds are germinated, arrange the protrays on the raised beds inside the shade net nursery. Water the tray by rose can everyday (twice / day) and drench

with 19:19:19 + MN @ 0.5 % (5g/l) solution using rose can or spray micronutrient at 0.5 % 18 days after sowing. The cauliflower seedlings are ready for transplanting in 25 days

**Preparation of field:** Bring the soil to fine tilth. Pits should be taken at a spacing of 45 cm either way in hills. Form ridges and furrows at 60 cm in plains.

### **Irrigation**

**Hills:** Once in a week during January and February.

**Plains:** Once in a week.

### **Drip irrigation**

Install drip system with main and sub-main and the inline laterals placed at the interval of 1.5 m. Place the drippers at the interval of 60 cm for 4 LPH or 50 cm for 3.5 LPH, in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

### **Application of fertilizers**

**Hills:** Apply 30 t/ha of FYM and 90 kg N, 90 kg P and 90 kg K as basal dose and 45:45:45 kg NPK/ha after 45 days.

**Plains:** Apply 15 t of FYM/ha and 50 kg N, 100 kg P and 50 kg K as basal and 50 kg N after 45 days. Apply 2 kg of Departmental vegetable micronutrient mixture without mixing with the chemical fertilizers.

### **Fertigation**

Fertigation requirement for F1 hybrid: 200: 125: 125 kg of NPK / ha. Apply once in every three days throughout the cropping period.

Spacing: 60x 45x45cm in paired row system

## Fertigation schedule

Recommended Dose: 200:125:125 kg/ha

Sl. No	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Transplanting to establishment stage	10	19:19:19+MN	62.66	11.906	11.906	11.906	10.00	9.70	12.00
			13-0-45	7.33	0.953	-	3.300			
			Urea (46% N)	15.33	7.866	-				
Sub total				85.333	19.913	11.906	15.206			
2	Curd initiation stage	25	13-0-45	111.333	14.473	-	50.100	56.00	15.30	40.00
			12-61-0	31.333	3.760	19.113	-			
			Urea (46% N)	204.00	93.84	-				
Sub total				346.666	112.073	19.113	50.100			
3	Curd development stage	35	Urea (46% N)	148.00	68.08	-	-	34.00	-	48.00
			0-0-50	120.666	-	-	-			
Sub total				268.666	68.080	-	60.333			
	Total Duration	70		Total	200.06	31.019	125.63	100	25	100

75% of RD of P applied as superphosphate = 586 kg/ha

- 1. 19: 19: 19+MN = 63 kg
- 2. 13: 0: 45 = 119 kg
- 3. Urea = 368 kg
- 4. 0-0-50 = 121 kg
- 5. 12:61:0 = 32 kg

**After cultivation:** Gap filling after 20 days of planting to maintain the population and uniform growth. Hoeing and weeding on 30th and 45th day. Avoid deep intercultivation as it is a shallow rooted crop.

## Plant protection

### Pests

#### Aphids:

Install yellow sticky trap @ 12 no/ha to monitor Macropterous adults (winged adult).

Apply phorate 10 % G @ 20 kg /ha or spray neem oil 3 % with 0.5ml teepol/lit or spray any one of the following insecticide

Insecticide	Dose
Azadirachtin 5% Neem Extract Concentrate	5.0 ml/10 lit.
Dimethoate 30 % EC	7.0ml/10 lit.

#### Diamond backmoth

1. Grow mustard as intercrop at 20:1 ratio.
2. Install pheromone traps @ 12 No/ha.
3. Release larval parasite *Diadegma semiclausum* @ 50,000/ ha, 60 days after planting

4. Spray NSKE 5 % or cartap hydrochloride @ 1 g/lit or *Bacillus thuringiensis* @ 1g/lit at primordial stage (ETL 2 larvae/plant) or any of the following insecticides

Insecticide	Dose
Azadirachtin 5% Neem Extract Concentrate	5.0 ml/10 lit.
Lufenuron 5.4 % EC	1.2 ml/lit.
Spinosad 2.5 % SC	1.2 ml/lit.
Trichlorofon 50 % EC	1.0 ml/lit.

## Diseases

### Club root:

#### Biological control

Seed treatment with *Pseudomonas fluorescens* at 10 g/ kg of seeds, followed by seedling dip @ 5g/ l and soil application @ 2.5 kg/ha along with 50 kg FYM before planting

#### Chemical control

Dip the seedlings in Carbendazim solution 2 g/l for 20 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/l of water. Follow crop rotation. Crucifers should be avoided for three years

**Leaf Spot:** Spray Mancozeb at 2 g/l or Carbendazim 1 g/l.

**Leaf Blight:** Spray Mancozeb @ 2.5 g/ litre.

**Blanching:** Blanching refers to covering of curds. A perfect curd is pure white. It is necessary to exclude sunlight to obtain this. The common practice is to bring the outer leaves up over the curd and tie them with a twine or rubber band. By using a different coloured twine each day. It is easy at the time of harvest to select those tied earlier.

#### Physiological disorders

**Browning or brown rot:** This is caused by boron deficiency. It appears as water soaked areas and later change into rusty brown. Spray one kg of borax in 500 l of water 30 days after planting.

**Whip tail:** This results from the deficiency of molybdenum. It is more pronounced in acidic soil. The leaf blades do not develop properly. In severe cases, only the midrib develops and it can be corrected by spraying 100 g of Sodium molybdate in 500 l of water 30 days after planting.

**Buttoning:** The term buttoning is applied to the development of small curds or buttons. The plants do not develop normally and leaves remain small and do not cover the developing curds. Deficiency of nitrogen and planting the early varieties late may cause these symptoms. Avoid transplanting of aged seedlings.

**Blindness:** Blind-cauliflower plants are those without terminal buds. The leaves are large, thick, leathery and dark green. It is due to the prevalence of low temperature when the plants are young or due to damage to the terminal bud during handling the plants or due to injury by pests.

**Yield**

Hills : 20 - 30 t/ha

Plains : 15 - 20 t/ha

**Market information**

Crop Growing districts	Dindigul, Theni, Coimbatore, Tiruppur
Major markets in Tamil Nadu	Mettupalayam, Coimbatore, Ottanchathiram, Koyambedu
Grade Specification	Size and colour





## Chapter C

# Root and Tuber vegetables

**Carrot:** *Daucus carota* L; Umbelliferae

### Varieties

**Hills:** Ooty-1, Early Nantes and New Korda.

**Plains:** India Gold, Pusa Kesar and Half Long Danvers.

**Climate and Soil:** The Carrot is a cool season crop and when grown at 15°C to 20°C will develop a good colour. The carrot crop needs deep loose loamy soil. It requires a soil pH range of 6.0 to 7.0.

### Season

**Hills:** At elevation above 1500 metres, carrot can be grown throughout the year under assured irrigation. At elevations between 1000 - 1500 metres. Carrot can be grown in July - February.

**Plains:** August.

**Seed rate:** 4 kg/ha.

Mark the rows with a spacing of 25 - 30 cm. Sow the seeds mixed with sand (one part of seed with 4 parts of sand).

### Thinning

**Hills:** 10 cm between plants.

**Plains:** 5 cm between plants.

### Preparation of field

**Hills:** Prepare the land to a fine tilth and form raised beds of one metre breadth and convenient length.

**Plains:** Two ploughings are given and ridges and furrows are formed at 30 cm spacing.

**Irrigation:** Once in five days.

**Application of fertilizers:** 30 t of FYM and 90:90:90 kg of NPK per ha as basal dose and 45:45:45 kg of NPK after 45 days. Apply 25 kg of ZnSO<sub>4</sub>/ha as basal.

**After cultivation:** Spray Fluchloralin 1 l a.i./ha immediately after sowing the seeds to control weeds or first weeding to be done on 15th day. Thinning and earthing up should be given on 30<sup>th</sup> day.

Splitting of roots is a physiological disorder which is usually seen when there is a sudden increase in soil moisture after prolonged drought. Forking is another phenomenon where in the hard soil does not allow the straight growth of tap root which results in formation of forked root.

Forked roots and split roots fetch poor price in market. Keeping the soil moisture at optimum condition will help to keep the soil also loose thereby help to avoid splits and forked roots.

**Plant protection:** Carrot is not much affected by pests.

**Nematode:** Application of neem cake @ 1 ton/ha at planting to control root knot nematode, *Meloidogyne* spp.

### Diseases

**Leaf spot :** Spray Mancozeb at 2 g/l.

**Yield:** 25 - 30 t/ha in 100 - 120 days.

### Root and Tuber vegetables

#### Market information

Growing districts	Nilgiris, Dindigul and Krishnagiri
Major markets in Tamil Nadu	Mettupalayam, Dindigul, Coimbatore and Chennai
Grade Specification	Size, diameter or length.

**Radish: *Raphanus sativus* L; Brassicaceae**

**Varieties**

**Hills:** White Icicle, Scarlet globe, Rapid Red White Tipped

**Plains:** CO 1, Pusa Rashmi, Pusa Chetki, Pusa Desi, Japanese White and Arka Nishant.

**Soil:** Sandy loam soils with high organic matter. The optimum soil pH is 5.5 to 6.8. Roots of best size, flavour and texture are developed at about 15°C.

**Season of sowing:** June -July in hills and from September in plains.

**Seed rate:** 10 kg/ha.

**Preparation of field:** The land should be prepared to fine tilth and levelled.

**Spacing:** 15 x 10 cm.

**Irrigation**

**Plains:** Once in a week.

**Drip irrigation**

Install the drip system with main and sub-main pipes and place the inline lateral tubes at an interval of 1.5. Place the dripper in lateral tubes at an interval of 60cm and 50cm spacing with 4LPH and 3.5 LPH capacities respectively. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

**Application of fertilizers**

**Plains:** Apply FYM at 25 t/ha and 25 kg N, 100 kg P and 50 kg K/ha as basal dressing and 25 kg N/ha after 30 days.

**Fertigation**

Fertigation requirement :50:100:50kg of NPK / ha. Apply once in three days  
Spacing : 30x15x10 cm in paired row system. A total of 10 rows is accommodated in one bed.

**After cultivation:** Weeding and hoeing should be done at the second weeding, thinning of thickly sown plants should be done.

**Plant protection**

**Pests**

**Aphids, flea beetles and mustard saw fly:** Spray Malathion 50 EC 1 ml/l twice or thrice at 10 days intervals.

**Diseases**

**White rust:** Spray Mancozeb 2 g/l or Copper oxychloride 2 g/l.

**Yield:** 20 - 30 t/ha in 45 - 60 days.

**Market information**

Crop Growing districts	Vellore, Dindigul, Thanjavur, Nilgris
Major markets in Tamil Nadu	Mettupalayam, Dindigul, Coimbatore and Chennai
Grade Specification	Size, Shape

**Fertigation schedule****Recommended Dose: 50:100:50 kg/ha****100% of TRD: 50: 25: 50****NPK kg/ha**

S.No.	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Vegetative stage	15	19:19:19 +MN 13-0.45 Urea	40	7.5	7.5	7.5	20	7.50	20
				5.5	0.7	-	2.5			
				4.0	1.8	-	-			
				subtotal	10	7.5	10			
2	Early Root development stage	20	19:19:19 +MN 13-0.45 Urea Urea	66	12.5	12.5	12.5	50	12.50	50
				28	3.6	-	12.5			
				20	8.9	-	-			
				subtotal	25	12.5	25			
3	Root maturity stage	10	19:19:19 +MN 13-0.45 Urea	26	5.0	5.0	5.0	30	5.0	30
				22	2.9	-	10.0			
				16	7.1	-	-			
				subtotal	15	5	15			
4	Total	45		Total	50	25	50	100	25	100

75% RD of Phosphorous applied as super phosphate = 500kg /ha.

1. 19:19:19 = 125 kg / ha
2. 13:0:45 = 50 kg / ha
4. Urea = 50 kg / ha

**Beet root: *Beta vulgaris* L.; Chenopodiaceae**

**Varieties:** Ooty 1, Crimson Globe, Detroit Dark Red and Red Ball.

**Soil:** It comes up well in all types of friable soils. The suitable soil pH is 6.0-7.0. It is considered to be a cool weather crop.

**Season and sowing:** July - August.

**Seed rate:** Sow 6 kg/ha directly in ridges at a spacing of 10 cm.

**Preparation of field:** Plough to a fine tilth and form ridges and furrows 30 cm apart.

**Irrigation:** Irrigate the field copiously immediately after sowing and afterwards as and when necessary.

**Drip irrigation**

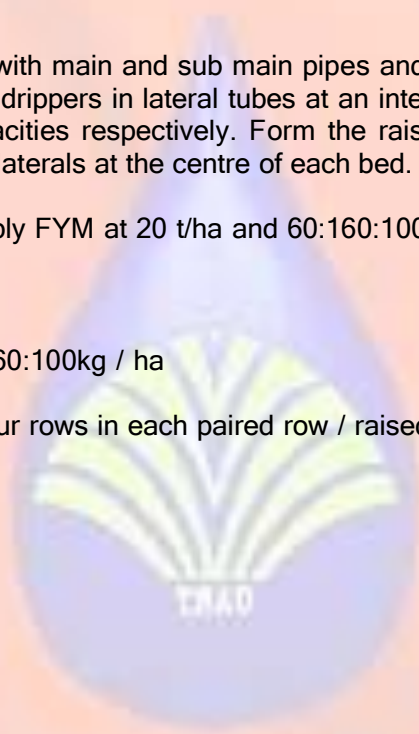
Install the drip system with main and sub main pipes and place the inline lateral tubes at an interval of 1.5 m. Place the drippers in lateral tubes at an interval of 60 cm and 50cm spacing with 4 LPH and 3.5 LPH capacities respectively. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

**Application of fertilizers:** Apply FYM at 20 t/ha and 60:160:100 kg NPK/ha as basal and 60 kg N/ha after 30 days.

**Fertigation:**

Fertigation requirement: 120:160:100kg / ha

**Spacing:** 30 x30 x10 cm as four rows in each paired row / raised bed system.



### Fertigation schedule

Recommended Dose: 120:160:100 kg/ha

S.No.	Crop Stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Vegetative stage	30	19:19:19+MN	42.11	8.00	8.00	8.00	40.00	12.50	10.00
			13-0-45	4.44	0.58	-	2.00			
			12-61-0	19.67	2.36	12.00	-			
			Urea	80.44	37.00	-	-			
			subtotal		48.00	20.00	10.00			
2	Early phase of Root development	60	13-0-45	88.89	11.55	-	40.00	40.00	7.50	60.00
			12-61-0	19.67	2.36	12.00	-			
			Urea	73.96	34.02	-	-			
			0-0-50	40.00	-	-	20.00			
			Urea							
			subtotal		48.00	12.00	60.00			
3	Maturity stage	30	12-61-0	13.12	1.57	8.00	-	20.00	5.0	30.00
			13-0-45	66.67	8.67	-	30.00			
			Urea	29.85	13.76	-	-			
			subtotal		24.00	8.00	30.00			
			Total		120.00	40.00	100.00	100	25	100

\*75% RD of P applied as super phosphate=810 kg/ha.

1. 19:19:19 = 42 kg / ha
2. 12:61:0 = 52 kg / ha
3. 13:0:45 = 160 kg / ha
4. 0:0:50 = 40 kg / ha
5. Urea = 184 kg / ha

**After cultivation:** 20 days after sowing thin to a single seedling per hill.

### Plant protection

#### Pests

**Leaf miner and flea beetle:** Spray Malathion 50 EC 2 ml/l.

#### Diseases

**Cercospora leaf spot:** Spray Mancozeb at 2 g/l.

**Rhizoctonia root rot:** Spot drenching with Carbendazim at 1 g/l.

**Yield:** 20 - 25 t/ha in 120 days.

### Market information

Crop Growing districts	Tiruppur, Coimbatore ,Nilgiris, Dindigul ,Theni,
Major markets in Tamil Nadu	Mettupalayam, Coimbatore, Erode
Grade Specification	Size



## **Potato: *Solanum tuberosum* L.; Solanaceae**

**Varieties:** Kufri Jyoti, Kufri Muthu, Kufri Swarna, Kufri Thangam , Kufri Malar and Kufri Giriraj.

**Soil and climate:** The soil should be friable, porous and well drained. The optimum pH range is 4.8 to 5.4. It is a cool weather crop. Potato is mostly grown as a rainfed crop. Cultivated in regions receiving a rainfall of 1200 - 2000 mm per annum.

### **Season and planting**

#### **Hills**

Summer : March - April  
Autumn : August - September  
Irrigated : January - February

**Plains:** October - November.

Use disease free, well spouted seeds weighing 40 - 50 g. Use Carbon disulphide 30 g/100 kg of seeds for breaking the dormancy and inducing sprouting of seeds. Plant the tubers 20 cm apart.

**Seed rate:** 3000 - 3500 kg/ha.

**Preparation of field:** Prepare the land to fine tilth. In hills provide an inward slope of 1.40 in the terraces. Provide drainage channel along the inner edge of the terrace. Form ridges and furrows with a spacing of 45 cm between ridges.

**Irrigation:** Irrigate the crop 10 days after planting. Subsequently irrigation should be given once a week.

#### **Drip irrigation**

Install drip system with main and sub-main and place the inline laterals at the interval of 1.5. Place the drippers at the interval of 60 cm for 4 LPH or 50 cm for 3.5 LPH in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.

**Application of fertilizers:** Apply 15 t of FYM/ha, and 2 kg each of *Azospirillum* and *Phosphobacteria* as basal and 120 kg N, 240 kg P and 120 kg K/ha in two splits; half as basal and the balance for top dressing 30 days after sowing. Apply magnesium sulphate at 60 kg/ha as basal dose.

#### **Fertigation**

**Fertigation requirement** - 120: 240:120 kg of NPK / ha. Apply once in every three days throughout the cropping period.

**Spacing:** 60 x 30 x 20cm in paired row system

**Fertigation schedule: Potato (Variety)**  
Recommended dose: 120:240:120 kg/ha

S. No.	Crop Stage	Duration in days	Fertilizer grade	Total fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Planting to crop establishment	20	19:19:19 +MN	63.15	12.00	12.00	12.00	10.00	5.00	10.00
				subtotal	12.00	12.00	12.00			
2	Vegetative stage	30	12-61-0 13-0-45 Urea	39.34 106.67 63.82	4.72 13.87 29.36	24.00 - -	- 48.00 -	30.00	10.00	30.00
				subtotal	47.95	24.00	48.00			
3	Tuber formation stage	35	19:19:19 +MN 13-0-45 Urea	63.15 53.33 37.04	12.00 6.93 17.04	12.00 - -	12.00 24.00 -	40.00	5.00	30.00
				subtotal	35.97	12.00	36.00			
4	Tuber development stage	35	12-61-0 13-0-45 Urea	19.67 53.33 31.92	2.36 6.93 14.68	12.00 - -	- 24.00 -	20.00	5.0	30.00
				Sub total	23.97	12.00	24.00			
				Total	119.89	60.00	120.00	100.00	25.00	100.00

75% RD of Phosphorus applied as superphosphate = 1125 kg/ha as basal dose.

In hills rock phosphate is the source for P

1. 19:19:19 = 126 kg/ha
2. 13:0:45 = 213 kg / ha
3. 12:61:0 = 59 kg / ha
4. Urea = 133 kg / ha

### After cultivation

**Weed control:** Spray of Gramaxone @ 2.5 l/ha in 500 lit of water as post - emergence. The critical period of weed-competition is upto 60 days and it is essential to keep the field weed-free during that period. Take up the first hoeing on 45th day without disturbing stolons and second hoeing and earthing up on 60th day.

### Plant protection

#### Pests

##### Cut worms:

- Fork the soil during summer months to expose the larvae and pupae for avian predators.
- Set up light trap between 7-10 pm to attract the adults.
- Set up pheromone traps @ 8/acre to monitor and attract male moths.
- Collect the first instar larvae from lace-like damaged leaves.
- Collect the grown up larvae from the soil (near the damaged stem) and destroy.
- Set up sprinkler system during day time to expose the hidden larvae for predation by birds.
- Apply NSKE 5% or neem oil @ 2 lit/acre using 500 lit of spray fluid.
- Collect grownup caterpillars mechanically and spray *Bacillus thuringiensis* @ 2g/lit.

### Potato tuber moth

- Select healthy tubers and plant at 15 cm depth to avoid oviposition.
- Set up pheromone traps @ 5/acre. Septa can be replaced once in a year.
- Release egg-larval parasite, *Chelonus blackburnii* @12,000 parasites/acre twice (on 40 and 70 days after planting)
- Earth up and cover the tubers to prevent oviposition in exposed tubers.
- Cover the top layers of seed tubers with *Lantana* or *Euclayptus* branches to repel the ovipositing female moths.
- Spray quinalphos @ 1 lit /ha at ETL of 5% leaf damage

### Aphids:

Apply carbofuran 3 % G @ 17 kg /ha or Phorate 10% G @ 10 kg /ha or drench thiamethoxam 25 % WG @ 200 g in 500 lit of water per ha or spray any one of the following Insecticide

Insecticide	Dose
Dimethoate 30%EC	7.0 ml/10 lit.
Oxydemeton -Methyl 25% EC	1.0 ml/lit.
Thiamethoxam 25 % WG -Foliar	2.0 gl/10 lit.

### Diseases

**Late blight:** Carefully select seed tubers. Remove ground creepers which serve as a source of infection. Spray Mancozeb 2 g/l or Chlorothalonil 2 g/l on 45, 60 and 75 days after planting. Grow late blight resistant varieties like Kufri Jyothi, Kufri Malar and Kufri Thangam.

**Brown rot:** Select disease free seeds. Give proper drainage facilities. Remove and destroy the affected plants.

**Early blight:** Spray Mancozeb 2 g/l or Chlorothalonil 2 g/l at 45, 60 and 75 days after planting.

### Virus diseases:

Use virus free potato seeds. Rogue the virus affected plants regularly. Control the aphid vectors by spraying dimethoate 30 EC or methyl demeton 25 EC @ 2 ml/lit

**Yield:** 15 - 20 t/ha in a duration of 120 days.

### Market information

Crop Growing districts	Dindigul, Nilgiris
Major markets in Tamil Nadu	Ottanchathiram, Koyambedu, Mettupalayam, Coimbatore
Preferred Varieties and hybrids	Kufri Jyoti, Kufri Swarna
Grade Specification	Hardness, higher shelf life, pure yellow colour Thala - 40-60 mm Rasi- 20-40 mm Podi - 10-20 mm

## **Sweetpotato: *Ipomoea batatas* (L) Lam; Convolvulaceae**

**Varieties:** CO 3, CO - CIP 1, Sree Nandini, Sree Vardhini, Kiran, Sree Bhadra, Sree Rethna, Gouri and Sankar.

**Soil:** Can be grown in loamy soil with a pH range of 5.6-6.6.

**Season and planting:** June – July and September. Plant the terminal vine cuttings (80,000/ha) at 20 cm spacing. The cuttings should be 10-15 cm in length with 2-3 nodes and to be collected from matured vines aged 3 months and above. Dip the vine cuttings in a solution by mixing 400 g of *Azospirillum* in sufficient quantity of water.

**Preparation of field:** Plough the field to fine tilth. The soil depth should be atleast 30 cm. Form ridges and furrows 60 cm apart or beds.

**Irrigation:** Irrigate before planting, on 3rd day and then after once a week. Stop irrigation one week before harvest.

**Application of fertilizers:** Apply 25 t FYM/ha and 20:40:60 kg NPK/ha as basal and 20:40:60 kg NPK/ha after 30 days. If 20 kg/ha *Azospirillum* is applied, apply only 2/3rd dose of N. It is preferable to apply N and P in the form of diammonium phosphate.

**After cultivation:** The field should be kept clean by hand weeding till vines are fully developed. Earth up the field on 25th, 50th and 75th day after planting. The vines are lifted and turned on 50<sup>th</sup> and 75th day after planting but before earthing up to prevent root formation at nodes and to make the originally formed roots to increase in size. Spray Ethrel five times at 250 ppm at fortnightly intervals commencing from 15 days after planting.

### **Plant protection**

#### **Pests**

##### **Sweetpotato weevil**

1. Remove previous sweetpotato crop residues and alternate host *i.e.*, *Ipomoea* sp. and destroy them.
2. Install sex pheromone trap right from beginning of the crop establishment.
3. Use pest free planting materials.
4. Dip the planting material in fenthion 100 EC or Fenitrothion 50 EC .
5. Rake up the soil and earth up at 50 days after planting.
6. Drench the soil with Endosulfan 35 EC or Fenthion 100 EC at 2 ml/l. Spray any one of the insecticides, if needed.
7. Harvest the crop immediately after maturity and destroy the crop residues.

#### **Diseases**

**Soft rot:** Spot drench with Carbendazim 1 g/l.

**Yield:** 20-25 t/ha of tubers in 110 - 120 days.

**Tapioca: *Manihot esculenta* Crantz.; Euphorbiaceae**

**Varieties:** CO 2, CO 3, CO (TP) 4, MVD 1, H 165, H 226, Sree Visakham (H.1687), Sree Sahya (H.2304), Sree Prakash (S. 856), Sree Vijaya, Sree Jaya, Sree Rekha and Sree Prabha.

**CTCRI CO (Tp) 5 (Sree Padmanabha)**

Resistance to cassava mosaic disease. Season June – July ; October – November. Fairly good starch content (28%). Moderate tuber yield (38 t/ha). Erect and top branching habit. Regular flowering and seed setting. Tubers long, cylindrical, white flesh and low in cyanoglucoside. Duration 270 – 300 days.

**Climate and soil:** Any well drained soil preferably red lateritic loam with a pH range of 5.5-7.0. Thrives best in tropical, warm humid climate with well distributed rainfall of over 100 cm per annum. Cultivated upto an elevation of 1000 m.

**Season and planting:** Plant throughout the year under irrigation. Plant during April for rainfed crop. Select healthy mosaic free vigorous plants for taking planting materials. Prepare setts of 15 cm long with 8 – 10 nodes from the middle portion of the stem. Avoid mechanical damage while preparation and handling of setts. The cut end should be uniform. Dip the setts in Carbendazim 1 g in one l of water for 15 minutes before planting. Plant the setts vertically with buds pointing upward on the sides of ridges and furrows. 17,000 setts are needed for planting one ha. For rainfed conditions, treat the setts with a mixture of potassium chloride @ 5 g/lit and micronutrients viz., ZnSO<sub>4</sub> and FeSO<sub>4</sub> each @ 0.5% for 20 minutes. Dip the setts for 20 minutes in *Azospirillum* and phosphobacteria each at 30 g/l.

**Virus elimination through tissue culture in cassava**

The protocol for virus elimination through tissue culture has been standardized for the varieties MVD 1 and H 226 by using meristem culture. The Murashige and Skoog (MS) medium supplemented with BAP at 0.1 mg/l for meristem establishment and shoot growth, and MS medium without growth regulators for rooting have to be followed. The *in vitro* plantlets are to be hardened in sterile pot mixture (sand : soil : FYM in 1 : 1: 1) under mist chamber for 10-15 days and later kept under shade net for 10 days before transferring them to the open field.

**Preparation of field:** Plough the field 4 - 5 times to get a fine tilth. The soil depth should be atleast 30 cm. Form ridges and furrows at the following spacings:

**Irrigated:** 75 x 75 cm (17,777 setts) and 90 x 90 cm (12,345 setts).

**Rainfed:** 60 x 60 cm (27,777 setts).

**Under Kanyakumari conditions:** 90 x 90 cm (12,345 setts).

**Irrigation:** First irrigation is given at the time of planting. Life irrigation is given on the 3rd day followed by once in 7 - 10 days upto 3rd month and once in 20 - 30 days upto 8th month.

**Drip irrigation**

Install drip system with main and sub-main and place the inline laterals at the interval of 1.5 m. Place the drippers at the interval of 60 cm for 4 LPH and 50 cm for 3.5 LPH in the lateral system. Form the raised beds at 120 cm width at an interval of 30cm and place the laterals at the centre of each bed.



**Sequential cropping:** Raise CO 2 vegetable cowpea during March and harvest green pods before planting cassava during June -July. After green pod harvest, incorporate the cowpea haulms into the field by disc ploughing. Through sequential cropping, 50% reduction in application of FYM (12.5 t/ha) and P (30 kg/ha) is ensured.

### **Manuring**

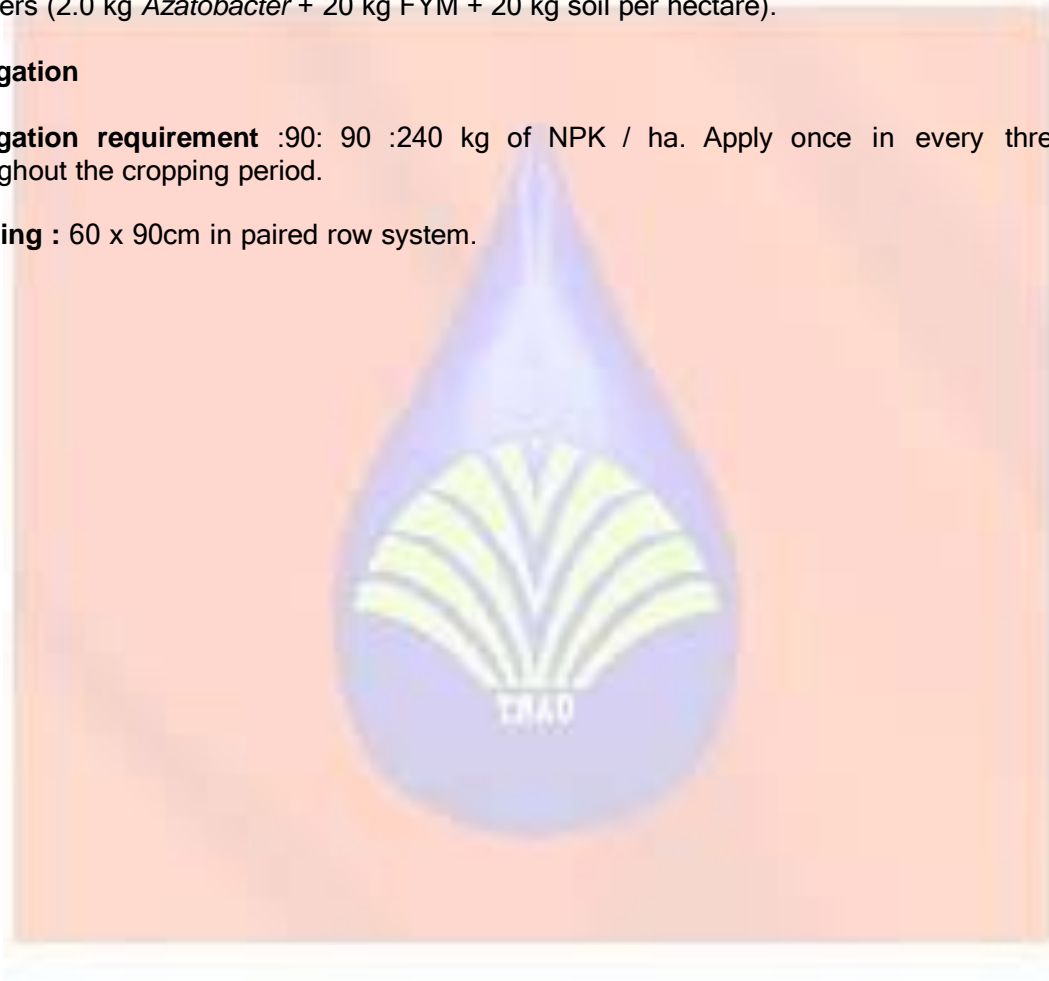
**Irrigated crop:** Apply 25 t FYM/ha and incorporate at the time of planting. Apply 45:90:120 kg NPK/ha as basal and 45:120 kg NK/ha 90 days after planting during earthing up.

**Rainfed crop:** Apply FYM at 12.5 t/ha along with 50 kg N, 65 kg P and 125 kg K/ha as basal. Apply 2 kg of *Azotobacter* through soil application at 30 – 60 days after planting on receipt of showers (2.0 kg *Azotobacter* + 20 kg FYM + 20 kg soil per hectare).

### **Fertigation**

**Fertigation requirement :** 90: 90 :240 kg of NPK / ha. Apply once in every three days throughout the cropping period.

**Spacing :** 60 x 90cm in paired row system.





### Fertigation schedule: Tapioca (variety)

S. No	Crop Stage	Duration in Days	Fertilizer Grade	Total Fertilizer (kg/ha)	Nutrient supplied			% Requirement		
					N	P	K	N	P	K
1	Planting to crop establishment stage	20	19:19:19+MN 13-0-45 0-0-50	23.57 34.67 7.87	4.48 4.50 -	4.48 - -	4.48 15.60 3.93	10.00	5.00	10.00
				subtotal	8.98	4.48	24.01	47.39		
2	Vegetative stage	70	12-61-0 13-0-45 Urea	11.40 105.33 26.80	1.34 13.69 12.33	6.80 - -	- 47.39 -	30.00	7.50	20.00
				subtotal	27.36	6.80	47.39			
3	Tuber formation stage	60	12-61-0 0-0-50 Urea	11.40 144.00 55.73	1.34 - 25.64	6.80 - -	- 72.00 -	30.00	7.50	30.00
				subtotal	26.98	6.80	72.00			
4	Tuber development stage	90	19:19:19+MN 0-0-50 Urea	23.57 182.67 48.87	4.48 - 22.48	4.48 - -	4.48 92.34 -	30.00	5.00	40.00
	Total duration	240		sub total	26.96	4.48	96.82			
Total					90.28 (or) 90	22.56(or) ) 22.50	240.2 2 (or)240	100	25	100

- 75% RD of Phosphorus applied as superphosphate 421.88 kg/ha.
  1. 19:19:19 = 47. kg / ha.
  2. 13:0:45 = 140kg/ha.
  3. 12:61:0 = 23kg/ha
  4. 0:0:50 = 335kg / ha
  5. Urea = 132 kg / ha.

**Chlorosis:** Foliar spray of 1% FeSO<sub>4</sub> + 0.5% ZnSO<sub>4</sub> at 60 and 90 DAP.

**After cultivation:** Fill up the gaps within 20 days of planting. Carry out 1st weeding 20 days after planting. Subsequent weedings should be done once in a month upto 5 months depending upon the weed intensity. Thin to two shoots per plant during 60th day. Grow aggregatum onion, coriander, short duration pulses and short duration vegetables as intercrops from planting date upto 60 days

### Plant protection

#### Pests

**Mites:** Soaking spray with dicofol 18.5 EC 2.5 ml/l during 3rd and 5th month.

#### White fly (*Bemisia tabaci*)

Integrated pest management practices:

1. Remove alternate weed hosts viz., *Abutilon indicum*.
2. Install yellow sticky trap at 12 Nos/ha.

3. Use nitrogen judiciously.
4. Avoid excessive irrigation.
5. Spray neem oil 3 % or fish oil rosin soap 25 g/l or Methyl demeton 25 EC 2 ml/l. While using neem oil, teepol or sandovit should be added at 1 ml/l for better contact with foliage. Apply Methyl demeton in the early stage and Phosalone in the later stages of crop growth.
6. Avoid use of synthetic pyrethroids.
7. Avoid extending the crop growth beyond its duration.

### **Spiralling whitefly**

1. Install sticky cum light trap and operate between 4 and 6 am to attract adults.
2. Spray Dichlorvos 76 WSC @ 1 ml/l or Triazophos 40 EC 2 ml/l. Add wetting agent.
3. Conserve parasitoids *Encarsia haitiensis* and *E. guadeloupae*.

### **Diseases**

**Mosaic:** Select the planting materials from healthy plants. For the control of white fly vectors, adopt IPM practices mentioned above.

**Cercospora Leaf spot:** Spray Mancozeb at 2 g/l twice at 15 days interval.

**Tuber rot:** Avoid water stagnation. Give good drainage facilities. Spot drench with Copper oxychloride 2.5 g/l or apply through soil *Trichoderma viride* @ 2.5 kg/ha as basal and at 3rd and 6th month after planting

**Crop duration:** 9 to 11 months.

### **Yield**

Irrigated : 40 - 50 t/ha

Rainfed : 20 - 25 t/ha

### **Market information**

Crop Growing districts	Salem, Namakkal, Erode, Dharmapuri, Villupuram
Major markets in Tamil Nadu	Salem, Dharmapuri, Erode

**Elephant foot yam:** *Amorphophallus campanulatus* Blume; syn: *A. paeoniifolius*; Araceae

**Varieties:** Gajendra, Sree Padma

**Soil and climate:** Rich red-loamy soil with a pH range of 5.5-7.0 is preferred. It is a tropical and subtropical crop. It thrives well with a mean annual temperature of 30-35°C. It requires well distributed rainfall of 1000-1500 mm spread over a period of 6-8 months, with humid and warm weather during vegetative phase and with cool and dry weather during the corm development period.

**Season and planting:** It undergoes a dormancy period of 45 to 60 days. Traditionally farmers take advantage of the dormancy period by planting during February-March so that the sets would sprout with the pre-monsoon showers. April – May is the planting season.

The tuber is cut into 750-1000g small bits in such a way that each bit has at least a small portion of the ring around each bud. Whole corms of 500 g size can also be used as a planting material. Use of cormels and miniset transplants of 100 g size as planting material at a closer spacing of 45 x 30 cm is also suggested. There are also projections with tender buds called “Arumbu”. These are removed before planting as they do not give vigorous growth.

An ordinary sized yam gives about 6 to 8 bits for planting. The cut pieces are dipped in cow dung solution to prevent evaporation of moisture from cut surface. In some places, the small round daughter corms are also planted. The cut pieces are planted in beds at 45 cm x 90 cm spacing or pit of 60 x 60 x 45 cm size is dug and planted. The pit should be filled with top soil and farm yard manure (2kg/pit) prior to planting. The pieces are planted in such a way that the sprouting region (the ring) is kept above the soil. About 3500 kg of corms will be required to plant one hectare. Sprouting takes place in about a month.

**Preparation of field:** The land is brought to fine tilth and beds of convenient size are formed.

**Intercropping:** Vegetable cowpea var. CO 2 is recommended as suitable intercrop in elephant foot yam. It can be intercropped profitably in coconut, arecanut, rubber, banana and robusta coffee plantations at a spacing of 90 x 90 cm. Half quantity of FYM (12.5 t/ha) and one third of NPK (27:20:33) will be sufficient for the intercrop.

**Irrigation:** It is mostly raised as a rainfed crop. However, irrigation is required when monsoon fails, where it is grown on a large scale. Water stagnation is harmful to the crop. Wherever irrigation facility is available, irrigation can be given once a week.

**Mulching:** Mulching immediately after planting not only conserves soil moisture and regulates soil temperature but also suppresses weed growth.

**Application of fertilizers:** Apply 25 tonnes of FYM/ha during last ploughing. The recommended dose of NPK/ha is 80:60:100 kg. Apply 40:60:50 kg NPK/ha at 45 days after planting along with weeding and intercultural operations. Top dress with 40:50 N and K one month later along with shallow intercultural operations.

**After cultivation:** Weeding and earthing up as and when necessary.

**Collar rot :** The disease is caused by a soil borne fungus *Sclerotium rolfsii*. Water logging, poor drainage and mechanical injury at collar region favour the disease incidence. Brownish lesions first occur on collar regions, which spreads to the entire pseudostem and cause

complete yellowing of the plant. In severe case, the plant collapses leading to complete crop loss.

**Management:** Use disease free planting material, remove infected plant materials, improve drainage conditions, incorporate organic amendments like neem cake, drench the soil with carbenilazim or apply biocontrol agents like *Trichoderma harzianum*l @ 2.5 kg/ha mixed with 50kg of FYM (lg/l of water).

**Harvesting:** It becomes ready for harvest in about 8-9 months after planting. The crop attains maturity when total senescence takes place.

**Yield:** 30 - 35 t/ha in 240 days.

For seed purpose, the yams can be left in the field itself till planting the next crop or the lifted yams can be stored in sand or paddy straw.



**Taro: *Colocasia esculenta* L. Scott; Araceae**

**Varieties:** Co 1, Panchamukhi and Satamukhi (Kovvur), Sree Pallavi, Sree Rashmi, Sree Kiran.

**Soil and climate:** It comes up well in loamy soils with a pH range of 5.5-7.0 and a combination of warm and moist climate with a mean temperature of 21-27° C. It can be grown up to 1500 m elevation with well distributed rainfall of about 1000 mm during growth period. In areas where rainfall is less, a good amount of supplementary irrigation is required for successful production.

**Planting material and seed rate:** Cormels weighing about 20-25 g form good planting material. Seed rate of 800 kg/ha is required.

**Season:** Under rainfed condition, planting during April to June is ideal. June – July and February – March. If grown as irrigated crop, it can be raised throughout the year.

**Preparation of field:** Plough the field to a fine tilth and form ridges and furrows at a spacing of 45 cm. In sandy loam soil, pit method is followed. Plant at a spacing of 45 cm in furrows. The cormels may be planted to a depth of 2.5 to 7.5 cm.

**Mulching:**

Planted seed tubers take 30 to 45 days for sprouting. Mulching helps to hasten sprouting and control weed growth.

**Gap filling:**

Under field conditions, 5-10 per cent of the seeds fail to sprout. To overcome this situation, about 2000-3000 corms / cormels per hectare may be planted in a nursery at a close spacing so that sprouted tubers from the nursery can be used for gap filling.

**Irrigation:** Once in a week.

**Application of fertilizers:** Apply 25 tonnes of FYM, 20 kg N, 30 kg P and 60 kg K/ha as basal and 20 kg N, 30 kg P and 60 kg K/ha 45 days after planting.

**After cultivation:** Weeding and earthing up should be done 45 to 60 days after planting. Deep cultivation should be avoided. Small inefficient suckers from the mother plants have to be removed along with the second weeding. It requires profuse irrigation and shade.

**Crop protection:**

Aphids and worms are pests attacking the leaves.

Control: Spray Quinalphos or Dimethoate 0.05%.

Mealy bugs and scale insects damage cormels and corms and hence select cormels free of these pests for planting. If infested, the seed cormels should be dipped in Dimethoate or Monocrotophos 0.05% solution for 10 minutes.

**Leaf blight (*Phytophthora colocasiae*):** Oval or irregular purplish or brownish necrotic lesions with water-soaked periphery appear on leaves. In severe cases, the entire leaf lamina and the petioles are affected giving a blighted appearance and collapse of the plant. Heavy incidence causes up to 50 per cent crop loss.

**Management :** Use of field resistant varieties viz., Muktakeshi and Jankhri, early planting to avoid heavy monsoon rains, use of healthy planting materials, removal of self-grown colocasia

plants, spray with fungicides viz., Mancozeb (0.2%) or Ridomil MZ 72 @ 2 g/l of water and treating the seed tubers with biocontrol agents viz., *Trichoderma viride*

### Harvesting

Crop will be ready for harvest in 6-8 months after planting. One month prior to harvest, all the suckers may be wrapped around the base of the mother plant and covered with soil by earthing up, for arresting further vegetative growth and sprouting of tubers. After this, irrigation has to be withheld to hasten maturity. Harvesting is done by carefully uprooting the plants and the mother corms and cormels are separated.

**Yield:** 8 - 10 t/ha in 180 days.





## **Dioscorea: *Dioscorea alata* and L.; *Dioscorea esculenta* L. Dioscoreaceae**

### **Varieties**

Peruvalli (*D.alata*) : CO 1, Sree Roopa, Sree Keerthi, Sree Shilpa.

Siruvalli (*D.esculenta*) : Sree Latha, Sree Kala.

**Soil and climate:** It requires warm and humid conditions with a mean temperature of 30°C and a well distributed annual rainfall of 1200-2000 mm. Sandy loam soil with a pH of 6.0 to 6.5 is preferred with good drainage and cool weather.

**Season and planting:** March - June.

Use mature tubers or pieces of 250-300 g tubers taken from the previous crop as seed material at the rate of 1875 – 2500 kg/ha. Mini setts of 25 g are recommended for planting directly in the field or raising a nursery and planting plants after 60 days. For planting lesser yam, medium sized tuber of 100-150 g is sufficient. Planting is done in beds or in ridges or in mounds or in rows 75 cm apart either way.

**Preparation of field:** Plough the field to a fine tilth and form ridges and furrows at 75 cm spacing for raising lesser yam. Ridges and furrows at 75 cm spacing or pits of 45 x 45 x 45 cm for planting greater yam at 90 x 90 cm. Fill the pits with top soil and FYM.

**Method of planting :** To plant greater yam, 3000-3700 kg and for lesser yam 1800-2700 kg of seed material is required.

**Irrigation:** Copious watering once in a week is necessary.

**Application of fertilizers:** Apply FYM @ 25 t/ha at the time of last ploughing. Follow fertilizer schedule of 40:60:120 kg NPK/ha as basal and 4 kg/ha of *Azospirillum* (mixed with 40 kg of soil) 30 days after planting. Apply 50 kg N and 120 kg K/ha 90 days after planting. Go for weeding before top dressing, followed by earthing up.

**After cultivation:** The vines should be trained on bamboo poles. Weeding as and when necessary. It can be intercropped profitably in coconut, arecanut, rubber, banana and robusta coffee plantations at a spacing of 90 x 90 cm. In Robusta banana + *Dioscorea* system, banana should be manured at the full recommended dosage and for yams, manuring at the 2/3<sup>rd</sup> recommended level is sufficient.

### **Trailing**

Trailing is necessary to expose the leaves to sunlight. It is done within 15 days after sprouting by coir rope attached to artificial supports in the open area or to the trees where it is raised as an intercrop.

### **Crop protection**

Yam scale is found to occur on the tubers both under field and storage conditions. As a prophylactic measure, dip the planting material. Use scale free seed tuber for planting.

### **Harvesting**

Greater yam and white yam become ready for harvest by 9-10 months after planting. Lesser yam takes 8-9 months for attaining maturity. Carefully dig out the tubers without causing injury.

**Yield:** 20 - 25 t/ha in 240 days.

**Chinese potato:** *Coleus parviflorus* L.; Syn : *Solenostemon rotundifolius*; Labiatae

**Varieties:** CO 1, Sree Dhara.

**Soil and climate:** Red, loamy and well drained soils. Comes up well in shade with warm humid climate. It requires very good rainfall for its growth and cannot withstand drought conditions. In case rains are not received, irrigation has to be provided for satisfactory growth.

**Raising nursery :** Raise a nursery, approximately one and half months prior to planting. An area of 500 m<sup>2</sup> is required to produce vines for planting one hectare of land. Cattle manure or compost may be applied @ 1 kg/m<sup>2</sup> and ridges / mounds may be prepared at a closer spacing of 45/60 cm. Healthy tubers that weigh about 15-20 g may be planted at 5cm spacing on the ridges / mounds so as to accommodate 750-1200 kg tubers in 500 m<sup>2</sup> area during March- April. Top-dress with urea (5 kg / 500 m<sup>2</sup>) at about three weeks after planting to encourage good vine growth. Stem cutting of 15-20cm length from these sprouts also used as planting material. To enable rapid multiplication of the planting material, single node cuttings can be planted directly in the secondary nursery. Such single node cuttings produce axillary shoots within one week can be planted in the main field.

**Preparation of main field and planting:** The field is ploughed 4 to 5 times to a fine tilth and form ridges and furrows 60 cm apart. Use herbaceous cuttings of 10 cm length taken from the nursery beds and plant in the main field during July – October at a spacing of 30 cm on the ridges either in vertical or horizontal position. Horizontal planting of vines to a depth of 4-5 cm and exposing the terminal bud ensures quick establishment and promote tuber yield. In loose soils having good drainage, planting can also be done on flat beds with provision for drainage.

**Irrigation:** At weekly intervals.

**Application of fertilizers:** FYM at 25 t/ha as basal and NPK at 30:60:150 kg/ha. Apply 30 kg N 30 days after planting at the time of earthing up along with 2 kg of *Azospirillum*. In case, the soil has eroded from the base of the plant, give one more earthing up at 30 days later to promote tuber formation.

**After cultivation:** 2 or 3 weedings and earthing up 2 months after planting.

**Crop protection :** Root knot nematode is a serious pest on coleus and the infested plants exhibit serious swellings or galls in the roots resulting in suppressed roots, stunted growth and wilting. Less than a millimetre long, the nematodes are tiny worms that enter the plant roots of the seedling when the plant is most vulnerable. Therefore, emphasis may be given for the selection of seed tubers free of nematodes.

Deep ploughing of the field immediately after harvest exposes the soil and kills the nematodes. We can also control the nematodes by practising summer fallowing and soil solarization. Cultivation of sweet potato (Sree Bhadra) as a preceding crop in May-June enables trapping of root knot nematodes in the soil. To control leaf folding caterpillars and vine borers, dipping the vines in insecticide solution (Dimethoate or Rogar 30 EC ie. 1.7 ml/litre) for 10 minutes prior to planting is helpful. In case, severe damage is noticed in the field, field spraying may be adopted with Malathion (or) Fenthion (or) Fenitrothion 50 EC 1 ml/litre).

**Harvesting:** Harvest the crop when the vines dry up at 4-5 months after planting. Pull out the plants and dig out the left over tubers in the field. Separate the tubers from the plant and destroy the crop residues by burning.

**Yield:** 15 to 20 t/ha in 120 days.

## Chapter D

### Bulb vegetables

**Onion - Small onion (Aggregatum); *Allium cepa* var. *aggregatum*; Alliaceae**

**Varieties:** CO 1, CO 2, CO 3, CO 4 and MDU 1, CO(On) 5 is a free flowering and seed setting type.

**Soil:** Red loam to black soils with good drainage facilities. The germination and bulb maturation is affected in clayey soil. It grows well in pH range of 6- 7 and a mild season without extremes of heat and cold.

**Season and sowing:** Sow the medium sized bulbs during April – May and October – November. It requires sufficient soil moisture during its growing period but heavy rains during bulb germination and bulb formation affects the crop growth.

**Seed rate:** Seed bulbs 1000 kg/ha. Medium sized bulbs are to be chosen for planting. Seeds @ 8kg/ha.

#### **Raising seedlings and transplanting**

This is the most common method practiced for irrigated crop as it results in high yield and large size bulbs. In plains, seeds are sown during October-November for a rabi crop. In hills, seeds are sown from March to June. Seeds are first sown in well prepared nursery beds of 90-120 cm width, 7.5-10.0 cm height and convenient length. Ratio between nursery area and main field is about 1:20. Seed rate varies from 8 to 10 kg/ha. Seedlings of 15 cm height and 0.8 cm neck diameter are ideal for transplanting and this is achieved in 8 weeks. However, it varies from 6-10 weeks depending on soil, climate and receipt of rain. There is a practice of topping seedlings at the time of transplanting if seedlings are over-grown.

**Preparation of field:** Plough the land four times to a fine tilth. Form ridges and furrows at 45 cm spacing. Sow the bulbs or plant the seedlings on both the sides of the ridges at 10 cm apart.

**Irrigation:** Irrigate at the time of planting of seedlings and third day and later at weekly intervals. With hold irrigation 10 days before harvest.

**Application of fertilizers:** Apply FYM 25 t/ha, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg/ha, N 30 kg, P 60 kg and K 30 kg/ha as basal and 30 kg N/ha on 30th day of sowing.

**Fertigation :** Apply a dose of 75% of the total recommended dose of superphosphate i.e. 285 kg/ha as basal dose. *Azospirillum* and *Phosphobacteria* each @ 2 Kg/ha along with FYM 50 Kg and Neem cake @ 100 kg are applied before last ploughing. Raised beds of 120 cm are formed at an interval of 30 cm and the laterals are placed at the centre of each bed.

**Planting design:** Bulbs or seedlings are planted in rows of 20 cm spacing and 12 cm between plants. Planting is done at 6 rows in each bed, thereby it accommodates 55,560 plants in one hectare. Irrigation is done after transplanting or planting the bulbs. Complete wetting is necessary to maintain uniform moisture level.

## Plant protection - Pests

**Thrips and onion fly:** Spray any one of the following insecticides based on the ETL of 1 maggot/hill

Insecticide	Dose
Dimethoate 30 % EC	7.0 ml /10 lit.
Oxydemeton -Methyl 25 % EC	1.2 ml/lit.
Quinalphos 25 % EC	1.2 ml/lit.

**Cutworm:** Drench the soil with chlorpyrifos @ 2 ml/l.

## Diseases

**Leaf spot:** Spray Mancozeb 2 g /l or Copper oxychloride 2.5 g/l. Add Teepol 0.5 ml/l of spray fluid.

**Basal rot:** Seed or bulb treatment with *Trichoderma viride*, @ 4g/kg and basal application of *T. viride*, @2.5kg/ha along with VAM 12.5 kg/ha.

(or)

### Follow the following IPM practices for pest and disease management

- Growing two rows of maize as barrier crops around field border.
- Selection of healthy onion seed bulbs.
- Bulb treatment -*Pseudomonas fluorescens* (5 g/kg) + *Trichoderma viride* (5 g/kg)
- Soil application of *P.fluorescens* (1.25 Kg/ha) + *T.viride* (1.25 kg/ha) + AM Fungi (VAM) (12.5 kg/ha) + Azophos (4kg/ha) + Neem cake 250 kg/ha.
- Installation of Yellow sticky traps 12/ha for thrips and leaf miner trapping.
- Installation of Pheromone traps 12/ha for cut worm (*S.litura*).
- Spray application of *P.fluorescens* (5 g/l) + *Beauveria bassiana* (10 g/l) on 30 DAP.
- Spray application of Azadairachtin 1% (2 ml/l) on 40 DAP.
- Need based application of Profenophos (2 ml/l) or Dimethoate (2 ml/l) or Triazophos(2 ml/l) for thrips/leaf miner/cut worm management.
- Need based application of Tebuconazole (1.5) ml/l) or Mancozeb (2 g/l)/Zineb (2g/l) for purple blotch disease management.

## Harvest and Yield

Spray Cycocel @ 200ppm + carbendazim @ 1000 ppm 30 days before harvest to extend the shelf life of onion. Harvesting is done by pulling out plants when tops are drooping but still green. During hot days when soil is hard, bulbs are pulled out with a hand-hoe. 12-16 t/ha in 70 to 90 days. 18 t/ha in 90 days for CO (On) 5 onion. Clean and dry the bulbs for 4 days in shade soon after harvest.

## Market information

Crop Growing districts	Perambalur, Trichy, Dindigul, Namakkal, Coimbatore, Erode, Tirunelveli
Major markets in Tamil Nadu	Dindigul, Palani, Palladam, Madurai, Trichy, Ottanchathiram, Coimbatore and Chennai
Preferred Varieties	Co (On) 5
Grade Specification	Shape, Size, skin colour, moisture content



## **Big onion or Common onion: *Allium cepa* var. *cepa*; Alliaceae**

**Varieties:** Bellary Red, Pusa Red, NP 53, Arka Niketan, Arka Kalyan, Agri Found Light Red, Agri Found Dark Red and Rose onion (small).

**Soil:** Red loam to black soils with good drainage facilities. The optimum pH is 5.8-6.5.

**Season:** May - June. Mild season is preferred.

**Seed rate and Sowing:** 10 kg/ha. Treat the seeds with *Azospirillum* @ 400 g/kg of seed using rice gruel as adhesive, dry under shade for 30 minutes and sow them. Apply VAM 1 kg/sq. m in the beds along with FYM 10 kg/sq.m before sowing.

**Preparation of main field:** Plough the land to a fine tilth and incorporate 25 t/ha of FYM at the time of last ploughing. Form ridges and furrows at 45 cm spacing. Plant 45 days old seedlings at 10 cm apart on both the sides of the ridges.

**Irrigation:** Irrigate at planting and third day and later at weekly intervals.

**Application of fertilizers:** Apply FYM 25 t/ha, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg/ha, N 50 kg, P 150 kg and K 75 kg/ha as basal dose and N 50 kg/ha as topdressing 30 days after planting. Apply Zinc sulphate as basal dose @ 50 kg/ha at the time of last ploughing.

### **Plant protection**

#### **Pests**

**Thrips and onion fly:** Spray methyl demeton 25 EC @ 1 ml/lit or dimethoate 30 EC @ 1 ml/lit with Teepol 0.5 ml/lit.

**Cutworm:** Drench the soil with chlorpyrifos @ 2 ml/l.

**Nematode:** Application of Carbofuran 3 G or Phorate 10G @ 1 kg a.i./ha at 10 days after transplanting.

#### **Disease**

**Leaf spot:** Spray Mancozeb 2 g/l or Copper oxychloride 2 g/l . Add 1 ml of Teepol to per l of spray fluid.

**Yield:** 15 - 18 t/ha in 140 - 150 days.

### **Bellary onion – Market information**

Crop Growing districts	Perambalur, Trichy, Thiruppur, Dindigul, Namakkal, Tirunelveli
Major markets in Tamil Nadu	Ottanchathiram, Koyambedu, Dindigul, Coimbatore
Grade Specification	Colour and Size Extra large onion (>6 cm dia.), Medium (4-6 cm dia.), Small (2-4 cm dia.), Light Red, light purple colour

## **Big onion and aggregatum onion production through fertigation**

### **Quality seedling production:**

- The seedlings of big / common bellary onion are produced in raised nursery beds. Nursery area of 12.5 cents with slanting slope of 2% is required for the seedling production to cover 1 ha.
- Unlike other transplanted vegetables, the nursery area of open / protected – raised beds may be used since, the seeds are too small and the number of seedlings requirement is also very high.
- Raised beds of 30cm height and convenient length at an interval of 30cm between beds must be formed for sowing the seeds.
- The beds are inoculated with Arbuscular mycorrhizae @ 1 kg / sq. m.

### **Seed treatment and seed rate:**

- 8-12kg of onion seeds are required to raise seedlings for one hectare of land. The seeds are treated with *Pseudomonas fluorescens* @ 10g/ kg of seeds.

### **Sowing :**

- The seeds of onion are small, and hence the seeds should be mixed with fine sand and sown in lines 10 cm apart.
- After sowing, the seeds are covered by thin layer of sand and then by paddy straw. The nursery is watered through rose can twice a day regularly.
- On tenth day, copper oxychloride @ 2g / litre of water is sprayed to protect the seedlings from damping off disease.

### **Drip irrigation**

- Installation of drip system is done with main and sub-main pipes and the inline lateral tubes are placed at an interval of 1.5 m.
- The drippers in lateral tubes are placed at an interval of 60 cm and 50cm spacing with 4LPH and 3.5 LPH capacities respectively.

### **Field preparation**

- The field selected for planting should be ploughed thoroughly by using chisel plough, disc plough and cultivator.
- FYM @ 25t / ha and 75% of the total recommended dose of single superphosphate (285kg.) Azospirillum, phosphobacteria 2 kg / ha and *Pseudomonas* 2.5 kg / ha along with FYM 50 kg and neem cake @ 100g are applied before last ploughing.
- Along with biofertilizers 50kg each of zinc sulphate and ferrous sulphate are applied before last ploughing.
- Raised beds of 1.2 m width and 30 cm height are formed for transplanting.
- Drip irrigation is done @ 8-12 hours depending upon the soil condition to get field capacity.

### **Planting:**

- Transplanting is done in rows at the spacing of 15 cm between rows (of 7 rows within the bed) and 10 cm between plants.
- A total population of 4,70,000 seedlings are required to cover one hectare of land.

### **After care:**

- Drip irrigation is done @ 1-2 hours per day depending upon the soil and climatic condition.
- Weeding: First weeding is done on 30<sup>th</sup> day after transplanting. Then weeding is done as and when necessary.



- Fertigation: For big onion, 60:60:30kg of NPK/ha is applied throughout the cropping period. The splits are approximately once in every 3 days.

#### Harvesting and post harvest management.

- The harvesting is done 75 to 160 days depending upon the varieties.
- The irrigation is stopped 15 days before harvesting and sprayed with 2500 ppm of maleic hydrazide. This will prevent sprouting of the bulbs in storage, by which they can be stored even for 6-7 months.
- The correct time of harvest is one week after 50% top fall. After lifting, the bulbs with tops should be cured in shade for 10-15 days before storage to remove field heat. Then proper sorting and grading is done.

#### FERTIGATION SCHEDULE Recommended dose: 60:250: 250 kg / ha

Crop stage	Duration in days	Fertilizer grade	Total Fertilizer (kg/ha)						
				N	P	K	H	P	K
Sowing establishment Stage	10	19:19:19 MN Urea	15.79	3.00	3.00	3.00	10.00	5.00	10.00
			6.50	3.00	-	-			
			Subtotal	6.00	3.00	3.00			
Vegetable stage	25	12:61:0 13:0:45 Amm.So4	7.46	0.89	4.55	5.94	30.00	7.50	20.00
			13.20	1.72	-				
			76.67	15.33	-				
			Subtotal	17.94	4.55	5.94			
Bulb formation stage	25	12:61:0 13:0:45 Amm.So4	7.46	0.89	4.55	-	30.00	7.50	30.00
			19.80	2.57	-	8.99			
			72.33	14.47	-	-			
			Subtotal	17.93	4.55	8.99			
Bulb development stage	30	19:19:19 MN Amm.So4	15.79	3.00	3.00	3.00	30.00	5.00	40.00
			19.80	2.57	-	8.91			
			62.00	12.40	-	-			
			Subtotal	17.97	3.00	11.91			
Total duration	90			59.84 (or) 60.00	15.00	27.76 (or) 30.00	100	25.00	100.00

75% of RD of Phosphorous applied as super phosphate = 45 kg x 6.25 = 281.25 kg/ha

- 19:19:19 = 32 kg/ha
- 12:61:0 = 14.92 kg / ha (or) 15.00 kg /ha
- 13:0:45 = 53 kg / ha
- Urea = 7 kg / ha
- Ammonium SO4 = 211 kg / ha

#### Effect of Endo root soluble and Mycorrhizae on Onion

Apply 1000g Endo Roots Soluble in two splits doses at 15 DAT and 45 DAT along with 100% N and K and 50% P for higher yield and saving of phosphorous

Apply mycorrhiza roots 1000g in two splits at transplanting and 30DAT along with 100% N and K and 50% P for higher yield and saving of phosphorous.

## Chapter E

### Leafy vegetables

**Amaranthus:** *Amaranthus* sp L.; Amaranthaceae

#### Varieties

- CO 1 (Mulaikeerai and Thandukeerai)
- CO 2 (Mulaikeerai and Thandukeerai)
- CO 3 (Clipping type)
- CO 4 (Grain type)
- CO 5 (Mulaikeerai and Thandukeerai)

**Soil:** Well drained loamy soils with slightly acidic nature and warm climate are suitable.

**Season and sowing:** Can be sown throughout the year.

**Seed rate:** 2.5 kg/ha.

Broadcast the seeds evenly on the bed after mixing with 10 parts of sand.

**Preparation of field:** The field is prepared to a fine tilth and beds of 2 x 1.5 m are formed. After germination, thin the seedlings to have a spacing of 12 – 15 cm.

**Irrigation:** Irrigate before and after sowing and at weekly intervals after germination.

**Application of fertilizers:** Apply FYM 25 t/ha, *Azospirillum* 2 kg and *Phosphobacteria* 2 kg/ha, N 75 kg and K 25 kg per ha as basal dose.

#### Plant protection

##### Pests

**Ants:** Apply lindane 1.3% dust @ 10 kg/ha around the beds to control ants, termites and other burrowing insects.

**Leaf eating caterpillar:** Carbaryl 50 WP @ 2 g/l .

##### Diseases

**Leaf spot:** carbendazim @ 1 g/l of water. Spraying sulphur compounds should be avoided.

#### Harvest and yield

##### Leafy types

25 days after sowing for Mulaikeerai (10 t/ha);

40 days after sowing for Thandukeerai (16 t/ha).

**Clipping types:** 10 clippings at weekly intervals (30 t/ha).

**Grain types:** CO 4 – 2.4 t grains/ha + 8 tonnes of tender greens.

## **CURRY LEAF; *Murraya koenigii* Linn. Sprengal; Rutaceae**

**Varieties:** Sen Kaambu, Dharwad-1, Dharwad-2

**Soil and climate:** Red sandy loam with good drainage will be ideal for its normal and fleshy growth, which will result in better leaf yield. The optimum temperature requirement is 26 to 37°C.

**Season of sowing and planting:** The main season of availability of curry leaf fruits is July-August within 3-4 days of collection of fruits, the seeds should be pulped and sown in nursery beds or poly bags. One year old seedlings are suitable for planting. One seedling is planted at the centre of the pit.

**Preparation of field:** The field is ploughed 3-4 times to get a fine tilth. Before last ploughing, well decomposed FYM is applied @ 20 tonnes/ha. Pits of 30 x30x30cm are dug one to two months before planting at a spacing of 1.2 to 1.5 m.

**Irrigation:** Immediately after planting the pits are irrigated. On the third day the second irrigation is given, then the irrigation is given once a week.

**Application of fertilizers:** After each harvest, 20 kg of FYM/plant is applied and mixed with soil.

**Inter cultivation:** Periodical hoeing has to be given. During first year, one intercrop like pulses can be taken. After attaining 1 m height, the terminal bud is cut off to encourage basal branching. In total, 5-6 branches are maintained per bush. Ten to twelve months after planting, the first harvest starts.

### **Plant protection**

#### **Pests**

**Citrus butterfly:** Hand picking and destruction of the larvae.

#### **Diseases**

**Leaf spot:** Spray carbendazim @ 1 g/l of water. Spraying sulphur compounds should be avoided.

**Harvest and yield:** At the end of first year 250-400 kg of leaves/ha can be harvested.

**In II year** : Once in 4 months, every time 1800 kg/ha, which would work out to 5400 kg/ha/year.

**III year** : Yield 5400 kg/ha

**IV year** : 2500 kg/ha once in 3 months, which would work out to 10,000 kg/ha/year

**V year onwards** : 5000 kg/ha once in 3 months, which work out to 20,000 kg/ha/year.

## CHAPTER F - MINOR VEGETABLE CROPS

Name of crop	Varieties	Method of propagation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	Yield
Coccinia( <i>Coccinia indica</i> )	Padappai	Stem cuttings from pistillate plants	2 x 2 m	10 t FYM, 75 kg N, 40 kg P and 75 kg K/ha	Erection of pandal or trellis and training the vines	Yields 6 months after planting and continues throughout the year	10 - 15 t/ha
Chekurmanis ( <i>Sauropus androgynus</i> )	-	Stem cuttings	45 x 60 cm	5 - 10 kg FYM per plant	Weeding, pruning once in a year	Yields four months after planting throughout the year	5 kg leaves per plant
Bread fruit ( <i>Artocarpus altilis</i> )	Seedless and seeded types	Root cuttings/air layering of root suckers/seedling	12 x 12 m	-	-	First harvest 5 to 6 years after planting. February - March, June - August	300 - 500 fruits/tree
Ceylon spinach ( <i>Talinum triangulare</i> )	-	Tender herbaceous stem cuttings	15 x 15 cm	-	Grows well under shade	Harvest within a month after planting and continues throughout the year	4000 - 6000 kg/ha

Name of crop	Varieties	Method of propagation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	yield
Mint ( <i>Mentha virides</i> )	-	Cuttings	15 x 15 cm	-	-	Harvest one month after planting and continues through out the year	2000 kg/ha
Palak ( <i>Beta vulgaris</i> var. <i>Bengalensis</i> )	Ooty 1	Seeds 20 - 25 kg/ha	20 x 10 cm	FYM 25 t/ha, N 60 kg, P 60 kg and K 60 kg/ha	-	First harvest of leaves one month after sowing. Total duration 3 months	20000 kg/ha
Basella(Green : <i>Basella alba</i> ) (Pink: <i>Basella rubra</i> )	-	Stem cuttings and seeds	2 x 2 m in pits	10 kg FYM per pit	Train the vines on trellis or pandals	Harvest 2 months after planting throughout the year	4000 - 6000 kg/ha
Brussels sprout ( <i>Brassica oleracea</i> var. <i>Gemmifera</i> )	Jade cross	Seeds 500 g/ha	60 x 50 cm	-	-	Starts yielding in 6 months; continues for 3 years	4 - 5 t/ha
Asparagus ( <i>Asparagus officinalis</i> var. <i>altilis</i> )	Marth Washington, Mary Washington.	Seeds and Crowns	30 x 30 cm	Basal: N 50 kg, P 10 kg and K 75 kg/ha	-	Harvest from third year of planting	1250 - 3750 kg/ha

Name of crop	Varieties	Method of propagation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	yield
Celery ( <i>Apium graveolens</i> )	Standard Bearer, Wright Grove Grant Giant Pascal	Seeds (125 g/ha)	60 x 15 cm	Top dress: N 140 kg, P 55 kg and K 220 kg/ha	-	Crop duration 4-5 months	10 t/ha
Rhubarb( <i>Rheum rhaponticum</i> )	Victoria, Cherry, Mc Donald, Ruby, Valentino & Sunrise	Root cuttings	Between plants 60 - 120 cm; between rows 1-2 m	Fertilizer mixture of 1:1:1	-	Stalks are harvested 2 years after planting, 5-6 stalks per plant for further growth. Crop duration 5 years	-
Chakravathi keera (Chenopodium album)	Ooty 1	Seeds (50 kg/ha)	30 x 15 cm Broadcasting thinning	Basal FYM -25 t/ha NPK -25-25-25 kg/ha Azospirillum & Phosphobacteria 2 kg/ha each	-	50-60 days harvest once	30 t/ha herbage
Lettuce ( <i>Lactuca sativa</i> )	Head type, Leaf cos type	Seed (500 g/ha)	30 x 15 cm	Basal and Top: FYM 30 t/ha, N 50/50 kg/ha, P 30/30 kg/ha and K 30/30 kg/ha	Top dressing 60 days after planting	Crop duration 2 months	10-15 t/ha



Name of crop	Varieties	Method of propagation	Spacing	Manures and Fertilisers	After cultivation including special practices	Cropping and harvest	yield
Knol-khol ( <i>Brassica caulorapa</i> )	White Vienna, Purple Vienna	Seed (1.5 kg/ha)	30 x 25 cm	Basal 30 t/ha and Top: 180:120:100 kg NPK/ha	-	Crop duration 75 days in main field	20 - 25 t/ha
Turnip( <i>Brassica rapa</i> )	i. <b>Temperate</b> <b>Types:</b> Purple top White Globe Snow. ii. <b>BallTropical</b> <b>Types:</b> Pusa ChandrimaPusa SwetiPusa Kanchan	Seed (4 kg/ha)	30 x 15 cm	Basal: FYM 30 t/ha, N 90 kg, P 125 kg and K 100 kg/ha. Top: N 90 kg/ha	Thinning of seedlings	Crop duration 75- 90 days	-
Winged Bean ( <i>Psophocarpus tetragonalobus</i> )	-	Seeds	1 x 0.5 m	Basal: FYM 10 t/ha, N 40 kg, P 100 kg and K 25 kg/ha	Staking	Duration 10- 12 months	10-12 t/ha
Chinese cabbage ( <i>Brassica pekinensis</i> )	Brassic- a Campestris Sp. Pekinensis Michihili as Veg-I	Seeds (375 g/ha)	45 x 45 cm	Basal: FYM 10 t/ha, N 90 kg, P 125 kg and K 100 kg/ha. Top: 90 kg/ha	Earthing up 60 days after planting	Crop duration 4 months	25 - 35 t/ha
Butter bean ( <i>Phaseolus lunatus</i> )	KKL-1	25 to 35 kg/ha	35 x 25 cm	FYM 20-30 t/ha 40:50:50 NPK kg/ha	-	80-85 days	500 - 1000 kg/ha of grains 5 - 10 t/ha tender pods.

# Part III

## Spices and Condiments

### Chapter A Major Spices

#### **Pepper: *Piper nigrum* L.; Piperaceae**

**Varieties:** Panniyur 2, Karimunda, Sreekara, Subhakara, Panchami, Pournami, IISR Thevam, IISR Malabar Excel, IISR Girimunda, IISR Sakthi, PLD-2.

Lower elevation and less shady areas- Panniyur 1.

Higher elevation and more shady areas - Karimunda.

Inter cropping in Arecanut – Panniyur 5.

**Soil and climate:** Pepper is grown mainly as a rainfed crop. Pepper requires heavy rainfall (150 - 250 cm), high humidity and warm climate. Thrives best on virgin soils rich in humus content and the crop can be grown at elevations up to 1500 m.

**Season:** June - December.

**Planting:** Slopes facing West and South should be avoided. Pits of 50 cm x 50 cm x 50 cm size are dug at a spacing of 2 to 3 m in either direction (Panniyur 1 - 3 x 3 m).

5 to 10 kg of FYM/Compost is mixed with top soil and the pits are filled. Rooted cuttings of black pepper are planted in June-July @ two per standard. Silver oak, Dadap and Jack can be used as standards and should be planted at a spacing of 7-8 m.

**Manuring:** Apply cattle manure or compost @ 10 kg/vine - before the onset of South West monsoon. 100:40:140 g of NPK per vine in two split doses during May - June and September - October. Slaked lime at 500 g per vine is applied in alternate years during May - June.

Apply *Azospirillum* @ 100 g/vine one month after the application of chemical fertilizers.

Integrated nutrient management - Inorganic N 50 % of the recommended dose + FYM 10 kg + 50 g *Azospirillum* + 50 g *Phosphobacteria* + 200 g VAM per plant.

The manures and fertilizers are applied around the vine at a distance of 30 cm from the base and incorporated into the soil.

**Irrigation:** Protective irrigation in basins during December - May at 10 days interval.

**Aftercultivation:** Two weedings are given during the months of June - July and October - November. The vines are to be trained to the standards. Excessive foliage of the standards may be pruned and the height of the standards may be limited to about 6 m. To increase the berry size spray NAA @ 40 ppm.

**Fruit drop:** The spike shedding can be reduced by foliar spray of Diammonium Phosphate 1.0 % four times viz., before flower initiation (May), during new leaves and flower emergence (June) before spike initiation (July) and pinhead stage of berries (August).

**Plant protection**

## Pests

### Thrips :

Spray dimethoate 30 EC @ 2 ml/lit or chlorpyrifos @ 2 ml/lit or dichlorvos 76 WSC @ 1 ml/lit or phosphomidan 40 SL @ 2 ml/lit three rounds at monthly intervals starting from new flush formation.

**Pollu beetle and leaf caterpillars:** Spray quinalphos 25 EC @ 2 ml/lit.

## Diseases

### Foot rot

**Nursery:** Apply *Trichoderma viride* @ 1 g/kg of pot mixture. Mulch the pot mixture with 150 gauge polythene sheet for 30 days and inoculate with *Pseudomonas*.

**MAIN FIELD:** Any of the following formulation can be drenched in the soil twice (May – June and October - November).

- Neem cake 1/2 kg per vine + Swabbing of Bordeaux paste upto 1 m from the ground level.
- *Trichoderma viride* @ 20 g/vine + FYM or Bordeaux mixture 1 % or Metalaxyl-Mancozeb @ 2 g/lit.
- Neem cake 2 kg per vine + 0.1% Metalaxyl (pre monsoon foliar spray and soil application).
- *Pseudomonas fluorescens* (50 g) (pre and post monsoon) + neem cake (2 kg) (post monsoon) + metalaxyl 0.1 %.

**Slow wilt:** Apply Phorate 10 G @ 30 g or Carbofuran 3 G @ 100g per vine (May – June and September - October) + Copper oxy Chloride @ 0.2 % (Soil drenching) or Potassium phosphonate @ 0.3% or Metalaxyl @ 0.1 %.

**Anthracnose:** Foliar spray with Bordeaux mixture @ 1 % or Mancozeb @ 0.2 %.

**Nematode :** Soil application *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* @ 10 g/vine is recommended for the management of root knot and reniform nematode population in Black pepper.

**Harvest:** Harvesting commences from third year onwards. The harvesting season is from November to March. Harvest is done by hand picking the whole spikes when few berries in the spike start turning red. The berries are separated and dipped in hot water (80°C) for one minute and sun dried for 7 to 10 days.

**Yield:** 2 to 3 kg/vine/year.

### Market information

Growing districts	Kanyakumari, Nilgiris, Kolli Hills, Lower pulneys
Major markets in Tamil Nadu	Kanyakumari, Nagarkovil
Preferred varieties	Tellichery, Alleppey and Malabar Garbled (MGI)
Grade specification	Pungency and aroma

## Bush Pepper

**Planting material:** One year old lateral branches with 2-3 nodes with the bit of orthotropic portion intact.

**Planting:** 3-5 well rooted cuttings per pit or pot

**Manures and Manuring:**

- 1:0.5:2 g of NPK per pot at bi monthly intervals
- 15 and 33 g of groundnut cake and neem cake per pit or pot.

**Pruning:** Pruning of hanging shoots to maintain the bushy nature, repeating at every two years interval.

Trade Mark of TNAU



**Cardamom: *Elettaria cardamomum* (Maton.); Zingiberaceae**

**Varieties:**

Malabar- Mudigree-1 and 2, PV 1, ICRI 1, ICRI 3, TKD 4, IISR Suvarna, IISR Vijetha, IISR Avinash, Mysore - ICRI 2, Vazhukka - PV2, Njallani (Green gold)

**Soil and climate:** Thick shady areas with loamy soil are ideal. Grown at an elevation from 600 to 1500 m. Areas exposed to heavy winds are unsuitable. Adequate drainage must be provided.

**Season:** June - December.

**Seeds and sowing:**

**Propagation through Seeds:**

Collect seeds from healthy and high yielding plants.

Seed rate – 600g/ha (fresh seeds).

Treat with commercial grade Sulphuric acid or Hydrochloric acid for 20 minutes.

Wash with water.

Prepare the beds with equal quantity of well rotten cattle manure, wood ash and jungle soil.

Sow the seeds in beds and cover with a thin layer of fine sand.

Mulching and shading may be provided to seed beds. The beds should be kept moist but not too wet. Germination starts usually a month after sowing and continues upto three months. One year old seedlings are transplanted to secondary nursery.

**Secondary nursery:**

Prepare the beds. As that of primary nursery, shade is provided by erecting overhead pandal.

Seedlings planted at a distance of 20 x 20 cm.

18-22 months old seedlings are used for transplanting.

Polybags of 20 x 20 cm size can be used

**Propagation from suckers:**

Suckers from high yielding plants are planted in clonal gardens.

Spacing 1.8 m x 0.6 m (6800 plants/ha of clonal nursery)

Shade and Irrigation is provided, 32 - 42 suckers obtained from each planting unit in 12 months

**Preparation of the field:** Dig pits of 60 cm<sup>3</sup> and fill with compost and top soil. Contour planting may be done in slopy areas.

**Spacing:** Larger types: 2.5 x 2.0 m; Smaller types: 2.0 x 1.5 m.

**Irrigation:** Generally Cardamom is grown as a rainfed crop, but sprinkler irrigation may be provided during summer for increased yields.

**Manuring:** Apply compost 25 t/ha; 75:75:150 kg of NPK per ha in two split doses during June - July and October - November.

**After cultivation:**

Shade regulation. Moderate shade - 50-60 %

Rainfed - 40 - 50 %

Irrigated - 55-60 %

Mixed population of medium sized shade trees- Karona, Red cedar, konikonna, Jack, Vellakil, Thempavu, Thambahom, Bolongi, Elangi.

Weed the field as and when necessary. Towards the end of monsoon rains, a light raking or digging and mulching is given around the plant to a radius of about 75 cm to conserve moisture during the dry period.

## Plant protection

### Pests

#### Thrips:

Pesticide	Dose
Diafenthiuron 50 % WP	8 g/10 lit
Phenthoate 50 % EC	5.0 ml/10 lit.
Quinalphos 25 % EC	12 ml/10 lit.

#### Capsule and shoot borer

Set up pheromone trap @ 12/ha to attract and destroy the female moths.

**Mosaic or Katte disease:** This is a serious disease affecting the productivity of Cardamom. This is transmitted by banana aphid which can be controlled by regular spraying with methyl demeton 25 EC, dimethoate 30 EC or phosphomidon 40 SL @ 750 ml/ha.

#### Damping off or clump rot or rhizome rot:

- Drench nursery with 1 lit of Formaldehyde in 50 lit water for 3 sq.m. before sowing.
- *Pythium*: prophylactic drenching with 0.25 % Mancozeb or 1 % Bordeaux mixture immediately after germination
- *Rhizoctonia* : Soil drenching with 0.05 % Carbendazim - 15 days after germination.

**Capsule rot or panicle rot or Azhukal:** Three sprays with 1 % Bordeaux mixture or 0.25 % Copper oxychloride or 0.2 % Mancozeb (August – September).  
Drench soil with 1 % Bordeaux mixture.

**Harvest:** Harvesting commences from third year onwards. Economic yields from 5<sup>th</sup> year. Harvesting is done once in a month. Pick only those fruits which are just ripe but not fully ripe. Fully ripe fruits tend to split on drying and do not develop the desirable dark green colour.

**Yield:** 200 - 250 kg/ha.

#### Market information

Growing districts	Theni
Major markets in Tamil Nadu	Bodinayakanur, Kumily, Thekkady, Kumbum
Preferred varieties	Alleppey Green Extra Bold' (AGEB),
Grade specification	Freshness, colour, aroma and size



## **Turmeric: *Curcuma longa* Val.; Zingiberaceae**

**Varieties:** CO 1, BSR 1, BSR 2, Roma, Suvarna, Sudarshana, Suguna, Sugandham, Ranga, Rasmi, Rajendra Sonia, Krishna, Suroma and Allepy Supreme, Kedaram, Prabha, Prathiba.

**Soil and climate:** A friable well drained red loamy soil in wet or garden lands under tropical conditions is ideal.

**Season:** May-June

### **Seed Treatment:**

- Seed rhizomes dipped in phosalone 35 EC 2ml/lit 0.3% Copper oxychloride for 30 min
- Seed treatment with *P. fluorescens* 10 g/kg and *T. viride* as 4 g/ Kg.

**Propagation:** Mother rhizome & finger rhizomes. Seed rate of finger rhizome-2000kg/ha.

### **Main Field Preparation:**

Main field is ploughed four times with chisel and disc plough each one time and cultivator twice. Ridges and furrows are formed at spacing of 45 cm (or) raised beds of 120 cm width are formed at an interval of 30 cm and the laterals are placed at the centre of each bed. The beds are wetted for 8-12 hours through drip irrigation depending upon soil moisture level.

**Spacing:** 45 x 15 cm. 25-30 g weight rhizomes are to be dibbled at a depth of 4 cm.

### **Manures and manuring**

**Basal:** FYM - 25 t /ha, neem or groundnut cake - 200 kg/ha, 25:60:108 kg of NPK per ha; 30 kg of FeSO<sub>4</sub> and 15 kg of ZnSO<sub>4</sub>, 10 kg in each of *Azospirillum* and *Phosphobacteria* per ha to be applied at the time of planting.

**Top dressing:** 25: 108 kg of N and K/ha applied on 30, 60, 90, 120 and 150 days after planting.

**Micronutrient application:** Apply 375 g each of Boron, Iron and Zinc, at rhizome development stage, as Borax, Ferrous sulphate, Zinc sulphate + 375 g of Urea in 250 lit of water/ha. Spray twice at 25 days interval.

The above micronutrients are dissolved in Super phosphate slurry (15 kg Super Phosphate is dissolved in 25 lit of water stored overnight and the supernatant solution is made upto 250 lit). In this solution, the micronutrients are added.

### **Fertigation:**

Fertigation is done as per the recommended dose with 150:60:108 kg of NPK/ha and is applied throughout the cropping period once in three days.

75 % of the recommended dose of phosphorous is applied as basal dose. Water soluble fertilizers like 19:19:19, Mono ammonium phosphate (12:61:0), Multi K (13:0:45) and urea are used.

**Fertigation schedule for turmeric**

Crop Stage	Duration (in days)	Nutrients requirement (%)			Quantity applied (kg/ha)	
		N	P	K		
Planting to establishment stage	15	10	20	10	19:19:19 Multi K Urea	15.78 17.33 21.20
Vegetative stage	60	40	30	20	19:19:19 Multi K Urea	9.83 96.00 100.57
Rhizome initiation stage	60	30	30	30	19:19:19 Multi K Urea	4.91 71.28 76.29
Rhizome maturation stage	135	20	20	40	19:19:19 Multi K Urea	15.78 40.42 47.06
Total Duration	270	100	100	100		

**Inter cultivation:** Onion, Coriander and Fenugreek can be planted as intercrop on the sides of the ridges 10 cm apart. Redgram and Castor can also be planted at wider spacing. First weeding after three weeks and whenever weeding is necessary. The plants are earthed up at the time of 2<sup>nd</sup> and 4<sup>th</sup> top dressings.

**Plant protection**

**Pre planting treatment:** The seed rhizomes are dipped in carbendazim 1 g/lit and phosalone 35 EC 2 ml/lit for controlling rhizome rot and scales.

**Pests**

**Pre planting treatment:** The seed rhizomes are dipped in carbendazim @ 1 g/lit and phosalone 35 EC @ 2 ml/lit or for controlling rhizome rot and scales.

**Rhizome scale:** Apply well rotten sheep manure @ 10 t/ha in two splits (one basally and other at earthing up) or Poultry manure in 2 splits followed by drenching dimethoate 30 EC @ 2 ml/lit or phosalone 35 EC @ 2 ml/lit.

**Nematode:** Avoid planting turmeric after Banana or solanaceous vegetables. Apply Carbofuran 4 kg a.i./ha twice on the third and fifth month after planting the rhizomes.

**Diseases****Rhizome rot:**

- Treat the seed rhizomes with 0.3% Copper oxychloride for 30 min or Drench with Bordeaux mixture 1 % or Copper oxychloride 0.25 % or Ridomil 0.1 % or
- Seed treatment with *P. fluorescens* 10 g/kg and *T. viride* 4 g/ Kg and soil application of 2.5 Kg/ha each of *P. fluorescens* and *T. viride* in 50 kg of FYM as basal and top dressing on 150 Days after Planting.

**Leaf spots:** Spray Carbendazim 500 g/ha or Mancozeb 1 kg/ha or Copper oxychloride 1.25 kg/ha or Propiconazole 500ml/ha.

**Harvest:** The plants will start lodging, yellowing and drying on crop maturity. The rhizomes are dug with spade or digging forks.

**Yield:** Fresh rhizomes: 25-30 t/ha  
Cured rhizomes: 5-6 t/ha

**Storage of seed rhizomes:** Seed rhizomes can be stored in open sand media with partial shade.

#### Market information

Growing Districts	Karur, Villupuram, Coimbatore, Salem, Dharmapuri, Krishnagiri, Erode
Major markets in Tamil Nadu	Erode, Karur, Coimbatore, Salem and Dharmapuri
Preferred varieties	Erode local, BSR, Salem variety
Grade specification	Bright Yellow colour, size above 3cm length, hard, when broken gives metal sound , smooth skin , without impurities



## **Ginger: *Zingiber officinale* Rosc.; Zingiberaceae**

**Varieties:** Rio de Janeiro, Maran, Nadan, Suruchi, Surabi, Suprabha, IISR Varadha, IISR Rejatha, IISR Mahima, Athira & Karthika

**Season:** May-June.

**Soil and climate:** A friable well drained loamy soil rich in humus with warm and humid conditions with 150 cm of annual rainfall are preferable. Grown as an irrigated crop in humid zones under tropics. Ginger can be grown from sea level to an altitude of 1500 m.

**Seed rate:** 1500 - 1800 kg of rhizome/ha.

### **Seed treatment:**

- Treat the seed rhizomes with Mancozeb or Copper oxychloride 3 g/lit or 200 ppm Streptocycline for 30 minutes

**Spacing:** Irrigated crop - 40 x 20 cm in ridges and furrows.

Rainfed crop - Raised beds of 20 x 20 cm or 25x 25 cm

### **Manures and Manuring**

**Basal:** FYM 25-30 t + 30 tonnes green leaves as mulch in three splits : 15 tonnes-immediately after planting, 7.5 tonnes – 60 days and 120 days after planting, 50: 25 kg of P and K per ha.

**Top dressing:** 37.5: 12.5 kg of N and K per ha applied on 45th and 90th day after planting.

**Aftercultivation:** Mulching is done at the time of planting with green leaves. After each top dressing, earthing up of plants is done.

### **Plant protection**

#### **Pests**

**Shoot borer:** Spray dimethoate 30 EC 2 ml/lit or phosphamidon 40 SL 2 ml/lit.

**Leaf roller:** Spray carbaryl 50 WP 2 g/ha or quinalphos 25 EC 2 ml/lit.

#### **Diseases**

##### **Soft rot (*Pythium* sp.):**

- Provide adequate drainage facilities
- Select healthy and disease-free seed rhizomes
- Treat the seed rhizomes with Mancozeb or Copper oxychloride 3 g/lit or 200 ppm Streptocycline for 30 minutes.
- In the field, drench the beds with 2.5 g/lit of Copper oxychloride or 1% Bordeaux mixture or Metalaxyl - mancozeb 4 g/lit..

##### **Rhizome rot**

Rhizome treatment with *Pseudomonas fluorescens* @ 20g/kg rhizome + soil application @ 10kg/ha immediately after planting and 45 days after planting followed by pre monsoon drenching with Metalaxyl 0.1%.

**Leaf spot:** Spray with 1 % Bordeaux mixture or Copper oxy chloride 0.25%.

**Harvest:** The crop can be harvested after 8 - 9 months when leaves start yellowing and drying.

**Yield:** 12 - 15 t/ha.

## Chapter B

### Tree Spices

**Clove: *Syzigium aromaticum* (L.) Merrill & Perry; Myrtaceae**

**Varieties:** Local.

**Soil and climate:** Deep rich loams with high humus content and lateritic soils are best suited. Humid tropical climate with an annual rainfall of 150 - 250 cm and a mean temperature range of 20°C to 30°C and elevation up to 1000 m are suitable.

**Season:** June - December.

Slopes facing South and West should be avoided. North and North-Eastern slope is preferred.

**Planting:** Seeds are extracted from ripe fruits and sown immediately in poly bags.

The seeds germinate in five to six weeks.

Take 30 cm<sup>3</sup> pits @ 6m x 6m spacing. Fill the pits with top soil, 50 g *Azospirillum* and FYM 10 kg/pit. Two years old seedlings are planted in pits.

**Aftercultivation:**

- Provide shade for seedlings.
- Mulch the basins with dried leaves.
- Weed the basins as and when necessary.
- Provide shade during the initial establishment by raising banana.
- Small temporary pandal may also provide partial shade during initial establishment.

**Irrigation:** Frequent watering is essential in the initial stages in the absence of rains. Apply 8 litres of water either through drip or through basin during the months of January - May.

**Manuring:**

One year old plants can be applied with FYM 15 kg, 20:20:60 g of NPK per plant in two splits during June - July and September - October.

Every year the dosage is correspondingly increased and a bearing tree of 7 years old may be applied with FYM 50 kg, 300:300:960 g of NPK per plant

50 g in each of *Azospirillum* and *Phosphobacteria* to be applied one month after manuring.

**Plant protection - Pests**

**Stem Borer:** Smear the surface of the stem and branches with carbaryl 50 WP at 2 g/lit of water. Pour quinalphos 25 EC 1 ml/lit in to the bore hole and plug it. Apply Phorate 60g/tree in the soil or trunk implantation.

**Black scale:** Foliar spray with Dimethoate 1ml/l.

**Diseases**

**Leaf spot:** Pre-monsoon spray of *Pseudomonas fluorescens* (Pf<sub>PPB</sub>) @ 0.2 % + Lawsonia leaf extracts (5 %) or Spray with Copper oxy chloride @ 0.25 % .

**Harvest:** Bearing starts from sixth year onwards. The flower buds should be harvested when they are fully mature but before opening. The buds are harvested as clusters and separated and dried in the sun for five to seven days.

**Yield:** 2 - 3 kg dried buds/tree.



## **Nutmeg: *Myristica fragrans* Houtt.; Myristicaceae**

**Varieties:** Vishwashree, Konkan Sugandha and Konkan Swad.

**Soil and climate:** Friable, well drained clay to red soils is suitable. Can be grown up to an elevation of 1000 metres with 150-250 cm of rainfall under humid tropical climate.

**Propagation:** Seeds /grafts/ budded plants.

**Seed Propagation:** Seeds are collected from regular bearing and high yielding trees (more than 10,000 fruits per tree per year) and having 30 g weight/fruit, 1 g wet mace /fruit and 10 g wet weight of nuts / fruit. Seeds are harvested during June – July. Sown immediately after extraction in beds at a spacing of 30 cm and 2.5 – 5.0 cm deep. Germination commences from 40 days and extends up to 90 days after sowing. Transplanted to poly bags (35 x 15 cm) one year old seedlings are transplanted to bigger poly bags (35 x 20 cm). Seedlings transplanted to main field from 18-24 months.

**Vegetative propagation:** Grafting (approach method) or budding (Patch method) is recommended to perpetuate high yielding nutmeg types. Best season is from October to January. Use only orthotropic shoots as scion materials.

**Season and planting:** Plant 12 - 18 months old seedlings/ grafts/ budded plants in pits of 60 cm<sup>3</sup> size. Take pits at a spacing of 8 m x 8 m. Fill with equal parts of forest soil and cattle manure. Season of planting is June – December.

**Manuring:** Apply FYM 15 kg, 20:20:60 g of NPK per tree during first year and FYM 50 kg, 300:300:960 g of NPK for adult trees (15 years onwards) in two splits June - July, September - October. Apply 50 g in each of *Azospirillum* and *Phosphobacteria* one month after manuring.

**Irrigation:** Irrigation is given once in 5 - 7 days during summer months.

**Aftercultivation:** Keep the area around the plant weed free. It requires medium shade especially during the initial stages of growth. Fast growing shade trees or banana are planted in between them a few months prior to planting and can be thinned out later. It can be grown as mixed crop with arecanut and coconut. In Arecanut plantations, Nutmeg can be planted after every third row of Arecanut.

### **Plant protection**

***Loranthus* sp:** It is a serious plant parasite affecting the growth of the nutmeg plant. Mechanically remove the plant parasite. Remove severely affected branches and twigs of nutmeg trees. Paint with Bordeaux paste.

**Harvest:** The bearing starts from six to seven years after planting. The mature fruits are harvested when they start splitting. The aril commonly known 'mace' and 'seed' are separated and dried.

### **Yield**

Fruits: 1000 - 2000 Nos./tree

Dried nuts: 5 - 7 kg/tree

Dried mace: 0.5 - 0.7 kg/tree.



**Cinnamon: *Cinnamomum zeylanicum* Blume.; Lauraceae**

**Varieties:** YCD 1, PPI - 1, Nithyasree, Navasree, Konkan Tej, Sugandhini

**Soil and climate:** Sandy or lateritic soils with high humus are suitable. Can be grown at an altitude of 800 - 1000 m from MSL with an annual rainfall of 150 to 250 cm.

**Season:** June - December.

**Propagation:** Seeds / Semi hardwood cuttings

Nursery: Seeds collected from selected mother trees are sown immediately in nursery beds in rows of 12 cm apart. July - August is the best season for sowing.

From beds, seedlings are transplanted to polythene bags when they attain a height of 15 cm.

**Planting:** Take pits of 60 cm<sup>3</sup> at 2 m x 2 m spacing. Fill the pits with top soil and FYM 10 kg. One year old seedlings or rooted cuttings are transplanted under partial shade.

**Irrigation:** Protective watering during summer is in beneficial.

**Manuring per plant**

Manures and fertilizers	1st year	Annual increase	10 <sup>th</sup> year onwards
FYM (kg)	-	2.0	20
N (g)	20	20	200
P (g)	18	18	180
K (g)	25	25	250

**After cultivation:** Provide temporary shade after transplanting.

Weeds are removed as and when necessary.

Young trees are cut close to the ground to produce side shoots from second or third year onwards. This process is called "Coppicing". By stooling around the stumps, more side shoots are encouraged from the base of the trees.

**Plant protection**

**Pests**

**Shoot borer:** Smear stem and branches with Carbaryl 50 WP 2 g/lit of water once in a month.

**Coffee red borer:** Trunk injection of hole with a waiting period of 20 days to be allowed between application and harvest of the bark.

**Leaf eating caterpillar, red ants and termites:** Dust Methyl parathion 1.3%.

**Diseases**

**Leaf spot:** Spray 1 % Bordeaux mixture or 0.25 % copper oxy chloride.

**Harvest:** The harvest starts from 4<sup>th</sup> or 5<sup>th</sup> year after planting. Cut the shoots in May and November for bark harvest.

Young shoots spring up from the stump ready for removal in subsequent season within 18 months when they attain one metre long and 1 to 2 cm thick.

Terminal ends of shoots are removed.

Peeling is done by knives after scraping off the outer bark.

Harvested produce is called as 'Quills'.

From leaves, Cinnamon oil can be extracted by steam distillation.

**Yield :** 100 g of dried bark/ bush/ year. 35 kg of leaf oil/ ha/ year.

## **Tamarind: *Tamarindus indicus* L.; Caesalpinaceae**

**Varieties:** PKM 1, Urigam, Hasanur and Tumkur, Prathisthan, DTS 1, Yogeshwari

**Soil and Climate:** Grown on variety of soils ranging from poor degraded, eroded, gravelly, saline and alkaline soils. Productivity is higher in red loamy, deep well drained soils. The absolute maximum temperature varies from 36-47.5 °C and the absolute minimum temperature varies from 0-17.5 °C. Rainfall requirement - 750-1900 mm. Altitude - up to 100 m above MSL.

**Propagation :** Seeds / Grafts

**Nursery:** Fresh seeds are sown in nursery beds in March -April. Soaking of seeds in 10 per cent cow urine or in cow dung solution (500 g in 10 l of water) for 24 hours. Two year old seedlings are transplanted to the main field.

**Vegetative propagation:**

**Softwood grafting:** March- April

**Air Layering:** Shoots treated with IBA 4000 ppm.

**Planting Season:** June - December.

**Spacing:** Plant at a spacing of 8-10 m x 8-10 m.

**Planting:** Take pits of 1 m<sup>3</sup> and fill with FYM (10 kg/pit) and top soil. Add 50 g of Methyl parathion 1.3 % dust in the pit. Immediately after planting, support the graft with stakes.

**Irrigation:** Regular watering should be given once in seven days.

**Fertilizers:** Apply 200:150:250 g of NPK per tree per year along with 25 kg of FYM and 2 kg of Neem cake.

**After cultivation:** Remove the rootstock sprouts. Remove the dried and diseased parts. Intercrops like leguminous crops, short duration vegetables, annual drumstick, Sesamum and Sorghum may be raised in the alley spaces up to four years.

**Training:** Early training is necessary to form a high head and uniform scaffold branches in all directions.

**Pruning:** removal of dried, diseased and criss cross branches.

### **Plant protection**

#### **Pests**

**Leaf caterpillar (*Achaea janata*):**

#### **Disease**

**Powdery mildew:** Spray Dinocap 1 g/lit or wettable sulphur 2g/l.

**Yield:** Grafts start yielding from 4 to 6 years. Pods are harvested in March-April every year. 150 - 200 kg/tree/year.

### **Market information**

Concentrated pockets of growing districts	Dindigul, Theni, Madurai and Trichy
Major markets in Tamil Nadu	Madurai, Trichy
Preferred varieties	<b>PKM 1, Urigam</b>

## **Allspice (*Pimenta dioica* Lindl.); Myrtaceae**

### **Soil and Climate**

Deep rich loams with high humus content and lateritic soils are best suited

Altitude : 1000 m above mean sea level.

Annual rainfall : 100-200 cm

Ideal temperature : 27°C

### **Propagation**

**Seeds:** Seeds are collected from high yielding and regular bearing trees. Seeds are extracted after soaking the fruits overnight in water and rubbing them in a sieve and washing with clean water. The seeds are ready for sowing after drying them in shade.

Nursery beds of 1.2 m width are prepared with light soil incorporated with organic matter or a mixture of sand and coir dust or coir dust alone. After sowing the beds are mulched to hasten germination. Dried leaves, paper and damp sacks are used as mulches. Germination takes place 15 days after sowing.

**Vegetative propagation:** Air layering in the month of January.

**Planting:** 9-10 months old seedlings of 25-30 cm height are used for field planting.

**Spacing:** 6 m x 6 m. Since the plant is dioecious in nature, it is desirable to keep a male: female ratio of 1:10 in plantation.

**Fertilizer:** FYM (10 Kg) + 20:180:50 g of NPK per tree in the first year.

For grown up trees of 15 years or more, FYM (50 kg) + 300:250:750 g of NPK / tree is applied as two split doses.

Apply manures in shallow trenches dug around the plant 1-1.5 m away from the tree.

### **Harvesting:**

Clonally propagated plants start flowering in three years while the seed propagated plants in 6 years.

Soil application of Paclobutrazol (1.25g/tree) induces flowering, increased number of panicles, flowers and setting of berries which in turn resulted in higher yield.

Fully developed green berries are harvested.

**Yield:** 20-25 kg dry berries per year/ tree.

## Chapter C

### Seed Spices

**Coriander:** *Coriandrum sativum* L.; Apiaceae

**Varieties:** CO 1, CO 2, CO 3, CO (CR) 4, GAU 1, UD 1, UD 2, UD 20 and UD 21

**Soil:** Well drained black cotton soil and red loamy soil

**Climate:** Cool and comparatively dry, frost free climate

**Season:** June - July and October - November.

**Seed rate:** 10 - 12 kg/ha (irrigated crop)  
20 - 25 kg/ha (rainfed crop)

**Seed Treatment:** Soak the seeds in water for 12 hours. Treat the seeds with *Azospirillum* @ 1.5 kg /ha for better crop establishment + *Trichoderma viride* @ 50 kg/ha to control wilt disease. Presowing seed hardening treatment with Potassium Dihydrogen Phosphate @ 10 g/lit of water for 16 hours is to be done for rainfed crop.

**Field preparation and sowing:**

Prepare the main field to a fine tilth.

Add FYM 10 t/ha before last ploughing.

Form beds and channels (for irrigated crop).

Sow the split seeds at a spacing of 20 x 15 cm.

Spray pre-emergence herbicide Fluchloralin 700 ml in 500 lit of water per ha .

The seeds will germinate in about 8-15 days.

**Manuring:**

**Basal:** Apply 10: 40: 20 kg of NPK/ ha for rainfed and irrigated crops.

**Top dressing:** Top dressing may be done at 10 kg N/ha 30 days after sowing for the irrigated crop only.

**Irrigation:** First irrigation immediately after sowing and the second on the third day. Subsequent irrigations at 7-10 days interval.

**Aftercultivation:**

Thinning is done 30 days after sowing by keeping 2 plants per hill.

Weeding is done as and when necessary.

Spray CCC @ 250 ppm one month after sowing for inducing drought tolerance in rainfed crops.

**Plant protection**

**Pests**

**Aphid:** Spray methyl demeton 25 EC @ 2 ml/lit or dimethoate 30 EC @ 2 ml/lit.

## Diseases

**Powdery mildew:** Seed treatment with *Pseudomonas fluorescens* (Pf 1) @ 10 g /kg and foliar spray of Pf1 2 g/lit or Spray Wettable sulphur 1 kg/ha or Dinocap 250 ml/ha at the time of initial appearance of the disease and 2<sup>nd</sup> spray at 10 days interval. Neem seed kernel extracts 5 % spray thrice (1st spray immediately after the appearance of disease, 2<sup>nd</sup> and 3<sup>rd</sup> at 10 days interval).

**Wilt:** Seed treatment with *Pseudomonas fluorescens* @10g /kg followed by soil application of Pf1 @ 5 kg /ha

**Grain mould:** Spray Carbendazim 0.1 % (500 g/ha) 20 days after grain set.

**Harvest:** The plants are pulled just when the fruits are fully ripe but green and start drying. The plants are dried and thrashed with sticks, winnowed and cleaned. For leaf, pull out the plants when they are 30-40 days old.

### Yield :

Grain yield	Kg/ha
Rainfed Grain yield	300-400
Irrigated	500-600
Leaf yield	6000-7000

### Market information

Concentrated pockets of growing districts	Thoothukudi, Virudhunagar, Ramanathapuram and Coimbatore
Major markets in Tamil Nadu	Virudhunagar
Preferred varieties	Co3
Grade specification	Pungent, golden colour, Well dried and matured , without shrivels

**Fenugreek: *Trigonella foenum graecum* L.; Leguminosae**

**Varieties:** Co 1, Pusa Early Bunching, Lam selection 1, Rajendra Kranti, Kissar Sonali, RMT1 and CO 2.

**Soil:** A rich well drained loamy soil is best suited.

**Climate:** Cool and comparatively dry, frost free climate

**Season:** June - July and October - November.

**Seed rate:** 12 kg/ha.

**Seed treatment:** *Azospirillum* 1.5 kg + *Trichoderma viride* @ 50 g/ha for 12 kg of seeds.

**Field preparation and sowing:**

Prepare the main field to a fine tilth.

Add FYM 20 - 25 t/ha before last ploughing. Form beds and channels of 3.5 x 1.5 m.

Seeds are sown at a spacing of 20 X 15 cm. Spray pre-emergence herbicide Fluchloralin 700 ml in 500 lit of water per ha.

**Manuring**

**Basal:** Apply 30:25:40 kg of N, P, K /ha.

**Top dressing:** Apply 20 kg of N at 30 days after sowing.

**Irrigation:** Give first irrigation immediately after sowing, second on the third day and subsequently at 7 - 10 days intervals.

**Aftercultivation:**

Plants are thinned at 20 - 25 days after sowing and the thinned seedlings are used as greens.

One pinching at a height of about 4" will encourage branching.

Weeding is done as and when necessary.

**Plant protection**

**Diseases**

**Root rot:** Soil application of Neem cake @ 150 kg/ha and Seed treatment with *Trichoderma viride* @ 4 g/kg or drenching with Carbendazim 0.5 g/l or Copper oxychloride 2 g/litre or *Trichoderma viride* @ 5 kg/ha.

**Powdery mildew:** Dust Sulphur at 25 kg/ha or foliar spray with wettable sulphur 2 g/lit at the time of appearance of disease.

**Crop duration and harvest**

20 - 25 days for greens.

90 - 100 days for grains.

**Yield**

Green yield: 4 - 5 t/ha.,

Grain yield: 500 - 700 kg/ha.



**Fennel:** *Foeniculum vulgare* Mill.; Apiaceae

**Varieties:** CO 1, UF 32, PF 35 and Gujarat Fennel 1

**Soil:** Rich in organic matter with well drained loamy soil or black or sandy soil.

**Climate:** It comes up well in fairly mild with frost free climate.

**Season:**

**Hills:** May - June.

**Plains:** October - November.

**Seed rate:**

Direct sowing: 9 - 12 kg/ha.

Transplanting: 3 - 4 kg/ha

Nursery area 100 m<sup>2</sup>.

**Field preparation**

Prepare the main field to a fine tilth.

Add FYM 10 t/ha before last ploughing.

Form beds and channels

Pre-emergence application of Pendimethalin @ 1 kg a.i./ha

5- 6 weeks old seedlings are transplanted at a spacing of 60 x 30 cm

**Thinning:** In direct sown crop thin 4 - 5 weeks old seedlings to 25 - 30 cm spacing

**Manuring**

**Basal:** Apply 25:10 kg N and P/ha.

**Top dressing:** Apply 25 kg N/ ha at the time of flowering.

**Irrigation:** First irrigation immediately after sowing, second on the third day and subsequent irrigations at 7 - 10 days intervals.

**Aftercultivation:**

Two or three weedings are necessary. The plants are earthed up after 3 months.

**Plant protection**

**Pests**

**Aphids:** Spray dimethoate 30 EC 2 ml/lit or methyl demeton 25 EC 2 ml/lit.

**Powdery mildew:** Dust Sulphur at 25 kg/ha or foliar spray with wettable sulphur 2 g/lit at the time of appearance of disease.

**Harvest:** The crop matures in 7 - 8 months. The umbels are harvested 4 - 5 times at 10 - 15 days intervals and dried in sun for 4 - 5 days and seeds are thrashed.

**Yield:** 500 - 750 kg/ha.

## Chapter D

### Other Spices

**VANILLA:** *Vanilla planifolia*; Orchidaceae

**Varieties:** No named varieties

**Soil:** Lateritic soil rich in humus having good drainage.

**Climate:** Humid tropical climate with an annual rainfall of 150 – 300 cms (well distributed for a period of 9 months and dry period of 3 months).

Elevation: 700 - 1500 m MSL and with latitude of 10° N and 20° S

Temperature: 21° C – 32° C.

**Standards:** *Glyricidia sp*, *Erythrina indica*, *Jatropha curcus*, *Plumeria alba* and *Casuarina equisetifolia*. Planting during on-set of rain after summer during May and June.

**Season for vanilla planting:** 6 months after planting standards (i.e.) September - October - November.

**Propagation:** Stem cuttings of 60 - 120 cm

**Spacing:**

**Plains:** 2.0 to 2.5 m X 1.2 - 1.5 m

**Hills:** 1.5 x 1.5 m

**Planting:** Pit size 30 cm<sup>3</sup> for standards and for planting of vanilla cuttings.

Place 2 nodes of unrooted cuttings of 60 - 120 cm below the soil surface.

**Training:**

Train the vines to a height of 1.2 to 1.5 m.

Then trained horizontally or allowed to grow downward towards the ground.

Horizontally trained vines are coiled round the pole connecting the two supporting trees.

Vines trained to grow downward is allowed to touch the soil and allowed to root and again brought back upward on the same supporting tree and the same procedure is repeated.

**Manuring:** Mulch the vine with pruned vegetation 2 – 3 times in a year.

**Recommended dose of fertilizers:**

Apply 40 - 60: 20 - 30: 60 - 100 g of NPK per vine per year. It is given in 2 to 3 splits.

Spray 1 % solution of 17: 17: 17 NPK mixture once in a month for boosting growth and flower production.

**Flowering:**

Flowering starts in the third year of planting during December - January.

Pinching of top 7.5 - 10 cm of vine 6 - 8 months before flowering seasons encourages flower bud initiation.

Pruning of older fruiting branches also encourages flower production.

Each inflorescence consists of 15 – 20 flowers.

**Pollination:**

The artificial pollination is useful in vanilla and pollination must be done on the same day as flowers start opening from 4.00 am and extend upto 1.00 pm.

About 10 to 20 inflorescence may be pollinated in a vine.

Normally 5 to 6 flowers in the lower side of inflorescence are pollinated.

Hand pollination is done using a needle or a piece of pointed wood or a tooth pick to lift the hood covering the anther cap so that the anthers are brought into contact with stigma

A skilled worker can pollinate 1000 - 1500 flowers in a day.

## **Plant Protection**

### **Pest**

**Leaf eating beetles, Feeding bugs and Caterpillars:** Spraying quinalphos 0.05 %.

### **Diseases**

**Fusarium wilt:** Infection starts in the axil of the leaf and spread to nodal region resulting in rot.

1. Spraying and drenching of 0.1 % Carbendazim.
2. Addition of organics also reduces the intensity of the disease.

**Phytophthora rot:** It causes rotting of beans, leaves and stems.

Spraying Bordeaux mixture 1 % or soil drenching with Copper oxy chloride 0.2 %

### **Sclerotium rot:**

It occurs in root tips and later extends to whole root system followed by yellowing and wilting of vines. Soil drenching of Carbendazim 0.1 %

**Shoot tip rot and Sclerotium rot:** Soil drenching of Carbendazim 0.1 %

**Harvesting:** The pods are ready for harvest in 6 to 9 months after flowering. The matured beans change colour from green to pale yellow. The right picking stage is when the distal end of the pod turns yellow. Daily picking of matured pod is essential. The pods are harvested by cutting with a knife.

**Yield:** Average cured bean yield is 300 to 600 kg / ha / year.

6 kg of green pods produces 1 kg of cured beans.

The economic life of vine is 12 - 14 years.

## **Paprika (*Capsicum annum* L.); Solanaceae**

**Variety:** Arka Abir, Kt-PI-19, Byadagi

**Soil:** Well drained, light fertile loam soil with moisture holding capacity is ideal. pH 6-7

**Climate:** Long, warm growing season, frost free for 4-5 months is ideal. In tropical southern India the crop is raised during winter months (August – December) is desirable and hence temperature - 21°C at night & 27 °C in day.

Optimum temperature for seed germination 18-24 °C.

**Seed Rate:** 600 g / ha

**Nursery:** Prepare 10 -12 beds of 7 m long, 1.2 m wide and 15 cm height.

Apply 15 – 20 kg well decomposed compost and 500 g of 15:15:15 NPK complex fertilizer to each bed 15 to 20 days before sowing.

Sow the seeds in rows 10 cm apart at 0.5 cm deep.

### **Field preparation**

Prepare the main field to a fine tilth.

Add FYM 20 to 25 t/ha before last ploughing.

**Transplanting: Age:** 35 - 40 days old seedlings are ready for transplanting

**Hills:** 45 x 45 cm

**Plains:** 60 x 45 cm

**Hardening:** Seedlings are first hardened by gradually withholding the Water 6-8 days before transplanting and exposing them to direct sunlight. Water the seedling 12-14 hr before transplanting

### **Fertilizers: (kg /ha)**

Time of application	N	P	K
Basal dose	60	100	60
Top dress 3 weeks after transplanting	20	0	20
Top dress 6 weeks after transplanting	40	0	40
Total	120	100	120

### **Plant Protection**

#### **Pest**

Mites: Apply wet able sulphur 2 kg / ha

Thrips: Spray with Fenazaquin 10 EC @150 ai /ha

Nematode: Apply carbofuran 3gin soil @ 25 kg /ha

## Diseases

**Damping off:** Drenching the beds with metalaxyl MZ @ 0.1 %

**Anthrachnose:** Seed treatment with Carbendazim (2 g / kg seed) and spray with Mancozeb 2 g/lit.

**Fruit rot:** Spray Copper oxychloride @ 2.5 g/lit.

**Powdery mildew:** Spray Wettable sulphur @ 0.3%

**Chilli leaf curl complex:** Sorghum leaf extract @5.0% + dicofol 2.5ml /l

**Harvesting:** The matured fruits are ready for harvest after 70-80 days of planting. Fruits are harvested 3 to 6 times in a crop. The harvesting is spread over a period of 3-4 months.

**Yield:** 25 - 35 t/ha



# Part IV

## Plantation crops

**Tea: *Camellia sinensis* L. O. Kuntze.; Camelliaceae**

**Varieties:** Pandian, Sundaram, Golconda, Jayaram, Evergreen, Athrey, Brookeland, BSS 1, BSS 2, BSS 3, BSS 4, BSS 5

**Soil and climate:** Tea requires well drained soil with high amount of organic matter and pH 4.5 to 5.5. The performance of tea is excellent at elevations ranging from 1000- 2500 m. Optimum temperature – 20-27 ° C.

**Nursery:** The nursery soil should be well drained and deep loam in nature with pH of 4.5 to 4.8. The rooting medium should be tested for pH and free from nematode infestation.

**Pre-treatment of rooting medium:** Treating with Aluminium sulphate can reduce soil pH. For this purpose the nursery soil is formed into beds of one metre width and about 8 cm height and of a convenient length. Then the beds are drenched with 2 % solution of Aluminium sulphate applied at 10 litres per 2.5 m<sup>2</sup> of area. Over this another layer of soil of 8 cm height is spread and again drenched with equal quantity of water twice. Then the soil is allowed to dry and the pH is checked before use in the nursery.

**Preparation of sleeves:** Polythene bags of 30 – 45 cm length, 10 cm width and 150 or 200 gauge thickness may be used. Drainage holes may be provided. The lower 3/4 of the sleeves should be filled with 1:3 sand and soil mixture and the top 1/4 with 1:1 sand and soil mixture and staked in rows. Overhead shade is provided.

**Selection and preparation of mother bush:** Healthy and vigorously growing high yielding bushes should be selected. For selected bush, application of 0.5 % Al SO<sub>4</sub>+ 1 % Mg SO<sub>4</sub> as foliar spray is recommended. One week later, apply 2 % Zn SO<sub>4</sub>. After one week apply 1 % Urea. Then 40 g of young tea mixture 60:90 NK mixture per bush may be applied upto 5 years.

**Preparation of cuttings:** Cuttings are taken on April - May and August - September. Semi hard-wood cuttings are prepared with one full leaf and an internode with a slanting cut at the bottom.

**Planting of cuttings:** The sleeves are watered thoroughly and holes are made in the soil. The cuttings are inserted in the hole and the soil around is pressed firmly to avoid airspace followed by watering. Small polythene tents may be provided which maintain high humidity and regulate the temperature inside. Cuttings may take 10 - 12 weeks for rooting. After 90 days - when all the cuttings have rooted, the polythene tent may be removed gradually over a period of 10 – 15 days.

**Manuring of nursery:** After the tent is removed the cuttings are sorted and staked. 30 g of Nursery soluble mixture of the following composition dissolved in 10 litres of water may be applied over an area of 4 sq.m. This should be done fortnightly.

**Composition of the fertilizer:**

Ammonium phosphate (20:20)	35 parts by Weight
Potassium sulphate	15 parts by Weight



(or) MOP	12 parts by Weight
Magnesium sulphate	15 parts by Weight
Zinc sulphate	3 parts by Weight
<b>Total</b>	<b>80 parts by Weight</b>

**Hardening of the cuttings:** Hardening of 4 - 6 months old young cuttings should be done by removing shade gradually in stages over a period of 4 - 6 weeks starting from a few hours exposure to sun every day initially and extending the time of exposure gradually.

### Methods of planting

**Single Hedge System:** Planted at the spacing of 1.20 x 0.75 m accommodating 10,800 plants/ha.

**Double Hedge System:** Planted at the spacing of 1.35 x 0.75 x 0.75 m accommodating 13,200 plants/ha.

**Season and planting:** May - June or September - October. Sleeves should be opened lengthwise without injuring the roots and planted in the pit and the soil is gently pressed.

**Irrigation:** Subsoil irrigation may be given for young teas during summer months.

**Manuring:** Manuring should be done 2 months after planting. Phosphorous should be applied at 80 - 100 kg/ha as Rock phosphate once in a year by placement at 15 - 25 cm depth upto the first pruning and thereafter once in two years. N: K ratio 2: 3 should be adopted for the first 3 years and a ratio 1: 1 thereafter may be followed.

Year of application	kg/ha/year		No. of applications	g/plant/year	
	N	K		Ammonium Sulphate	Urea
I year	180	270	5	13	27
II year	240	360	6	23	15
III year	300	450	6	29	18
IV year onwards	300	300	6	33	19

Application of fertilizers should be done before the onset of monsoon. Fertilizers should be broadcast around the drip circle avoiding contact with the collar.

**Aftercultivation:** Control perennial grasses (Forbicot weeds) by spraying Glyphosate 1.75 lit + Kaoline 2 lit + 2 kg of wetting agent in 450 lit of water followed by Gramoxone 500 ml in 200 lit of water to control dicot weeds.

### Training young tea

**Centering:** To induce more laterals centering should be done 3 - 5 months after planting. The main leader stem should be cut, leaving 8 - 10 matured leaves.

**Tipping:** First tipping at a height of 35 cm and second tipping at 60 cm respectively from ground level.

**Pruning:** To maintain convenient height and vegetative growth and to remove dead and diseased branches, pruning is done.

Area to be pruned every year =  $\frac{\text{Total extent of the garden}}{\text{Number of years between prunings}}$

## Pruning cycle

Pruning interval = (Elevation in feet / 1000) + 1

Pruning should be done in April - May or August - September respectively to S.W or NE monsoon areas.

### Types of pruning

**Rejuvenation pruning:** The whole bush should be cut near the ground level less than 30 cm with a view to rejuvenate the bushes.

**Hard pruning:** Formation pruning of young tea at 30 to 45 cm (12" to 18") for proper spread of bushes.

**Medium pruning:** To check the bush growing to an inconvenient height this type of pruning is done in order to stimulate new wood and to maintain the foliage at lower levels less than 60 cm.

**Light pruning:** Pruning depends on the previous history of the bush raising the height of medium pruning by an inch or less to manageable heights for plucking (less than 65 cm).

**Skiffing:** This is the lightest of all pruning methods. Remove the top 5 - 8 cm new growth to obtain a uniform level of pruning surface (more than 65 cm).

**Shade regulation:** Pollarding of shade trees should be done prior to heavy rains at a height of 8 - 10 m from the ground level.

**Annual lopping:** Cutting the erect type branches on the laterals in shade trees before monsoon season.

### Plant protection - Pests

**Scales:** Spray carbaryl 50 WP @ 2 g/lit. or phosalone 2 ml/lit or quinalphos 25 EC 2 ml/lit or chlorpyrifos 20 EC 2 ml/lit.

**Sahydrassis/Phassus borer:** Locate the particle mat covering at the base tea bush and remove.

Insert a thick wire in the bore hole to kill the larvae.

Thrips: Spray any one of the following insecticide

Insecticide	Dose
Azadirachtin 5 % Neem extract concentrate	5.0 ml/10 lit.
Azadirachtin 1.0 % EC (neem based)	2.0 ml/lit.
Ethion 50%EC	5.0 ml/10 lit.
Profenofos 50 % EC	2.0 ml/lit.
Quinalphos 25 % EC	7.5 ml/10 lt.

**Aphids:** Spray phosalone 35 % EC @ 2.0 ml/lit

**Red spider mite, Pinkmite, scarlet mite:**

Insecticide	Dose
Azadirachtin 5% Neem extract concentrate	5.0 ml/10 lit
Azadirachtin 1.0% EC (neem based)	2.0 ml/lit
Dicofol 18.5 % SC	2.0 ml/lit
Ethion 50 % EC	5.0 ml/10 lit
Fenazaquin 10 % EC	1.6 ml/lit
Fenpyroximate 5 % EC	1.2 ml/lit
Flumite 20%SC/flufenzine 20%SC	5.0 ml/10 lit
Hexythiazox 5.45% EC	1.2 ml/lit.
Phosalone 35 % EC	1.0 ml/lit.
Profenofos 50 % EC	2.0 ml/lit.
Propargite 57 % EC	2.0 ml/lit.
Spiromesifen 22.9 % SC	1.0 ml/lit.

#### Tea mosquito bug:

- Monitoring the incidence of tea mosquito bugs at regular intervals.
- Removal of alternate hosts like neem, cashew, guava in the surroundings
- When the infestation is lesser: Spraying of any one of the following:
  - Imidacloprid (0.6 ml/l)
  - Thiamethoxan (0.6 g /l)
  - Profenophos (2 ml/l).

#### Diseases

##### Blister blight:

1. Spray Hexaconazole 200 ml + Copper oxychloride 210 g/ha at 5 days interval/ha. (or)
2. Spray 210 g of Copper oxychloride and Nickel chloride per ha at 5 days interval from June – September, 11 days intervals in October and November (or)
3. Copper oxychloride 210 g + 200 ml Propiconazole/ha at 10 days interval.

**Crop duration and harvest:** Plucking commences when the tea bush is 3 years old. The plucking of extreme tip of the growing branch consists of an unopened bud together with two leaves is popularly known as “Two leaves and a bud” while fine plucking is anything less than this. Plucking continues throughout the year in South at weekly intervals during March – May and at intervals of 10 -14 days during the other months.

Rush period - harvesting of 2 - 3 leaves with a bud at 7 to 10 days interval

Lean period - harvesting of two leaves and a bud at 10 - 15 days interval

**Yield:** The yield of green leaves is 10 t/ha.

#### Market information

Growing Districts	Nilgiris, Coimbatore, Dindigul, Theni, Kanyakumari and Tirunelveli districts
Major markets in Tamil Nadu	Coimbatore, Nilgiris
Grade specification	Size of the tea leaves : Whole, large tea - Higher grading Method of production : CTC process (Crush, Tear and Curl) and Orthodox

**Coffee: *Coffea arabica* L.; *Coffea canephora* Pierre ex Frechna; Rubiaceae**

**Varieties**

**Arabica varieties:** SIn 795, SIn 7, SIn 9, SIn 10, Cauvery and its selections HRC (Hawaian Red Cuturra), Chandragiri and sanRoman

**Robusta varieties:** SIn 274, SIn 270, SIn 3.

**Soil:** Soil should be deep, friable, open textured rich in plant nutrients with plenty of humus and of slightly acidic nature (pH - 4.5 to 6.5)

Varieties	Elevation (m)	Rainfall (mm)	Distribution
Robusta	500 - 1000	1000 - 2000	Blossom shower - February - March
Arabica	1000 - 1500	1600 - 2500	Blossom shower - March - April
Backing shower during April - May is required for both the varieties.			

**Propagation:** by seeds.

**Preparation of seeds:** Healthy and well developed fully ripe berries are harvested from specially identified plants for use as seed bearers. After discarding the floats, the sound fruits are depulped, sieved and mixed with sieved wood ash and dried in shade. The seed is then graded to remove all cut, triangular and elephant beans. Prior to planting, the seeds are treated with Agrosan or any Organomercurial compound to prevent fungal infection.

**Nursery practices:** Select light loamy soil of good drainage and high organic matter content with water and shade facilities.

Form raised beds of 15 cm height, 1m width and of convenient length.

Incorporate 30 - 40 kg of well rotten compost, 2 kg of finely sieved agricultural lime and 400 g of rock phosphate to a bed of 1 x 6 m size.

In heavy soils, it is necessary to add coarse sand for drainage and aeration.

**Sowing:** Pre-sowing seed treatment with *Azospirillum* and *Phosphobacteria* can be done.

Seeds are sown in December - January in the bed 1.5 - 2.5 cm apart with the flat side down wards in regular rows. Then they are covered with a thin layer of fine soil and a layer of paddy straw. Water the beds daily and protect from direct sunlight by an over head pandal. Seeds germinate in about 45 days after which they are transplanted to secondary nursery beds for raising ball or Bag nursery.

**Bag nursery:** Polythene bags with adequate number of holes in the bottom half are taken and are filled with a prepared mixture containing jungle soil, FYM in the proportion of 6:2:1.

An area of 12 x 8 m can accommodate 5000 seedlings. Seedlings are planted in polythene bags.

**Season:** June - September.

**Preparation of field:** Selective felling may be done while retaining a number of desirable shade trees. Terracing should be done in deep slopy areas. After the summer showers, pits of 45 cm<sup>3</sup> are dug. The pits are left open for weathering and then filled and heaped for planting. At the time of filling, apply 500 g of rock phosphate per pit along with top soil. Planting is done along the contour in slopy areas.

## Spacing

**Arabica Coffee:** 1.5 to 2.0 m either way.

**Dwarf varieties:** Sanraman: 1 x 1 m.

**Robusta coffee:** 2.5 m either way.

**Planting shade trees:** Dadap is commonly used as a lower canopy shade. Stakes of 2 m length are planted for every two coffee plants. Silver Oak and Dadaps are planted during June when South-West monsoon commences. During summer the stem of young Dadaps are painted with diluted lime or wrapped with polythene sheets in order to prevent them from sun scorch. Regulate shade by cutting criss-cross branches during monsoon season. Silver oak trees are planted at 6x6m for permanent shade.

**Irrigation:** It is generally grown as a rainfed crop. But irrigation with sprinkler during March - April increases blossoming and results in higher yields.

## Manuring:

Species	Pre-blossom March N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O	Post blossom May N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O	Mid-monsoon August N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O	Post-monsoon October N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O	Total
<b>ARABICA</b>					
Young coffee 1 <sup>st</sup> year After planting	15:10:15	15:10:15	---	15:10:15	45:30:45
2 <sup>nd</sup> and 3 <sup>rd</sup> year	20:10:20	20:10:20	---	20:15:20	60:45:60
4 <sup>th</sup> year	30:20:30	20:20:20	---	30:20:30	80:60:80
Bearing coffee 5 years and and above for less than one tonne/ha crop	40:30:40	40:30:40		40:30:40	140:90:120
For one tonne/ha and above	40:30:40	40:30:40	40:30:40	40:30:40	160:120:160
<b>ROBUSTA</b>					
For less than one tonne/ ha crop	40:30:40	---	---	40:30:40	80:60:80
For 1 tonne /ha and above	40:30:40	40:30:40	---	40:30:40	120:90:120

**Pruning:** Centering and desuckering should be carried out for 5-6 years after planting. Done immediately after the harvest (June-July and September - october) and till the onset of monsoon. Unproductive wood between all primaries, secondaries and tertiaries should be removed.

Rejuvenation / collar Pruning: Removal of dead, exhausted, dried and worn out branches. Done immediately after the harvest.

Hard pruning: Plants are cut at 5-20 cm above the ground level and one leader shoot is allowed.

Medium Pruning: Removal of lateral shoots to regulate shade.

Light pruning: Removal of Suckers.

**Intercropping:** Orange, Pepper, Banana, Pine apple, Avocado, Custard apple.



**After cultivation:** Weeding and mulching should be done as and when necessary. Digging is done to a depth of 30 cm towards the end of monsoon (October - November). The weeds and vegetative debris are completely turned under and buried in the soil while the stumps are removed. This is known as the cover digging. In slopy areas dig trenches on the contour 45 cm wide and 30 cm deep of any convenient length. Prune water shoots and disease affected shoots.

## Plant protection

### Pests

**White stem borer:** Attacks arabica coffee grown under inadequate shade.

- Maintain/create optimum shade
- Borer infested plants should be thoroughly trace, uprooted during March and September, burnt to avoid economic loss during the subsequent years.
- Install pheromone traps @ 25 /ha, if the incidence is high.
- Remove the loose scaly bark on the main stem and thick primaries using coir glove or coconut husk.
- Pad with making a window in the stem at 5 cm x 5cm and fill it with absorbant cotton dipped in insecticide solution and close it.

**Berry borer:**

- Carry out timely and thorough harvest.
- Avoid gleanings as far as possible.
- Pick up and destroy the gleanings.
- Meticulously remove the leftover berries.
- Remove offseason berries to save main crop.
- Avoid excessive shade.
- Prune plants properly to facilitate better ventilation and illumination.
- Set up traps with ethyl : methyl alcohol (1 : 1) to attract adults.
- While processing at the estate level dry coffee berries to the prescribed moisture level :

Arabica / robusta parchment 10 %, Arabica cherry 10.5 % and robusta cherry 11.0 %.

**Shot hole borer beetle:**

Attacks branches and suckers of robusta coffee. This pest thrives under heavy shade and can be controlled by pruning the branches

**Green scales and mealy bugs:**

Release coccinellid predator *Cryptolaemus montrouzieri* @ 300 beetles/acre.

Spray *Verticillium lecanii* @  $6 \times 10^6$  spores/ml or spray any one of the following insecticide

Insecticide	Dose
Oxydemeton -Methyl 25 % EC	2.5 ml/lit.
Quinalphos 25 % EC	2.5 ml/lit.

**For the control of leaf miner spray** Oxydemeton -Methyl 25 % EC @ 2.5 ml/lit.

### Diseases

**Rust:** Spray 0.5 % Bordeaux mixture in February - March (Pre-bloom) followed by 0.03 % Oxycarboxin in May - June (Pre-monsoon).

Repeat in July - August (mid-monsoon) September - October (Post-monsoon) with any one of the above fungicides or



Spray 0.5 % Bordeaux mixture during the month of June followed by 0.02 % Triadione fon during September and 0.5 % Bordeaux mixture during the month of December.

**Black rot or Koleroga:** Centering and handling of the bushes should be done prior to the onset of South-West monsoon.

Remove affected twigs.

Spray 1% of Bordeaux mixture during break in monsoon.

**Collar rot:** Treat seeds with Carbendazim 1 g/kg or Carboxin 0.7 g/kg.

Maintain filtered shade in nursery.

Drench nursery beds with Mancozeb or Captan 0.5 g/lit before sowing.

**Brown eye spot:** Spray Captan or Mancozeb or Ferbam 2 g/lit or Carbendazim 0.5 g/lit in September.

**Black root rot:** Dig out and burn infected bushes.

Dig a trench 30 cm deep around affected spot along with a ring of healthy bushes.

Prune the healthy bushes within and outside the trench to allow sunlight.

Keep the trench free from fallen leaves.

Do not replant for 18 months.

**Harvest:** Harvest starts during October and extends upto February. Coffee fruits should be harvested as and when they become ripe. Coffee is just ripe when on gently squeezing the fruits the beans inside come out easily.

**Fly picking:** small scale picking of ripe berries during October to February

**Main picking:** well formed and ripened berries are harvested during December. Bulk of the yields are obtained from this picking.

**Stripping:** picking of all the berries left irrespective of ripening.

**Cleanings:** This is collection of fruits that have been dropped during harvesting.

Unripe fruits should be scrupulously sorted out before using the fruits for pulping. They may be dried separately as cherry.

**Yield:** Dry parchment 750 - 1000 kg/ha.

#### Market information

Growing Districts	Dindigul, Nilgiris, Salem and Theni
Major markets in Tamil Nadu	Coonoor, Bodinayakanur , Mettupalayam
Types	Arabica, Robusta
Grade specification	Washed, Unwashed, Monsooned, Instant, Ground, Roasted, Speciality

**Cashew: *Anacardium occidentale* L.; Anacardiaceae**

**Varieties:** VRI 1, VRI 2, VRI 3, VRI 4 and VRI (CW) H1

**Soil and climate:** It grows up well in all soils. Red sandy loam is best suited. Plains as well as hill slopes upto 600 - 700 feet elevation are suitable for cultivation.

**Season:** June - December.

**Propagation:** Soft wood grafting, air layer and epicotyl grafting.

**Requirement of plants:** 200 plants/ha.

**Preparation of field:** Pits of 45 cm<sup>3</sup> size are dug and filled up with a mixture of soil + 10 kg FYM + one kg neem cake and 100 g Methyl parathion 1.3 %.

**Spacing:** 7 m either way.

**High Density Planting:** Spacing of 5 x 4 m accommodating 500 plants per hectare is recommended prune the interlocking branches during the July-August to maintain the frame.

**Manuring (per tree)**

Manures and fertilizers	I year	II year	III year	IV year	V year onwards
FYM or Compost (kg)	10	20	20	30	50
N(g)	70	140	210	280	500
P(g)	40	80	120	160	200
K(g)	60	120	180	240	300

Fertilizer application may be done during October - November in the East Coast areas. Wherever possible the fertilizer can be applied in 2 equal split doses during June-July and October-November periods under eastcoast area, a fertilizer schedule of 1000:125:250 g NPK/tree is recommended tree.

Irrigation: Normally grown as a rainfed crop. Irrigation once in a week from flowering to fruit maturity stage is good to increase the yield.

**Intercropping:** Plough the interspaces after the receipt of rain and raise either groundnut or black gram till the trees reach bearing age.

**Training and pruning:** Develop the trunk to a height of 1 m by removing low lying branches. The dried twigs and branches should be removed every year.

**Plant protection**

**Pests**

**Stem borer –**

- Collect and destroy affected shoots.
- Swabbing the bark of exposed roots and shoots with carbaryl 50 WP@ 2 g/lit. Twice a year before the onset of South West Monsoon (March – April) and after cessation of monsoon (November) painting of coal tar + kerosene mixture (1:2) or swabbing with a suspension of carbaryl 50 WP (4 g/lit) upto one metre length in the exposed trunk region

after shaving the bark or swab the tree trunk with neem oil 5% thrice during January-February, May-June, and September-October

- Root feeding with 10 ml of water kept in a polythene bag on one side of the tree and keep the same amount on the other side of the tree (Total 20 ml/tree) divided into two equal halves will give protection when there is moderate incidence.
- Remove grubs from early stage infested trees and drench the damage portion with Chlorpyrifos 0.2% @ 10 ml/lit or Neem Oil 5%

#### **Tea mosquito bug:**

- Spray application of phosalone 35 EC @ 2.0 ml, followed by carbaryl 50WP @ 2g/l at vegetative flush stage, panicle initiation stage and nut formation stage respectively are recommended for the management of tea mosquito bug.
- Spray schedule involving three rounds of spray viz., first spraying with Profenophos (0.05%) at flushing stage, second spraying with Chlorpyrifos (0.05%) at flowering and third spraying with Carbaryl (0.1%) at fruit set stage is most effective.

**Apple borer:** Spray dichlorvos 76 % EC @ 6.0 ml/10 lit.

**Root borer:** Pour in the bore holes split into two halves (insecticide 5 ml + 5 ml water).

#### **Diseases**

##### **Die back or Pink disease:**

Prune the affected shoots just below the affected portion and apply Bordeaux paste.

Spray 1 % Bordeaux mixture or copper oxychloride 0.25 % twice in May- June and again in October as a prophylactic measure.

**Harvest:** The plant starts yielding 3<sup>rd</sup> year onwards. The peak picking months are March to May. Good nuts are grey green, smooth and well filled. After picking, the nuts are separated from the apple and dried in the sun for two to three days to bring down the moisture content to 10 to 12 %. Properly dried nuts are packed in alkathene bags. This will keep for 6 months.

**Yield:** 3 - 4 kg/tree/year.

#### **Market information**

Growing Districts	Cuddalore, Tirunelveli
Major markets in Tamil Nadu	Jayankondam, Vridhachalam, Panruti
Grade specification	White/ Pieces, splits, butts

## **Cocoa: *Theobroma cacao* L.; Sterculiaceae**

**Varieties:** Criollo, Foresterio and Trinitario. CCRP - 1, CCRP - 2, CCRP - 3, CCRP - 4, CCRP - 5, CCRP - 6 and CCRP - 7.

**Soil and climate:** Potash rich alluvial soils friable in nature with high humus and moisture retentivity with a pH of 6.6 - 7.0 are suitable. Cocoa is normally cultivated at altitudes upto 1200 m above MSL with an annual rainfall of 150 cm and a relative humidity of 80 % and annual mean temperature of 24°C to 25°C. Cocoa can be grown as intercrop in coconut and arecanut gardens.

**Season:** June - July and September - October.

**Seeds and sowing:** Propagated by seeds. Before sowing the seeds the pulp adhering to the seeds has to be removed. Cocoa seeds are individually sown in polybags soon after extraction.

### **Pot mixture:**

The bags are filled with pot mixture containing.

- Red soil -2 parts
- Sand -1 part
- FYM- 1 part
- Super phosphate - 5 kg/ton of the above mixture

This can be filled in 320 gauge polythene bag with 30 cm height and 20 cm width provided with two holes in the bottom. Nursery plants are ready for transplanting at 6 months of age when they attain a height of 60 cm.

**Planting:** Seedlings are transplanted with a ball of earth in 45 cm<sup>3</sup> pits at a spacing of 3 x 3 m either way. Stake the plants to ensure upright growth and early establishment. Periodical mulching with leaves and watering should be done. Temporary shade has to be provided.

**Irrigation:** Irrigation should be given as and when necessary. During summer months irrigation should be given once in three days.

**Manuring:** Trees of 3 years of age and above are manured with 100 g N, 40 g P and 140 g K per tree in two split doses during April - May and August - September. Trees younger than three years may be applied with half of this dose.

<b>Fertilizer</b>	<b>I year after planting(g)</b>	<b>II Year after planting(g)</b>	<b>III Year after planting(g)</b>
Urea	75	145	200
Super phosphate	85	165	250
Muriate of Potash	80	160	240
Time of application	2 split doses / year (Feb - March & July - Aug)	3 split doses / year (Feb - March, May - June & Aug - Sep)	3 split doses / year (Feb - March & May - June & Aug - Sep)

Micro nutrient application: Foliar application of FeSO<sub>4</sub> @ 0.5% + Zn So<sub>4</sub> @ 0.5% in 2 split doses/ year.

**Pruning:**

**Formation pruning:** Done in young plants of cocoa (1 year after planting). The height of first jorquette is kept at 1-1.5m from the ground.

**Structural pruning:** done generally 16-24 months after planting. Done to maintain tree at optimum height.

**Maintenance Pruning:** Starts from second year of planting. Remove low and hanging branches. Remove excess number of chupons regularly. Remove unproductive branches, dead, diseased and badly damaged branches in periodical intervals.

**Aftercultivation:** Weeding is done as and when necessary. The unproductive shoots, dead, diseased twigs should be removed periodically. Banana is better raised as a primary shade plant in the early years of plantation.

**Plant protection****Pests****Tea mosquito bug:**

- Monitoring the incidence of tea mosquito bugs at regular intervals.
- Removal of alternate hosts like neem, cashew, guava in the surroundings
- When the infestation is lesser: Spraying of any one of the following:
  - Imidacloprid (0.6 ml/l)
  - Thiamethoxan (0.6 g /l)
  - Profenophos (2 ml/l).

**Mealy Bug:**

- Monitoring the incidence of mealy bugs at regular intervals.
- Removal of alternate weed hosts like Parthenium.
- Collection and destruction of infested plant parts before spraying.
- When the infestation is lesser: Spraying of neem oil 2 % or fish oil rosin soap 25 g/l.
- On severe incidence, spraying of any one of the following chemicals is recommended.
  - Dimethoate (2 ml/l)
  - Profenophos (2 ml/l)
  - Chlorpyrifos (5 ml/l)
  - Imidacloprid (0.6 ml/l)
  - Thiamethoxam (0.6 g/l).
- Release coccinellid predator *Cryptolaemus montrouzieri* @ 10 nos/tree.

**Aphids:** Spray dimethoate 35 EC 1 ml/lit at monthly intervals.

**Grey Weevil:** Spray phosphamidon 40 SL 2 ml/lit.

**Hairy caterpillar:** Dust Methyl parathion 1.3 D or spray Methyl parathion 20 EC 2ml/lit.

**Semilooper:** Dust Methyl parathion 1.3 D.

**Rodents:**

**Rats & squirrels:** keep 10g of Bromodiolone (0.005%) wax cakes on the branches twice at an interval of 10-12 days.

## Diseases

**Black pod disease:** Spray 1 % Bordeaux mixture or 0.2 % Mancozeb or Copper oxychloride at 20 days interval.

**Stem canker:** Remove the infected areas and apply Bordeaux paste at 10 %

**Dieback disease:** Spray 1 % Bordeaux mixture or Copper oxy chloride at 0.25 %.

**Charcoal pod rot:** Spray with 1 % Bordeaux mixture or Copper oxy chloride at 0.25 %.

**Cherelle wilt:** Spray carbendazim @ 0.1 % or Dithane M 45 @ 0.2 % or Copper oxy chloride @ 0.25 %.

**Pink disease:** Prune the affected branches and swab the cut ends regularly with 1 % Bordeaux mixture.

**Harvest:** Bearing starts from 3<sup>rd</sup> year but economic yield starts from 6<sup>th</sup> year onwards. The season of harvest is April – May and November – December.

**Yield:** 500 - 1000 kg of dry beans/ha.





**Rubber: *Hevea brasiliensis* Muell-Arg.; Euphorbiaceae**

**Varieties:** Tjir 1, PB 86, BD 5, BD 10, PR 17, GT 1, RR11 105, RRIM 600, PB 28/59, PB 217, PB 235, RRIM 703, RR11 5, PCK-1, 2 and PB 260.

**Soil and climate:** It requires deep and fertile soil with pH of 4.5 to 6.0. Requires tropical temperature 20 – 30° C with the well distributed rainfall of 2000 – 5000 mm and an elevation of 300 – 800 m above MSL. is ideal.

**Season:** June - July.

**Propagation:** Propagated by green budding and brown budding.

Nursery: **bed size:** 60-120 cm width and of convenient length.

Spacing: Seedling stumps - 23 x 23 cm, 30 x 30 cm and 34 x 20 cm

Budded stumps - 30 x 30 cm

Stump budding - 60 x 60 cm

Bud wood nursery - 60 x 90 cm or 60 x 120 cm.

**Seedling Nursery:**

**Manuring:** Basal -2.5 t/ha of FYM and 350kg/ha of Rock Phosphate.

1.5 - 2 months after planting -10:10:4:1.5 NPKMg mixture -2500 kg/ha.

Urea @550 kg /ha -3 to 3.5 months.

**Planting:** Pit size of 1 m<sup>3</sup> are dug and filled up with top soil and compost.

Planting material	Spacing (m)	Population / ha
<b>Budded plants</b>		
Hilly areas	6.7 X 3.4	445
Plains	4.9 X 4.9	420
<b>Seedlings</b>		
Hilly areas	6.1 X 3.0	539
Plains	4.6 X 4.6	479

**In situ sowing:** Germinated seeds are sown *in situ* in the pits. Healthy ones are retained and the others removed.

**Manuring:** Manuring is done for immature rubber trees at pre-tapping stage.

Apply 12 kg of compost or FYM and 120 g of rock phosphate in each pit before planting.

Apply 10:10:4:1.5 NPK and Mg as per schedule given below:

Months after planting	Period of application	NPK and Mg mixture (10:10:4:1.5)	
		g/plant	Kg/ha
3	September/October	225	100
9	April/May	445	200
15	September/October	450	200
21	April/May	450	250
27	September/October	550	250

33	April/May	550	200
39	September/October	450	200

Apply 400 kg of mixture per ha in 2 doses, once in April/May and another in September/October from the 5th year till the tree is ready for tapping. For matured rubber trees under tapping apply NPK 10:10:10 grade mixtures at the rate of 900 g/tree (300 kg/ha) every year in two split doses. Add 10 kg commercial Magnesium sulphate for every 100 kg of the above mixture if there is magnesium deficiency.

**After cultivation:** Growing of cover crops, incorporation of cover crops and weeding are important operations for soil conservation. *Pueraria phaseoloides*, *Calopogonium muconoides*, *Centrosema pubescens* and *Desmodium evalifolium* are common cover crops.

**Tapping:** Trees attain tappable stage in about 7 years. First tapping in seedling trees will commence when the trunk attains a girth of 55 cm at 50 cm height from the ground. In budded trees the girth should be 50 cm at 125 cm height from the bud union.

**Tapping system:**

S/2 d/2	(half spiral, alternate day for 6 months and rested for 3 months)	100% Intensity
S /2 d/2 6m /9	(half spiral, alternate day for 6 months and rested for 3 months)	67 intensity
S /2d/3	(half spiral, third day)	67 intensity
S/2 d/3 1m/2	(half spiral, daily for one month and rested for next month)	100% intensity
S /1 d/4	Full spiral, fourth day	100% intensity
V /2 d/2 12m/16	Half circumstances and cut alternate day for 12 months and rested for the next 4 months	75% intensity

**Rain guarding:** Fixing a polythene rain guard to the trunk of the tree above the tapping panel during the raining season is recommended in areas where the annual yield is 700 kg/ha or more.

**Ethrel treatment:** Ethrel is recommended to increase latex yield of trees tapped on panel D. It is applied at 5 % a.i. concentration with a brush below the tapping cut to a width of 5 cm after light scraping of the outer bark. The first application may be done after a drought period preferably after a few pre-monsoon showers and subsequent applications may be done in September and November. However, continuous application of Ethrel is not recommended for periods of more than 3 years at a stretch.

**Tapping panel dryness (Brown bast):** Syndrome characterized by prolonged dripping of latex with the gradual decline in volume yield, pre coagulation of latex and partial or complete drying of tapping area (10-25 per cent).

**Control:** Reduce tapping intensity or give a tapping rest for 3 to 12 months.

## **Plant protection**

### **Pests**

#### **Scale insect:**

When severe infestation is noticed, spray malathion 50 EC @ 2 ml/lit.

#### **Mealy bug:**

Spray fish oil rosin - soap 25 g/lit.

Release Australian lady bird beetle, *Cryptolaemus montrouzieri* @ 10/tree.

#### **Termite (White ant):**

Drench the soil at the base of affected plants with chlorpyrifos 20 EC @ 2 ml/litre.

#### **Cockchafer grub:**

Drench soil at the base of plants in the affected area with the solution of chlorpyrifos 20 EC @ 2 ml/litre.

#### **Mites:**

Spray dicofol 18.5 EC @ 2.5 ml/lit.

### **Diseases**

#### **Abnormal leaf fall and Secondary leaf fall:**

Prophylactic spraying of the foliage prior to the onset of South-West monsoon with, Bordeaux mixture 1% at 4000 - 5000 lit/ha using high volume sprayers.

Oil based Copper oxy chloride using low volume sprayer or through aerial application.

Two rounds of spray using about 17 to 22 lit of fungicide oil mixture per ha per round (1:6 proportion) at 10 to 15 days interval (or)

a single round of spray with about 30 - 37 lit of fungicide oil mixture per ha (1:5 proportion).

**Powdery mildew:** Dusting during the defoliation period commencing from the bud break in about 10 % of the trees, giving 3 to 5 rounds at weekly to fortnightly intervals before 10.00 a.m. using 11 to 14 kg 325 mesh fine Sulphur dust per round per ha. Sulphur dust can be mixed with talc in the proportion of 7:3. Wettable sulphur (1 kg in 4000 lit of water) is also effective in nurseries and for young plants as a spray.

**Bird's eye spot:** Repeated sprayings with Bordeaux mixture 1% or Mancozeb or Copper oxychloride 0.2 %.

**Leaf spot:** Spray 1 % Bordeaux mixture or 0.2 % Mancozeb or 0.1 % Carbendazim at fortnightly intervals.

#### **Pink disease:**

Frequent tree to tree inspection during July – September period for detecting the infected trees and application of Bordeaux paste in the early stages upto 30 cm above and below the affected region.

In advanced cases apply Bordeaux paste and when it dries up scrape off the superficial mycelium and damaged bark and apply Bordeaux paste once again.

Prune off and burn the dried up branches after disinfecting by Bordeaux spraying.

**Patch canker or Bark cankers:**

The affected region may be scraped to remove all the rotting bark and the coagulated rubber and the wound washed well with Dithane M 45 @ 0.75 %.

When the fungicide dries up apply wound dressing compound.

**Dry Rot, Stump Rot, Collar Rot or Charcoal Rot:**

Clean up affected areas, by washing with Carbendazim (0.1%) solution.

Scrape out the fructifications.

Affected bark and wood show black lines. Wash the wound again with fungicide solution.

When it dries up apply a wound dressing compound.

Avoid accumulation of rubber at the base of the trees.

**Brown root disease:**

Open up the root system.

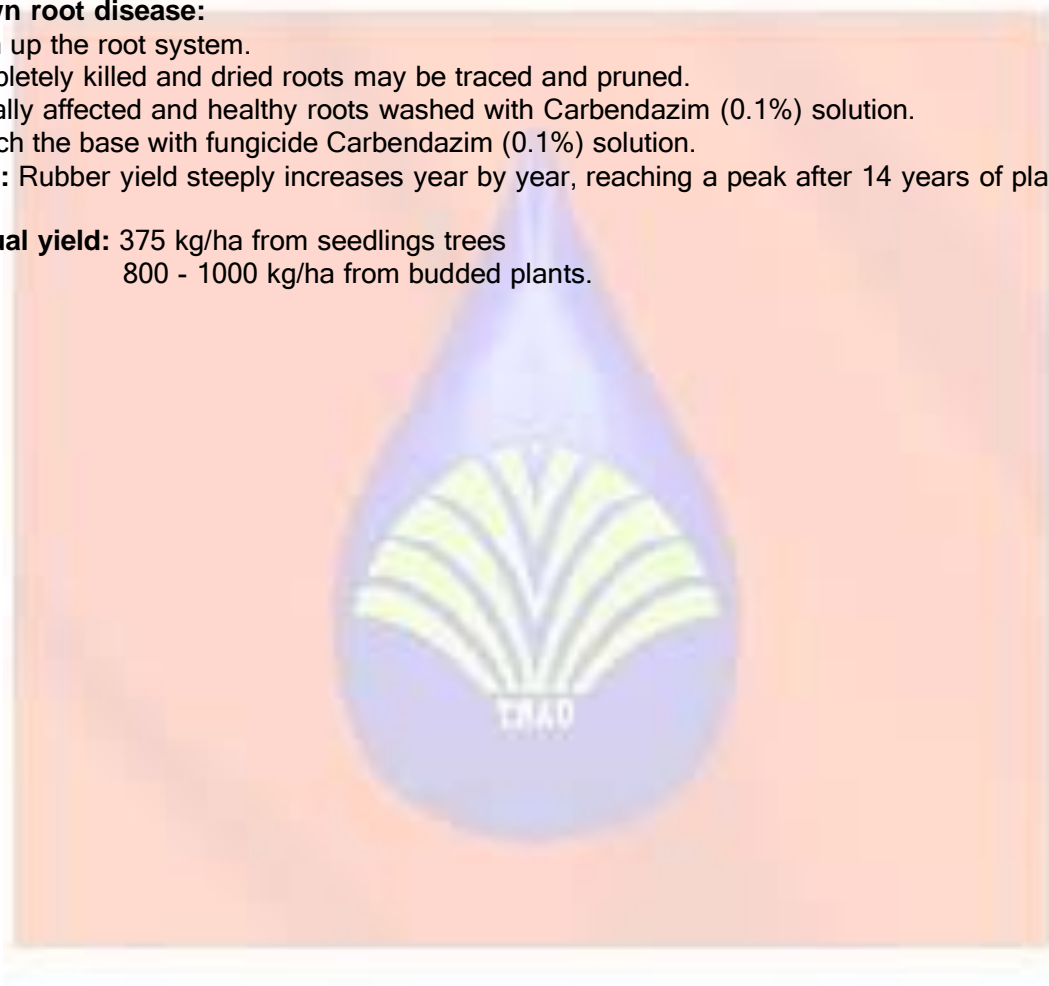
Completely killed and dried roots may be traced and pruned.

Partially affected and healthy roots washed with Carbendazim (0.1%) solution.

Drench the base with fungicide Carbendazim (0.1%) solution.

**Yield:** Rubber yield steeply increases year by year, reaching a peak after 14 years of planting.

**Annual yield:** 375 kg/ha from seedlings trees  
800 - 1000 kg/ha from budded plants.



## Coconut (*Cocos nucifera* L.); Palmae

### Varieties:

**Hybrids:** VHC1, VHC2 and VHC3

**Tall:** VPM3, ALR 1, ALR 2 and West Coast Tall

**Dwarf (tender coconut):** COD, CYD, CGD and MYD

**Soil and climate:** Light sandy soils to heavy soils with a pH - 5.2 to 8.0. Proper drainage, good water-holding capacity, presence of water table within 3 m and absence of rock or any hard substratum within 2 m of the surface.

Altitude: 600 to 900 m

Rainfall: 200 cm per year.

**Planting seasons:** Jun - Jul and Dec - Jan. The planting can also be taken up in other seasons wherever irrigation and drainage facilities are available.

**Spacing:** For garden: 25' x 25' (Square system - 7.5 x 7.5 m) - 175 plants/ha.  
Field border as a single row - 20' spacing between plants

**Planting:** Pit size of 3 cubic feet.

Sprinkle methyl parathion Dust to prevent white ant damage. Fill the pit to a height of two feet (60 cm) with FYM, red earth and sand mixed in equal proportions. At the center of the pit, remove the soil mixture and plant the seedling after removing all the roots. Press the soil well around the seedling and provide the seedling with shade by using plaited coconut leaves or palmyrah leaves. Keep the pits free from weeds. Remove soil covering the collar region. As the seedlings grow and form stem, fill up the pits gradually by cutting the sides.

**Water management:** Summer irrigation - production of female flowers and setting percentage increases. Moisture stress - stunted growth, drooping of leaves, immature nut fall

Months	Normal condition (for best yield)	Moderate water scarcity condition	Severe water scarcity condition
<b>A. Drip irrigation</b>			
March - September	80 lit / day	55 lit / day	27 lit/day
October - February	50 lit / day	35 lit/ day	18 lit /day
<b>B. Basin irrigation</b>			
March - September	410 lit / 5 days		
October - February	410 lit /8 days		

**Drip irrigation in coconut:** Root zone of coconut for moisture absorption is concentrated in a circular area of 200 cm radius around the base of coconut tree up to a depth of 100 cm. Irrigating coconut trees by a set of four drippers set equidistant in a circle 100 cm away from the base of the tree and discharging water at the rate of 30 l/h for 2.5 h with a irrigation frequency of 8 days can maximize the wetting area of soils in the effective root zone of coconut.



### Drought management and soil moisture conservation:

#### a. Mulching with coconut husks/leaves/coir pith

Apply coconut husks with convex surface facing upwards (100 Nos.) or dried coconut leaves (15 Nos) or coir pith up to a height of 10 cm in the basin of 1.8 m radius around the palms during summer season

#### b. Burial of coconut husk or coir pith

Bury husks @ 100 Nos. with concave surface facing upwards or 25 kg of coir pith /palm in circular trenches, dug 30 cm width and 60 cm depth at 1.5 metres radius - preserves the monsoon rains.

### Manuring & Fertilizer application

Age(Years)	FYM(kg/tree)	Urea(kg/tree)	Super Phosphate(kg/tree)	Muriate Potash(kg/tree)
1	10	0.308 (140 g N)	0.500 (80g P <sub>2</sub> O <sub>5</sub> )	0.480 (300 g K <sub>2</sub> O)
2	20	0.616 (280 g N)	1.000 (160 g P <sub>2</sub> O <sub>5</sub> )	0.960 (600 g K <sub>2</sub> O)
3	30	0.924 (420 g N)	1.500 (240 g P <sub>2</sub> O <sub>5</sub> )	1.440 (900 g K <sub>2</sub> O)
4	40	1.23 (560 g N)	2.000 (320g P <sub>2</sub> O <sub>5</sub> )	1.920 (1200 g K <sub>2</sub> O)
5 <sup>th</sup> year on wards	50	1.23 (560 g N)	2.000 (320g P <sub>2</sub> O <sub>5</sub> )	1.920 (1200 g K <sub>2</sub> O)

Apply manures and fertilizers in circular basins of 1.8 m from the base of the palm, incorporate and irrigate.

The fertilizers may be applied in two split doses, in June - July and in December to January.

**TNAU Coconut Tonic Nutrition:** For nut bearing coconut, root feed TNAU coconut tonic @ 200 ml/palm once in six months.

**Bio-fertilizer recommendation :** 50 g of *Azospirillum*, 50 g of *Phosphobacteria* ( or ) 100 g Azophos and 50 g of VAM. Mix all the contents in sufficient quantity of compost or FYM and apply near feeding roots once in 6 months / palm starting from planting. Don't mix with chemical fertilizers and pesticides

**Organic recycling:** Any one of the green manure crops like sunhemp, wild indigo, calapagonium or daincha may be sown and ploughed *in situ* at the time of flowering as a substitute of compost to be applied. Sow sunhemp @ 50 g/palm in the basin and incorporate before flowering. Coir pith compost or vermicompost made from coir pith/ coconut leaves/ other wastes from coconut grove can be applied.

### Intercropping in coconut

- Below 7 years of age: annual crop
- 7 - 20 years of age: Green manure crops and fodder crops
- Above 20 years of age

<b>Annuals</b>	Groundnut, bhendi, turmeric, tapioca, sweet potato, sirukizhangu, elephant foot yam, ginger, pineapple
<b>Biennials</b>	Banana varieties viz., Poovan and Monthan are suitable
<b>Perennials</b>	Cocoa, pepper (Panniyur 1 or Panniyur 2 or Panniyur 5 or Karimunda), nutmeg and vanilla



**Weed management:** The inter-space in the coconut garden has to be ploughed twice in a year in June-July and December - January. Intercultural operation is essential to keep weed population under check, to enhance the utilisation of the applied plant nutrients by the coconut trees, to facilitate proper aeration to the roots of coconut, to induce fresh root growth.

For the broad-leaved weeds, pre-emergence spraying of atrazine @1.0 kg a.i. / ha for the control of grasses and sedges. Post emergence spraying of glyphosate @ 10 ml and 20 g ammonium sulphate/litre of water.

#### Yield and Earliness:

S.No	Variety	Nut yield (Nos / tree / year)	Earliness (year)
1.	Hybrid	100	3 - 5
2.	Tall	60 - 80	6 - 7
3.	Dwarf (tender coconut)	70 - 90	4 - 5

#### Pests and diseases

##### I) Rhinoceros beetle

- i. Remove and burn all dead coconut trees in the garden (which are likely to serve as good breeding ground) to maintain good sanitation.
- ii. Collect and destroy the various bio-stages of the beetle from the manure pits (breeding ground of the pest) whenever manure is lifted from the pits.
- iii. Incorporate the entomopathogen i.e, fungus (*Metarhizium anisopiae*) in manure pits to check the perpetuation of the pest.
- iv. Apply Methyl parathion dust in the manure pits once in three months to kill the grubs.
- v. Soak castor cake in small mud pots and keep them in the coconut gardens to attract and kill the adults.
- vi. Treat the longitudinally split tender coconut stem and green petiole of fronds with fresh toddy and keep them in the garden to attract and trap the beetles.
- vii. Examine the crowns of tree at every harvest and hook out and kill the adults.
- viii. Fill the crown and the top most three leaf axils with a mixture of Aldrin 5 D and fine sand (1:1 by volume) once in three months, particularly before and after the monsoon months to check the damage by adults. For seedlings, apply 3 nos. of naphthalene balls/palm weighing 3.5 g each at the base of interspace of leaf sheath in the 3 inner most leaves of the crown once in 45 days.
- ix. Set up light traps following the first rains in summer and monsoon period to attract and kill the adult beetles.
- x. Field release of Baculovirus inoculated adult rhinoceros beetle reduces the leaf and crown damage caused by this beetle.
- xi. Mixture of either neem seed powder +sand (1:2 @ 150 g per palm or Neem Seed Kernel powder + Sand (1:2) @ 150 g per palm applied in the base of the 3 inner most leaves in the crown effectively controlled rhinoceros beetle damage.

##### II Black headed caterpillar

- i. The incidence of the pest is noticed from the month of November to May and from August to November after rainfall. The coconut trees of all ages are attacked. Among the larval parasites, the bethylid *Parasierold nephantidis* is the most effective in controlling the pest. The optimum level of release is 1:8 of host parasite ratio. The parasite should be released under the coconut trees then the pest is in the 2<sup>nd</sup> or 3<sup>rd</sup> instar larval stage. Parasite release trap may be used to release the parasite at the site of feeding. Parasites should not be released in the crown region since they will be killed by predators like spiders and reduvils.
- ii. Remove and burn all affected leaves/leaflets.

- iii. Release the larval (Bethylids, Braconid and Iohneumonid) and pupal (Eulophid) parasites and predators periodically from January, to check the build up of the pest during summer.
- iv. Spray Malathion 50 EC 0.05 % to move the undersurface of the leaves thoroughly in case of severe epidemic outbreak of the pest in young palms.
- v. Harvest all mature nuts, and drill a downward slanting hole and inject 5.0 ml of into the stem at about 1.5 m above the ground level and plug with clay mixed with Copper oxychloride. Plucking tender coconuts or harvesting the nuts should be avoided strictly for forty days after treatment.
- vi. Root feeding for the control of coconut Black headed caterpillar: Select a fresh and live root, cut sharply at an angle and insert the root in the insecticidal solution containing water 10 ml in a 7x10 cm polythene bag. Secure the bag tightly to the root with a cotton thread. Twenty four hours later, check whether there is absorption. Select another root. These methods should not be resorted to as a routine practice and it is suggested only for cases of severe epidemic outbreak of the pest and when the survival of the tree is threatened.

### III. Red palm weevil

- i. Remove and burn all wilting or damaged palms in coconut gardens to prevent further perpetuation of the pest.
- ii. Avoid injuries on stems of palms as the wounds may serve as oviposition sites for the weevil. Fill all holes in the stem with cement.
- iii. Avoid the cutting of green leaves. If needed, they should be cut about 120 cm away from the stem.
- iv. Plug all holes and inject Pyrocone E or Carbaryl at 1% ml or 10 ml of 5 ml of Dichlorvos into the stem by drilling a hole above the points of attack.
- v. Setting up of attractant traps (mud pots) containing sugarcane molasses 2 ½ kg / toddy 2 ½ litres + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem /logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers.

### IV. Termites

- i. Locate termite mounds in or near the coconut nursery or garden and destroy.
- ii. Incorporate 120 kg of Heptachlor 3 D per ha into the soil twice a year, i.e, on receipt of summer and monsoon showers (Heptachlor 3 D per tree). Spray Aldrin 0.15 % or HCH 0.25 % or Neem oil 5 % once on the base and upto 2 m height of the trunk for effective control.
- iii. Spray Copper sulphate 1 % or Cashew nut shell oil 80 % followed by Copper sulphate 1 % then neem oil 5 % and copper sulphate 1 %, then NSKE 20 % to preserve planted coconut leaves from the termite attack.

**V. Scale insect:** Pluck mature nuts and Do not harvest nuts for 1 ½ months after spraying.

**VI. Mealy bugs:** Remove leaflets harbouring these insects and destroy them and spray Malathion at 0.1 % or Dimethoate 0.03 % or Methyl demeton 0.025 % or Phosphomidon 0.05 %

or Methomyl 0.25 %. Application of neem oil 3% was effective in controlling mealy bug.

**VII. Leaf caterpillars, nut caterpillar and nut coreld bud:** Collect and destroy the immature stages of the insects wherever possible and spray Carbaryl 0.1 %. A combined treatment of root feeding of 5 ml water. followed by the release of Parasitoids at every 15 days interval of time effectively control leaf eating caterpillars.

**VIII. Palm civet:** Poinson baiting with ripe banana fruit sand wixed with 0.5 g Carbofuran 3 g granules.

**IX. Rat:** Tree banding with inverted iron cores or Prosopis thorns. Baiting with Bromodialone 0.005% at 10 g/tree at crown region twice at an interval of 12 days.

**X. Thanjavur wilt:** Aureofungin – sol 2 g+one g Copper sulphate or 2 ml of Tridemorph dissolved in 100 ml water may be applied as root feeding. The active absorbing root of pencil thickness be selected and a slanting cut is made. The solution is taken in a polythene bag or bottle and the cut end of the root is dipped in the solution. Forty litres of 1% Bordeaux mixture should be applied as soil drench around the trucks in a radius of 1.5 metre. Neem cake (5 kg/tree can be applied along with fertilizers and Azotobactor (200 g/tree).

For early diagnosis of Thanjavur Wilt, and EDTA test utilizing the root samples has been developed and based on the O.D values the disease intensity can be detected.

Disease intensity -	Optical Density value
Mild -	0.18 - 0.22
Moderate -	0.24 - 0.59
Severe -	> 0.59
Healthy palm -	0.02 - 0.10

Intercrop with banana to reduce the severity of Thanjavur Wilt.

**XII. Bud rot:** The infective tissues from the crown region should be removed and protected with Bordeaux paste. Spray Bordeaux mixture at 1% or Copper oxy chloride 0.25 % on crown region as pre-monsoon spray. Spray Copper oxy chloride 0.25 % after the onset of monsoon.

**XIII. Stem bleeding disease:** The bark of the trunk should be removed in the bleeding area and Bordeaux paste should be applied in this area.

- Preparation of 1% Bordeaux mixture: A quantity of 400 g of copper sulphate should be dissolved in 20 litres of water and 400 g of lime in another 20 litres of water separately. The copper sulphate solution should be added to the lime solution constantly stirring the mixture. Earthen or wooden vessels alone should be used and metallic containers should not be used. To find out whether the mixture is in correct proportion, a polished knife should be dipped in the mixture for one minute and taken out. If there is reddish brown deposit of copper, additional quantity of lime should be added till there is no deposit in the knife.
- Preparation of Bordeaux paste: Take 200 g of Copper sulphate and dissolve it in one litre of water and 200 g of lime in one litre of water separately.; both are mixed simultaneously in a third vessel and the resultant mixture can be used as a paste.

**XIV. Pencil point disease:** Because of micronutrient deficiency, the stem will taper towards its tip with lesser number of leaves. The leaf size will be greatly reduced and the leaves will be pale and yellow in colour. Along with the recommended fertilizer dose, 225 g each of Borax, Zinc sulphate, Manganese sulphate, Ferrous sulphate, Copper sulphate and 10 g of Ammonium molybdate may be dissolved in 10 l of water and poured in the basin of 1.5 m radius.

### **SPECIAL PROBLEMS IN COCONUT**

1. **Rejuvenation of existing garden:** The low yield in vast majority of gardens is due to following measures are taken.
  - i. Thinning of thickly populated gardens: In the farmer's holdings, 41 per cent of the trees give a yield of less than 20 nuts/palm/year. By cutting and removal of these trees the yield could be increased by 1750 nuts/ha. After removal of low yielding trees, the populations should be maintained at 175-200 palms/ha.
  - ii. Apply manurial schedule of 50 kg of FYM or green leaf plus NPK at 560, 320, 1200 g/palm and irrigate at 10 days intervals during summer months in addition to manuring.
2. **Button shedding:** Shedding of buttons and premature nuts may be observed to many reasons: Provide regular irrigation, requested nutrition to reduce the button shedding.

#### **Barren nuts**

Apply extra 2 kg of  $K_2O$  with 200 g of Borax/palm over and above the usual dosage of fertilizer to correct the barren nuts in coconut.

- a) Regularly survey for pest and diseases
- b) Select seedlings 9 to 12 months after planting. Seedlings, which have germinated earlier, having good girth at collar and early splitting of leaflets, should be selected for planting.

#### **TNAU MN mixture @ 1 kg/tree/year**

(\* Enriched FYM prepared at 1:10 ratio of the MN mixture and FYM, mixed at friable moisture and incubated for one month in shade).

#### **Market information**

Growing Districts	Thiruvavur, Coimbatore, Kanyakumari, Tanjore
Major markets in Tamil Nadu	Coimbatore, Tanjore, Chennai
Preferred varieties	Tall Dwarf, Tall x Dwarf
Grade specification	Colour, Nut Weight



## **Arecanut: *Areca catechu* L.; Palmae**

**Varieties:** Mangala, Sumangala, Subamangala, Mohitnagar, Srimangala, Samruthi (Andaman), Hirehalli dwarf, VTLAH 1,2 and Thirthahalli dwarf.

### **Soil and climate:**

Arecanut is capable of growing in a variety of soils. It thrives best in well drained soils. Adequate protection from exposure to South-Western sun is essential to avoid sun-scorch. Quick growing shade trees have to be planted on the southern and western sides well in advance of planting seedlings. It is sensitive to moisture deficit and should be grown where adequate water facilities are available.

Grows in a wide range of temperature ranging from minimum of 4°C to a maximum of 40°C. Altitude upto 1000 m above Msl. Rainfall – 750 – 4500 mm.

**Season:** June - December.

**Seeds and sowing:** For raising seedlings seed nuts from pre-marked and pre-potent mother palms of outstanding performance are selected

Sown immediately after harvest at a spacing of 5 - 6 cm apart in sand beds under partial shade with their stalk end pointing upwards.

After the sprouts have produced two to three leaves (90 days old), they are transplanted to Secondary nursery beds at a spacing of 30 x 30 cm or polythene bag of 30 x 10 cm filled with forest soil and are allowed to grow for 12 to 18 months under partial shade. Periodical watering should be given.

### **Planting:**

Dwarf and compact seedlings with more number of leaves of 1 – 2 years age should be selected.

Plant in pits of 90 cm<sup>3</sup> at a spacing of 2.75 m either way and covered with soil to the collar level and pressed around.

Provide shade during summer months.

Growing Banana or other crops in advance may also provide shade.

**Irrigation:** Irrigate weekly once during November - February, once in 4 days during March - May. Flood irrigation 175 lit/ tree/ day. In drip irrigation 16 - 20 lit/ tree/ day.

**Manuring:** Apply to each bearing palm (5 years and above) 10 - 15 kg of FYM or green leaf. 100:40:140 g of NPK/ tree/ year. To palms less than five years old, half of the above dose is recommended. Manures are applied during January - February after the North - East monsoon in a basin of 0.75-1.00 m radius around the tree to a depth of 20 - 30 cm.

**Aftercultivation:** Weeding is done twice or thrice in a year. Wherever the land is slopy terracing has to be done to prevent soil erosion.

**Intercropping:**

Cocoa, Black Pepper, Coffee, Cinnamon, Clove and citrus

**Plant protection****Pests**

**Mites:** Spray Dicofol 18.5 EC at 2.5 ml/lit of water.

**Spindle bug:** Drenching spray with Methyl parathion 1.3 D @ 2.5 g/lit of water or Dimethoate @ 1.5 ml/lit.

**Inflorescence caterpillars:** Dust Methyl parathion 20 EC 2 ml/lit or WP @ 2.5 g in one litre of water.

**Nematode:**

Soil application of *P. fluorescens* (Pfbv 22) and *B. subtilis* (Bbv 57) each @ g / vine was found to be effective in reducing the root knot and reniform nematode population in Black pepper.

**Diseases****Bud rot or Mahali disease:**

Infected tissues of the bud should be scooped off and treated with 10 % Bordeaux paste.

Destruction and removal of seed palms and bunches

Drenching crowns of surrounding healthy palms with 1 % Bordeaux mixture.

**Foot rot or anabe:**

Affected palms have to be isolated by digging trenches all round.

The severely affected palms should be cut and destroyed.

The stumps should be pulled out by digging and the drainage improved.

Soil application of neem cake @ 2 kg / palm / year followed by root feeding with 125 ml of 1.5 % (15 ml/litre of water) Tridemorph at 3 months interval or Soil drenching of Bordeaux mixture (1%).

**Stem breaking:** Wrapping up of the green portion of the stem which are exposed to the South-West sun to protect against sun-scorch.

**Yellow Leaf Disease:**

Application of balanced nutrients with additional quantity of super phosphate

Apply 1 kg of lime/tree/year.

Apply organic manures @ 12 kg/ tree/year.

**Leaf spot:** Foliar spray with Bordeaux mixture 1 % or 0.2 % Dithane M 45

**Nut crack:**

Spray Borax 2 g/lit with proper water management.

**Harvest:** The bearing starts after 5 years of planting. Nuts are harvested when they are three quarters ripe. The number of harvests will vary from three to five in one year depending upon the season and place of cultivation.

**Yield:** 1250 kg/ha



## **Oil Palm - *Elaeis guineensis* Jacq; Palmae**

Varieties - Dura, Tenera, Pisifora.

**Climate:** Temperature is 21°C to 32°C, annual rainfall - 200 cm and relative humidity - 75 - 100 %. Altitude - 450 -900 m above MSL.

**Soil:** Moist deep, loamy soils, rich in humus with good water permeability are suitable. Soil pH - 4 - 6

**Nursery techniques:** Fruits are separated from the bunch. Remove the exocarp and mesocarp with knife. Dry the seeds on concrete or wooden floors under shade for 2 days and stored for 3-9 months. Seeds are soaked in water for 5 days (changing the water daily) and spread out to dry for 24 hours. Dried seeds are put in 250 gauge and 23 X 13 cm size polythene bags filled with top soil, sand and well decomposed cattle manure in equal proportions and placed for germination. Germination (90-95 %) starts 10-12 days. Apply fertilizer mixture containing 15:15:6 of NPK @ 8 g in 5 litres of water for 100 seedlings.

**Planting:** Pit size 60 cm<sup>3</sup>. Planting can be done in triangular system with spacing of 9 m x 9 m x 9 m, accommodating 140 palms/ha, May-June is the suitable season for planting.

**Mulching:** Empty bunches, male flowers, coconut husk, sugarcane trash can be used as mulch.

**Irrigation :** Yielding palm of 3 years age and above - minimum of 150 litres/day.

**Drip irrigation:** 5 hrs of irrigation per day using 4 drippers per palm @ 8 litres of water /hr/dripper.

**Ablation:** Removal of all inflorescences during the initial three years to gain adequate stem girth, vigour and root system. Ablation is done at monthly intervals by pulling out the young inflorescence.

**Manuring:** For five year old palm, apply 50 kg compost of FYM or green leaves may be applied.

**Fertilizer schedule:** N: P: K : Mg So<sub>4</sub>(g/palm/year)

1<sup>st</sup> year = 400:200:400:125

2<sup>nd</sup> year = 800:400:800:250

3<sup>rd</sup> year onwards = 1200:600:1200:500 (2 equal split doses on July- Aug & Dec - Jan)

**Leaf pruning:** Severe pruning will adversely affect both growth and yield of palm, cause abortion of female flowers and also reduce the size of the leaves. It was suggested that the palms aged 4 – 7 years should retain 6-7 leaves per spiral (48-56 leaves), those aged 8 – 14 years 5-6 leaves per spiral (40- 49 leaves) and those above 15 years should have 4-5 leaves per spiral (32 – 40 leaves).

**Cover cropping:** *Pueraria phaeseoloides*, *Calopogonium mueconoides*, *Centrosema prutascens*, *Mimosa invisa*, *Mucana* sp.

## Plant Protection

### Pests:

**Rhinoceros beetle:** Trap the adults with fermented castor cake or pheromone bait. Use Bio agents like virus (*Baculovirus oryctes*) and Fungi (*Metarhizium anisopliae*). Treat the compost pit with Carbaryl or Quinalphos @ 0.025 % to kill the young stages of pest.

**Red Palm Weevil:** Removal of damaged and rotten bunches and apply tar to the wounds and cuts on the stem portion to avoid egg laying.  
Trap the adult beetles using pheromone baits.

### Case Worm:

#### Diseases:

**Stem wet rot:** Removal of infected portion and protective covering with Carbendazim (1%) .

**Bud Rot Disease:** The affected crown should be removed and drenched with Carbendazim or Thiram @ 0.1 %.

**Basal stem rot:** Removal and destruction of diseased palms. Apply 5 kg of Neem cake per year per tree. Root feeding with Calixin 10 ml or 10 g Aureofungin sol in 100 ml of water per tree per year.

**Harvesting:** First harvest can be done 3.5 to 4 years after planting. Few ripe fruits are loose/fall off indicates the bunch is ready for harvest. In Young palms, Chisel harvesting is followed. If palms become taller (from 10th year onwards), then harvesting is done by hook. Harvesting rounds should be made as frequent as possible to avoid over ripening of bunches. Harvesting rounds of 10-12 days are generally practiced. During rainy season harvesting rounds of 6-7 days are followed.

**Yield:** 25 - 30 tonnes of fresh fruit bunches/ hectare.

## **Palmyrah: *Borassus flabellifer*, Palmae**

**Varieties:** SVPR - 1

**Soil:** Arid, deep sandy & loamy soils are suitable. Dry areas with low rainfall are also ideal.

**Propagation:** Seed. Germination of 63.25 % are achieved 6 weeks after sowing

**Seed sowing:** Seed nut should be high yielder of padaneer & fruits, dwarf in stature, early and regular bearer, free from pest & diseases. Select matured fruit bunches and yellow tinch in styler region. Seeds are stored in shade for 3 weeks. Shrunken, weight less and bored seeds are rejected. Seeds may be directly sown in situ or in nursery to raise the seedlings. For direct sowing 3 – 4 whole fruits are planted in pits (20 cm<sup>3</sup>) at 10 m apart and half filled with sand and soil mixture. Pit is covered with dried leaves. Sowing may be taken up during rainy months (November). Germination takes place within 3 weeks.

**Nursery transplanting:** Seeds can be sown in mound formed by keeping sand to form a bed of 1 m broad, 60 cm height or nursery beds built with bricks of 2 m broad, 60 cm height. Seeds are sown in 10 cm space and covered with sand. About 1 yr old seedling is lifted from the nursery and containerized in polythene bags. After rooting transplant in the main field.

**Spacing:** 3m x 3m (1110 palms/ha)

**Manuring:** Generally farmers adopt Sheep penning to the palms. Application of 10 kg FYM/pit before planting. Dosage may be increased biannually till reaching 60 kg FYM/tree/year

**After cultivation:** Consist of gap filling; inter ploughing, basin rectification in the initial few years,. Gap filling may be carried out by using containerized seedlings. Basin rectification has to be done before rains; it helps collection and storage of rain water.  
Pruning: pruning of 30 per cent leaves @ 10 per cent in phased manner.

### **Inter cropping**

Cowpea, moringa, green gram, red gram, bengal gram, ber, amla, pomegranate, west Indian cherry & guava can be intercropped.

### **Growth and yield**

Palmyrah is a slow grower. First frond appears in about 5 months. First fan shaped tree leaves appears only in the 2<sup>nd</sup> year. When it attains the height of 12 – 18 m, comes to flowering (13 – 15 yrs) for padaneer (Sweet sap) purpose. Average of 100 – 200 lit obtained for a period of 4 months from Feb – May. Padaneer and fruit yield are highly variable in individual palms.

**Tapping:** Extraction of sap (Neera/ Padaneer) from inflorescence is called tapping. According to sex of the palm & age of the inflorescence, different kinds of tappings are available.

**Aripanai** - In male palm sheath covering the young inflorescence is removed and dried for 3 weeks. End is cut every time & pot is tied (1- 1 ½ months).

**Vallupanai** - One month old spikes are selected. Each male spike bearing sessile flowers is pretreated by pressing and stroking & 3 - 6 such spikes are brought together, wrapped with leaves & fitted to a pot.

**Thattupalai** – It has to be done in female palm to soften the tissue by hitting the inflorescence main axis with iron rod

**Kaivetty** - employed when the inflorescence is about 2 - 3 months old.

Female palms are tapped for a longer period. *i.e.*, April- Dec. and male for Dec – Feb. Sap is collected twice a day. Each time at the end of the collection of sap, a new cut surface is made by thin slicing. Tapped sap is called Neera or padaneer.

**Yield:**

150 litres of padaneer / Tree / year

24 kg jaggery/ Tree / year

Jaggery recovery/litre of padaneer: 180 - 250 g of jaggery



## **Betelvine: *Piper betel*; Piperaceae**

**Varieties:** Karpurakodi, Kallarkodi, Revesi, Karpuri, Vellai kodi, Patcha vethalai, SGM 1 and SGM (BV) - 2.

**Soil and climate:** Well drained fertile clay loams are suitable. It does not tolerate saline and alkaline conditions. Betelvine require a cool shade, considerable humidity and regular supply of moisture in the soil.

**Seeds and sowing:** The vines are propagated by terminal stem cuttings or setts about 30 – 45 cm long. Setts obtained from the top portions of the vines are easy to root and hence best for planting. Number of setts 1,00,000/ha. Setts with vigorous apical buds and nodal adventitious roots are selected and planted at the base of the live supports, which are to be planted 4 to 5 months earlier.

**Season:** November - December and January - February.

**Field preparation and planting:** The field is prepared to a fine tilth and beds of 2 m wide are formed to a convenient length. Provide drainage trenches of 0.5 m width by 0.5 m depth in between two adjoining beds. Plant the seeds of the live supports *i.e.* Agathi (*Sesbania grandiflora*) in long rows. About 750 banana suckers are planted at the edges of the beds, which are used, for tying the vines on the live support and for packing the betel leaf. When the Agathi supports grow to a height about 4 m they are topped. The crop is planted in two rows in beds of 180 cm width on Agathi plants with a spacing of 45 cm between plants in the row.

**Irrigation:** Irrigate the field immediately after planting and afterwards once in a week.

**After cultivation:**

**Training of the live Standards:** Before the establishment of vines the side branches of Agathi trees upto a height of 2 m are removed for early creeping of the vines.

**Training of the vines:** Training is done by fixing the vine at intervals of 15 to 20 cm along the standards loosely with the help of banana fibre. Training is done every 15 - 20 days depending upon the growth of vines.

**Lowering of vines:** Under normal cultivation, the vines grow to height of 3 m in one year period. When they reach this height their vigour to produce normal size leaf are reduced and they need rejuvenation by lowering during March - April. After the vine is lowered a number of tillers spring up from the nodes at the bends of the coiled vines at the ground level and produce many primary vines. After each lowering, irrigation should be given.

**Manuring:** Apply 150 kg N/ha/year through Neem cake (75 kg N) and Urea (75 kg N) and 100 kg P<sub>2</sub>O<sub>5</sub> through Super phosphate and 30 kg Muriate of potash in three split doses first at 15 days after lifting the vines and second and third dose at 40 - 45 days intervals. Apply on beds shade dried neem leaf or *Calotropis* leaves at 2 t/ha and cover it with mud (2 t in 2 split doses).



## **Plant protection**

### **Pests**

**Scale insects:** Scale insects: Spray NSKE 5 %

**Mites (Sevvattai):** Spray wettable sulphur 50 WP @ 1 g/lit or dicofol 18.5 EC 0.5 ml/lit.

**Aphids:** Spray chlorpyrifos at 2 ml/lit on Agathi leaves. Clip off excess Agathi leaves.

**Mealy bugs:** Spray chlorpyrifos 20 EC at 2 ml/lit or dimethoate 30 EC 2ml/lit. Concentrate the spray towards the collar region.

**Nematode:** Application of Neem cake at 1 t/ha or chopped and shade dried *Calotrophis* leaves at 2.5 t/ha to soil, after lowering the vines.

Soil application of *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* @ 10 g / vine for the control of root knot nematode and quick wilt of betel vine .

### **Diseases**

#### ***Phytophthora* Wilt:**

Select well matured (more than 1 year old) seed vines free from pest and diseases.

Soak the seed vines for about 30 minutes in Streptocycline 500 ppm or Bordeaux mixture 0.5 %.

Apply 150 kg N/ha/year through Neem cake (75 kg N) and Urea (75 kg N) and 100 kg P<sub>2</sub>O<sub>5</sub> through Super phosphate and 30 kg MOP in 3 split doses first at 15 days after lifting the vines and second and third dose at 40 - 45 days intervals.

Apply shade dried neem leaf or *Calotrophis* leaves at 2 t/ha and cover it with mud (2 t in 2 split doses) on beds. Drench Bordeaux mixture 0.25 % in basins formed around the vine at monthly intervals starting from October – January, three times soil drench and six times spray from June - July. During winter season avoid frequent irrigation. Remove the affected vines away from the garden and burn them. Application of Alliette 3 g/lit 4 times at monthly intervals.

Application of *Trichoderma viride* @ 5 g/vine.

**Bacterial leaf spot, blight and bacterial stem rot:** Spray Streptocycline 400 ppm + Bordeaux mixture 0.25% when the first disease symptoms appear. Continue spraying at 20 days intervals. Always spray the chemical after plucking the leaves.

**Anthracnose (Theechal):** Spray 0.2 % Ziram or 0.5 % Bordeaux mixture after plucking the leaves after the first appearance of the symptom. The variety Karpoori is susceptible to the disease.



**Powdery mildew:** Spray 0.2 % Wettable sulphur after plucking the leaves.

**Harvest:** It depends upon the growth of the vines and market condition. Once harvesting starts it continues almost every day.

**Yield:** 75 to 100 lakh leaves/ha/year.

**Variety released in each spice and plantation crops in India**

Pepper	Cardamom	Ginger	Turmeric	Coriander	Fenugreek	Cinnamon	Coffee
Varieties for higher elevation: (above 1000 mtr)	Malabar ICR1 – 1, 3 TDK – 4, 11	Green Ginger Himachal Suruchi	CO 1, BSR 1, 2 Prabha,	CO 1, CO 2, CO 3, CO(CR)4	CO 1, CO 2, Rajendra Kanti. RMT – 1,	YCD – 1, SL- 63 PPI – 1	<i>Coffea arabica</i> Sel. 5 B
Panniyur-1, 4, 7	Mudigere 1, 2	Suprabha	Prathiba,	Guj. CO 1,	Lamsel – 1	Nithya shree	Sel. 7-3
Kalluvailly,	MCC – 40	Suravi	Swarna	Guj. CO 2,	Hisarsonchi	Navashree	Sel. 7 – 4
Aimpirian	IISR-Coorg Suvasini	Rio-de-jeniro	Suguna	Rajendra Surabi,	RMT – 303		Cauvery
Panchami	IISR Avinash	Nadia	Sudharsana,	RCr-41	Gunj Methi 1		Sachin more
Chumala	IISR Vijetha I	Dry ginger	Ranga	Sadhana,	Hisar Suvama		
Lower elevation	PV 1	Maran	Rasmi	Swati,	Hisar Madhavi		<i>Coffea canephora</i>
Panniyur – 1, 6	Mysore	Himagiri	Sona	Sindhu,	Hisar Mukta		
Sreehara	ICR1 – 2,	Varadha	Varuna	CS – 287	RMT – 143		Sel. 274,
Subhara	Vazhukka			Hisar Anand	RMT-305		C x R
Panchami	NCC – 200			Azad Dhania-1	Pant Ragini,		
Pournami	(Njallani)			RCr – 20,	Pusa Early		

# Part V

## Medicinal and Aromatic Plants

### Chapter A Medicinal Plants

**Glory lily (*Gloriosa superba*)**  
**Colchicaceae**

**Varieties** : No named variety.

**Soil** : Red soil with good drainage facility and P<sup>H</sup> range of 6.5 - 7.5. Clayey soils are not suitable for cultivation

**Climate** : Dry climate, with an annual rainfall of 70 cm is suitable.

**Planting material:** Propagation through tubers. Select tubers weighing 40-60g. Sprouting is observed during July to August.

**Seed rate** : 2000 kg tubers / ha. Tubers have to be treated with 0.1% carbendazim solution by soaking for half an hour to avoid tuber rot.

**Season** : July-August

**Field Preparation:** After ploughing the land, apply FYM @10t /ha.

**Spacing** : Planting is done two ways viz., channel method and broad row or raised ridges. Channel method is suitable for flood irrigation and broad row method is adopted for drip irrigation. For the first method, channels of 2 feet width, 1 foot depth are prepared running east to west direction. The second method involves preparation of raised ridges in a similar direction (2 feet width, 1 foot height). The inter row distance should be 5.5 feet. Tubers have to be planted at 5-10 cm depth.

**Fencing** : Being a climber, glory lily needs support, which may be done using live standards (*Commiphora beryii*) or dead standards (*Dodonea viscosa*) or by GI wires. Care should be taken not to damage the tubers while laying the support.

#### **Nutrient management**

Apply 150:50:100 kg of NPK ha<sup>-1</sup>, (One third nitrogen, entire P and one third potassium as basal and the remaining nitrogen and potassium in two splits) along with vermicompost 5t /ha + bioinoculants (*Trichoderma viride* and *Pseudomonas fluorescence* @2.5 kg/ha with ZnSO<sub>4</sub> @ 25kg/ha, FeSO<sub>4</sub> @ 50 kg/ha, Borax @ 10 kg/ha, Sodium molybdate @ 0.5kg/ha at the time of planting along with foliar application of FeSO<sub>4</sub> (1%), ZnSO<sub>4</sub>, (0.5%) Borax (0.2%) and gibberellic acid spray twice @ 200 mg/kg at early and late flowering stage.

#### **Irrigation:**

Irrigation is done immediately after planting and once in five days interval. Weekly irrigation is essential at the time of flowering and pod set.

**After cultivation:**

Care should be taken not to damage the growing tip. Once the tip is damaged, the plant will not produce subsequent branches or laterals which will reduce the flowering and pod yield.

**Pollination:**

As self pollination percentage is low, assisted hand pollination is required. The mature stamens are collected and dusted on receptive stigma during early morning hours (7-11 am). The ideal stage of receptive stigma can easily be judged by the tricolour (green, yellow and scarlet) petals. This method followed by foliar application of 0.1 % boron + 0.5 % zinc sulphate at fortnightly intervals have to be done to induce higher seed set.

**Plant protection:**

Leaf blight disease

**Symptoms of *Curvularia* blight**

1. The disease appears in the form of small narrow elongated spots in the initial stage, but in due course they extend along with the leaf becoming bigger.
2. On older plants, the typical symptoms are long elliptical necrotic lesions, straw coloured center with brown margins
3. The lesions can be several centimeters long and wide
4. In advance stages, several spots coalesce on the leaves, destroying large areas giving the crop a distinctly blasted appearance.

**Symptoms of *Alternaria* blight**

1. Symptoms may appear in all stages.
2. Initially, small, pale to brown, irregular or round spots may appear on the leaves
3. Each spot has a central necrotic lesions with concentric rings
4. In advance stages, several spots coalesce together to form large blighted areas

**Management methods**

1. Remove the infected plant debris from the field
2. Spray Mancozeb @ 0.2% concentration or Propiconazole (0.1% conc.) or Hexaconazole (0.1% conc.) at the time of infection.
3. Four to five sprays may be given at 15 days interval for check the leaf blight severity in this crop
4. Spray 0.5 per cent  $\text{ZnSO}_4$  two times at fortnightly interval starting from 45th day after planting

**Insect pests of glory lily and their management**

The major pests recorded on glory lily were the lepidopteran caterpillars viz., lily caterpillar, *Polytela gloriosae*, semilooper, *Plusia signata* and tobacco cutworm, *Spodoptera litura*. Among these pests, lily caterpillar is a serious and regularly occurring pest on gloriosa at any time during the cropping season (August to February) from seedling stage to maturity. The early instars of these caterpillars feed on chlorophyll of the leaves but the later instars feed voraciously leaving only the hard stem of the plant resulting in complete devastation.

For the management of the insect pests of glory lily, foliar application of Neem Seed Kernel Extract 5% or Neem oil 3% is recommended to be the most effective. As a last resort, when the pest population crosses the economic threshold level, i.e., 10 per cent damage, any one of the following insecticides may be sprayed for the management of all the three caterpillars; quinalphos 25 EC @ 750 ml ha<sup>-1</sup>, carbaryl 50WP 1 kg ha<sup>-1</sup> and chlorpyrifos 20 EC 1.250 lit ha<sup>-1</sup>.

**Harvest:**

The crop duration is 180 days and pods can be harvested when the colour starts turning light yellow and when skin of the pods shrinks. After harvest, pods should be dried for 2-3 days to facilitate separation of seeds from locule. The seeds are dried again under open sun for 3-5 more days until the seed moisture maintains to 6-8 per cent. After drying, sand, stone and other unwanted particles have to be removed and the healthy seeds should be packed in bags.

**Yield:**

400-500 kg dry seeds/ha and 1000 kg tubers/ ha/ year

Trade Mark of TNAU



### ***Coleus forskohlii* (Lamiaceae)**

- Varieties** : No named variety
- Soil** : Red sandy soil and sandy loam soil are highly suitable. Soil drainage is essential and hard pan and water logged soils should be avoided.
- Climate** : Suitable for plain and lower hills. Requires 70 cm annual rain fall
- Propagation** : Terminal three to four nodal cuttings measuring 10 cm length is used
- Land Preparation:** Apply 15 t FYM/ha. Ridges are formed at a spacing of 60 cm. Cuttings have to be planted at a spacing of 45 cm.

#### **Nutrient management:**

Nutrients	Quantity (kg / ha)
N	30
P	60
K	50

The above nutrients can be applied in two split doses viz., 30 and 45 days after planting. In micronutrient deficient soils, ZnSO<sub>4</sub> can be applied as basal fertilizer.

#### **Irrigation:**

Irrigate immediately after planting and later at weekly intervals. With hold the irrigation ten days before harvest.

#### **Plant protection:**

The occurrence of wilt is becoming a major problem in coleus cultivation. Pathogens associated with wilt and root rot are *Fusarium chlamydosporum*, *Macrophomina phaseolina*, *Rhizoctonia solani* and *Sclerotium* sp coupled with incidence of root knot nematode *Meloidogyne incognita*. Due to these diseases, the yield loss is upto 50 to 60%

#### **Management strategies for diseases**

Select the coleus cuttings from disease free plants.

Coleus cuttings have to be treated with Carbendazim solution (0.1%) before planting

Soil drenching with Carbendazim (0.1%) or propiconazole (0.1%)

Soil application of FYM @ 12.5 ton/ha + 500 kg neem cake/ha + *Trichoderma viride* @ 2.5 kg /ha before planting is effective for biomanagment of nematode fungal disease complex involving *Meloidogyne incognita* and *Macrophomina phaseolina*

Application of chemical nematicide Carbofuran 3G @ 1 kg a.i/ha before planting for control root-knot nematode.

Use drip irrigation to minimize the spread of pathogens from infected plants to healthy plants

**Nematodes:**

Dipping of stem cuttings in 0.1% *Pseudomonas fluorescens* at planting. Growing marigold (*Tagetes erecta*) as intercrop in between the rows of medicinal coleus and incorporated during earthing up at 60-70 days after planting (or) Soil application of *Trichoderma viride* @ 2.5 kg/ha.

**Harvest:**

Crop can be harvested six months after planting. Before harvest, top portion should be removed when sufficient moisture is in the soil. Roots are dug manually or by tractor drawn harvester. The soil particles are removed and the tubers are cut into small bits using motorized chopper to facilitate drying. The cut root bits are dried under sun for 3-5 days with frequent turnings until the moisture drops to 6-8 per cent.

**Yield:**

Green roots: 15 - 20t /ha

Dry roots: 2 - 2.5 ton/ha





**Senna: *Cassia angustifolia* Vahl. (Leguminosae)**

**Varieties :** KKM - 1, Anand Late Selection, ALFT-2 and Sona

**Soil and climate:** In Tamil Nadu, it is grown in sandy or sandy loam or laterite soils. It is a hardy warm weather crop grown under rainfed and irrigated conditions.

**Seed rate:** 15 - 20 kg/ha.

The seeds are scarified with sand or can be soaked overnight in water and sown in beds at a spacing 45 x 30 cm during February - March or June - July.

**Season:** February - March and June - July.

**Manuring**

**Basal:** Apply FYM 10 - 15 t/ha and N, P and K at 25, 25 and 40 kg/ha.

**Top dressing:** Apply 25 kg N in two splits at 40 and 80 days after sowing.

**After cultivation:** One or two weedings.

**Plant protection - Pests**

**Aphids:** Spray dimethoate 30 EC or methyl demeton 25 EC at 1 ml/lit of water.

**Harvest:** The first harvest of leaves and pods are done 2 months after sowing and subsequent harvests at 30 days interval. Leaves and pods are dried for 7 - 10 days.

**Yield - Irrigated**

Dried leaves : 2 t/ha.

Dried pod : 150 - 200 kg/ha.

**Rainfed**

Dried leaves : 1 t/ha.

Dried pods : 75 - 100 kg/ha.

**Seed Production Technology:**

Seeds attain physiological maturity at 40 days after anthesis, associated with colour change of pods from green to brown. Seeds can be processed by using 8/64" round perforated metal sieves. Hard seededness can be effectively overcome by acid scarification with commercial sulphuric acid @ 100 ml/kg of seed for 10 minutes.

**Periwinkle: *Catharanthus roseus* (Apocynaceae)**

**Varieties:** Nirmal, Dhawal and Prabal

**Soil and climate:** It is suited to all types of soil and tropical climatic conditions. Well distributed annual rainfall of 100 cm or more is ideal for raising as a rainfed crop.

**Seeds and planting:** Propagated through seeds either by direct sowing or through transplanting.

**Seed rate:** 2.5 kg/ha : Direct sowing

0.5 kg/ha : Through seedlings

45 - 60 days old seedlings are transplanted at a spacing of 45 x 20 cm during June - July or September - October.

**Manuring**

**Basal:** Apply FYM at 10 t/ha and N P and K at 50 kg each /ha.

**Top dressing:** Apply 50 kg N 60 days after planting.

**Aftercultivation:** The crop requires 2 weedings, the first 90 days after sowing/transplanting and second 60 days after the first weeding.

**Harvest:** The crop becomes ready for harvest of roots after one year. Two leaf strippings can be taken, the first one after 6 months and the second after 9 months of sowing. Aerial parts are cut and the soil is ploughed for harvest of roots. Fruits are collected without damage.

**Yield**

	Irrigated	Rainfed
Roots	1500 kg/ha	750 kg/ha
Stems	1500 kg/ha	1000 kg/ha
Leaves	3000 kg/ha	2000 kg/ha

**Seed Production Technology:** The physiological maturity of periwinkle seeds is attained at 40 days after of anthesis with maximum dry weight, germination and vigour with a change of pod colour from green to yellow with translucence.

Seeds can be processed by using 4/64" round perforated metal sieves with maximum seed recovery.

**Medicinal solanum: *Solanum viarum* Clarke.(Solanaceae)**

**Varieties:** RRL-20-2, RRL-SL-6, Glaxo, Arka Sanjivini and Arka Mahima.

**Soil and climate:** Well drained loamy soils are suitable. Grows well under moderate climatic conditions.

**Seeds and planting:** Being a hardy plant, even land with medium fertility can give a good stand. Propagated through seedlings.

**Seed rate:** 400 g/ha. Requires a resting period of one month and sowing should not be delayed further. Seedlings are raised in nursery and transplanted at six leaf stage at a spacing of 50 x 50 cm during June - July. Drench the seedlings with Copper oxy chloride 2.5 gm/lit of water to prevent damping off disease in Nursery.

**Irrigation:** Irrigation should be given once in a week in the first month and later reduced to once in a fortnight.

**Manuring**

**Basal:** Apply FYM 10 t/ha. N, P and K at 25, 40 and 40 kg/ha respectively.

**Top dressing:** 25 kg of N at second month after planting.

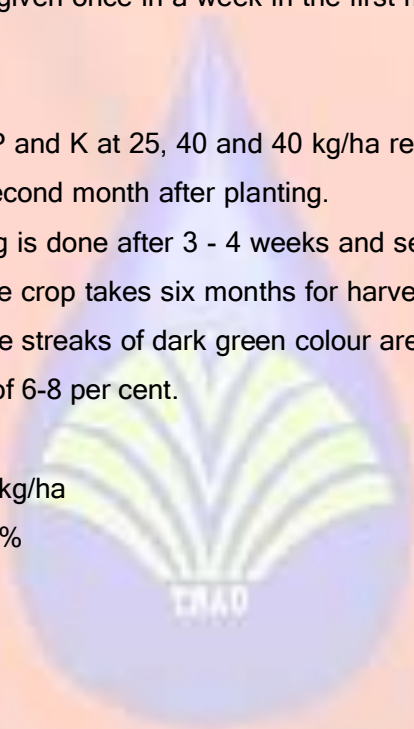
**After cultivation:** First weeding is done after 3 - 4 weeks and second weeding at 2 – 3 months.

**Harvest:** After transplanting, the crop takes six months for harvest. The berries are harvested when it turns yellow colour while streaks of dark green colour are still present. The berries are sun dried to the moisture level of 6-8 per cent.

**Yield**

Fresh berries : 700 - 800 kg/ha

Solasodine content : 2.0 to 2.5 %



## Chapter B

### Aromatic Plants

#### Lemongrass: *Cymbopogon flexuosus* (Graminae)

**Varieties:** OD-19, OD-408, RRL-39, Pragathi, Praman, CKP-25, Krishna and Cauvery.

**Soil and climate:** Sandy loam with abundant organic matter and pH of 6.0. It comes up well under tropical and sub-tropical conditions with a high rainfall 200 - 250 cm and humidity.

**Seeds and planting:** 55,600 slips/ha at a spacing of 60 x 30 cm in ridges. Can also be propagated through seeds at 4 kg/ha. Seedlings are to be raised and transplanted during June - July.

**Manuring:** Apply FYM or compost at 20 - 25 t/ha as basal. Apply 50 kg N/ha annually, half at planting and half, one month after planting. From the second year onwards, first dose of fertilizer should be applied after cutting and again one month after the first dose.

**Irrigation:** Life irrigation on third day and further irrigation at 7 - 15 days interval.

**Aftercultivation:** Hand hoeing and weeding as and when required.

#### Plant protection - Pests and diseases

In general, pests and diseases may not affect the plant. If there is any sucking pest, spray methyl demeton 25 EC or dimethoate 30 EC 1 ml/lit. For caterpillars, spray phosalone 35 EC.

**Harvest:** Harvest the leaves first at 90 days after planting and thereafter at 90 days interval.

Cut the bush 10 - 15 cm above the ground level and herbage is withered under shade for one day prior to distillation. They are then chopped into small pieces and fed into steam distillation stills for distillation of essential oil. Oil recovery 0.3 - 0.5 %.

#### Yield

**Herbage** : 20 - 30 t/ha.

#### Oil

First year : 50-100 kg oil/ha.

Second year onwards : 200-300 kg oil/ha.

**Citronella: *Cymbopogon winterianus*; Graminae**

**Varieties:** Java-2, Jorlab-2, Java citronella, Java II, Ceylon citronella and Bio-13, Mandakini and Manjusha are the high yielding varieties.

**Soil and climate:** Sandy loam with abundant organic matter and pH of 6.0. It comes up well under tropical and sub-tropical conditions with a high rainfall 200 - 250 cm and humidity.

**Season:** June - July. 28,000 slips/ha at a spacing of 60 x 45 cm in ridges.

**Manuring**

**Basal:** FYM 30 t/ha and NPK at 25:40:40 kg/ha.

**Top dressing:** 75 kg N/ha in 3 equal splits of 25 kg each at 3, 6 and 9 months after planting.

**Irrigation:** Life irrigation on third day and again at 10 - 15 days interval.

**Aftercultivation:** 1 - 2 weedings at the initial stages and earthing up after each harvest.

**Plant protection - Diseases**

**Leaf blight:** Spray any one of the Dithiocarbamates namely Mancozeb or Zineb at an interval of 15 - 20 days.

**Harvest:** The first harvest at 6 months after planting. Second and subsequent harvest at two and a half months intervals.

**Yield**

**Herbage :** 20 - 30 t/ha/year.

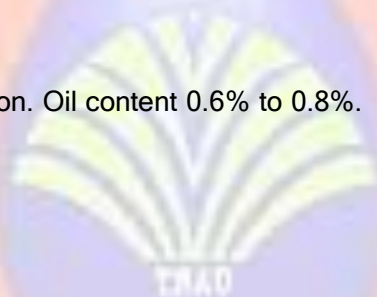
Oil is extracted by water distillation. Oil content 0.6% to 0.8%.

**OIL**

First year : 50 - 100 kg/ha.

Second year : 100 - 150 kg/ha.

Third year : 250 - 300 kg/ha.



**Geranium: *Pelargonium graveolens* (L) Hervitt. (Geraniaceae)**

**Varieties:** Algerian, Reunion, IIHR-8, Kodaikanal 1, Hemanti and Egyptian.

**Soil and climate:** A deep light porous well drained soil, rich in organic matter and acidic in reaction with a pH 5.5 to 6.0 is suitable. An elevation ranging from 1000 - 2400 m with an annual rainfall of 100 to 150 cm evenly distributed throughout the year is ideal.

**Propagation:** Geranium is propagated by stem cuttings. Cuttings of about 10 cm taken from current season growth with a well formed crown of leaves with 3 - 4 nodes and terminal bud and raised in polythene bags of 10 x 10 cm size. Thorough field preparation leading to fine tilth condition is essential. Pits of 30 x 30 cm size are dug and cattle manure at 250 g/pit is applied and rooted cuttings of 2 months age are planted at a spacing of 45 x 45 cm during April - May.

**Manuring:** 60 kg in each of N, P and K/ha is recommended. P and K are applied every year at the time of first harvest while N is applied in equal splits depending upon the number of harvests per year.

**Irrigation:** Geranium is usually grown as a rainfed crop. Irrigation during dry periods increases the yield.

**After cultivation:** Weedings, uprooting and burning the diseased plants throughout the life cycle of the plant. From the second year onwards, give a deep soil forking around the plants to improve the growth of more suckers.

**Pruning:** Pruning of the bushes is necessary when the bush shows signs of decline. The branches are cut back leaving 15 - 20 cm once in 4 - 5 years.

**Plant protection - Pests**

**Nematode:** To control the nematodes (*Meloidogyne hapla*) in nursery, apply Carbofuran at 2 kg a.i./ha once in 6 months in June and December.

**Diseases: Wilt:** Drench with Carbendazim 1 g/lit at monthly intervals.

**Harvest and distillation:** In the first year of planting, only one harvest can be done at 7 - 8 months and thereafter 3 or 4 harvests can be done in a year. The tender tip portion with 6 - 12 nodes constitutes the materials for harvest. The harvested material is withered in shade for two to three hours and distilled.

**Yield**

Herbage : 20 - 25 t/ha.

Oil yield : 15 - 20 kg/ha.



**Palmarosa: *Cymbopogon martinii* var. *motia* (Roxb) Wats.;**

**Graminae**

**Varieties:** Trishna, Tripta, PRC-1, IW 31245, IW 3629, IW 3244, OPD-1, OPD-2, Vaishnavi, and RRL(B)-77.

**Soil and climate:** A well drained loamy soil is suitable. Comes up well under tropical conditions with an annual rainfall of about 150 cm.

**Seeds and planting**

**Through seeds:** 2.5 kg of seeds/ha.

Sow in raised nursery beds in lines 15 - 20 cm apart. Transplant at 3 - 4 weeks in ridges at a spacing of 60 x 60 cm during June - July.

Through slips: Establishment will be poor as compared to seedlings.

28,000 slips will be required to plant one hectare at 60 x 60 cm spacing.

**Manuring**

**Basal:** FYM 10 t/ha and NPK at 20:50:40 kg/ha.

**Top dressing:** 15 kg/ha in 3 splits at 3, 6 and 9 months of planting.

**Aftercultivation:** Give 1 - 2 weedings in the early stages and earth up after each harvest and top dress.

**Harvest:** The first harvest commences at 3 - 4 months of planting. Subsequent harvests at 3- 4 months interval.

**Yield**

**Herbage :** 20 - 30 t/ha/year.

**Oil**

First year : 50 kg/ha.

Second year : 200-250 kg/ha.

**Seed Technology:** Seeds attain physiological maturity at 40th day after 50% flowering when the fluff (seed) moisture is around 20%. Leaching of fluffs in running water for 8 hours followed by soaking in KNO<sub>3</sub> at 0.5% for 6 hours recorded maximum germination.

**Patchouli; *Pogostemon patchouli* Hook. (Labiatae)**

**Varieties:** Johore, Singapore and Indonesia are commonly cultivated. Out of these, the first one yields the best quality oil where as the other two give high oil yield.

**Soil and climate:** Well drained loamy soil with slightly acidic condition is suitable. Thrives best in hot and humid conditions, under shade of rubber, coconut, coffee, etc.

**Propagation and Planting:** Rooted stem cutting of 15-20 cm are used. The field is prepared to a fine tilth and the rooted cuttings are planted at a spacing of 60 x 30 cm during April – May.

**Manuring**

**Basal:** Apply NPK at 30 kg/ha each.

**Top dressing:** 30 kg N/ha after 3 months of planting.

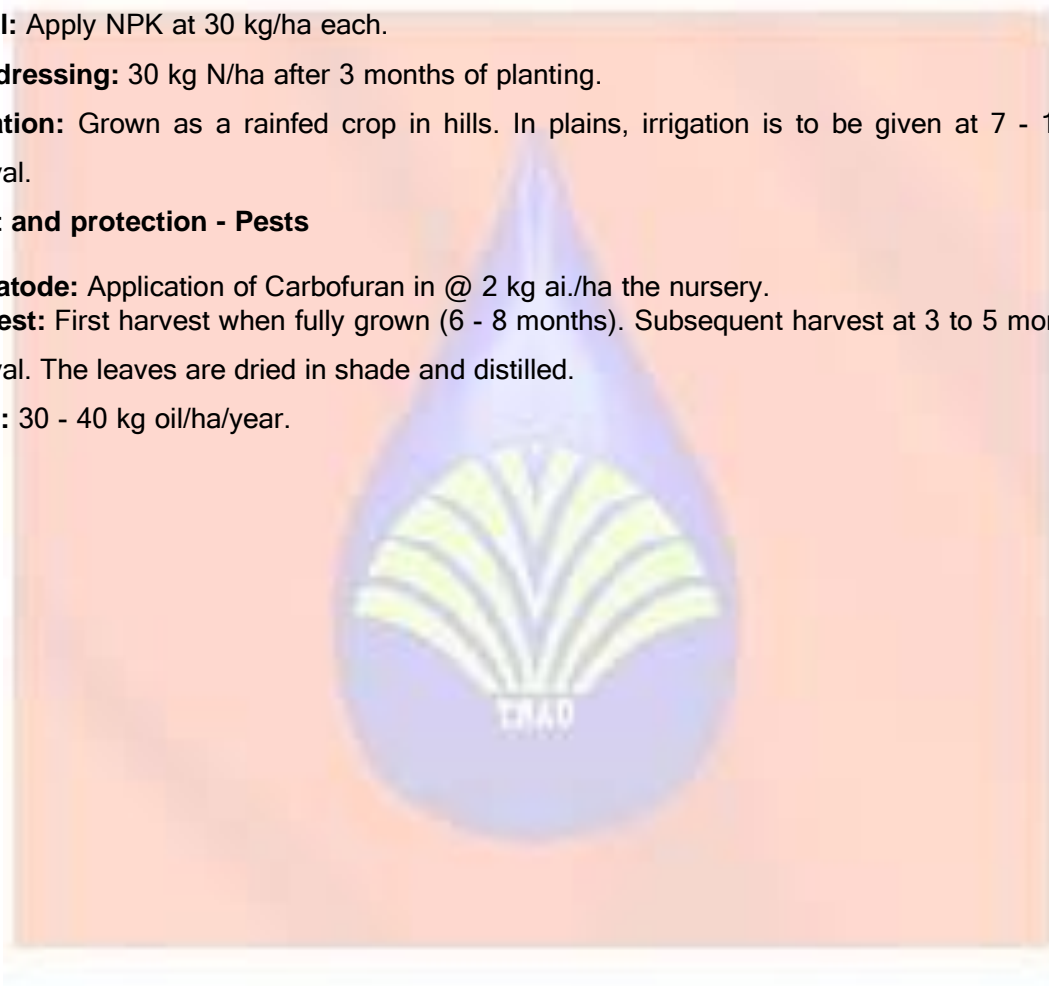
**Irrigation:** Grown as a rainfed crop in hills. In plains, irrigation is to be given at 7 - 10 days interval.

**Plant and protection - Pests**

**Nematode:** Application of Carbofuran in @ 2 kg ai./ha the nursery.

**Harvest:** First harvest when fully grown (6 - 8 months). Subsequent harvest at 3 to 5 months interval. The leaves are dried in shade and distilled.

**Yield:** 30 - 40 kg oil/ha/year.



**Mint: *Mentha sp; Labiatae***

**Varieties**

Japanese mint - Kalka, , Gombi, Himalaya, Sambhav, Saksham, MAS-1, MA-2, Hybrid-77, Shivalik and EC-41911

Spear mint - Arka Neera, Ganga, Neerkalka, MSS-1, MSS-5 and Punjab Spearmint-1.

Bergamot mint – Kiran

Pepper mint - Kukrail, Pramjal and Tushar

**Soil and climate:** Well drained loamy and acidic soil high in organic matter content is suitable. Sub-tropical areas receiving an annual rainfall of 100 - 150 cm are good.

**Propagation and planting:** Rooted stem cuttings are planted in beds at 40 x 40 cm spacing during June - July.

**Manuring**

**Basal:** Apply NPK at 80, 50 and 40 kg/ha.

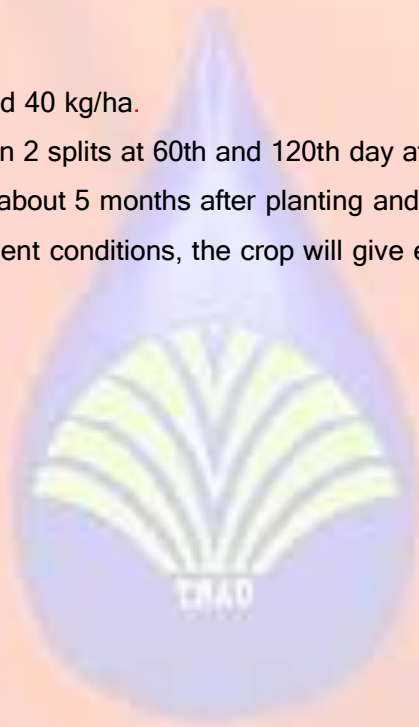
**Top dressing:** Apply 30 kg N in 2 splits at 60th and 120th day after planting.

**Harvest:** First cutting starts in about 5 months after planting and subsequently at 3 months interval. Under good management conditions, the crop will give economic yield for about four years.

**Yield**

**Herbage** 15 - 20 t/ha/year.

**Oil** 50 - 100 kg/ha/year.



### Production techniques for other important medicinal plants

No	Crop	Uses	Alkaloids	Varieties	Seed rate (Kg/ha)	Spacing (cm)	Population / ha	Duration (Days)	Yield (Kg/ha)
1.	<i>Withania somnifera</i> (Ashwagandha)	Stress reliever, tonic	Withanine and Somniferine	Jawahar Rakshita	5kg seed	60 × 30	37000	6 months	500 kg dry root
2.	<i>Phyllanthus amarus</i> (Keezhanelli)	Hepato-tonic	Hypo phyllanthin	Navyakrit	2 kg seed	30x15	2.2 lakh seedlings	3 months	2.5 ton dry herbage
3.	<i>Mucuna pruriens</i> (Poonakali)	Cures parkinsons disease	Mucunine and Mucunadine	White and Black seeded	10 kg seed	90x60	19,000 plants	6 months	1200 kg seed
4.	<i>Aloe vera</i> (Kutralai)	Cosmetics	Cathartic anthraglycosides (barboline)	-	10,000 suckers	90x90	10,000 plants	13 months	40 ton
5.	<i>Piper longum</i> (Tippili)	Bronchitis, Cough	Longumine	Vishvam	55,500 rooted cuttings	60x30	55,500 plants	5 years	750 kg dry spikes/year
6.	<i>Acorus calamus</i> (Vasambu)	Cough, digestive	Calamine	-	10,000 rhizomes	60x60	28,000	1 year	10 ton rhizomes
7.	<i>Hibiscus rosasinensis</i>	Blood purifier	Laxative	Red single whorl	3085 rooted cuttings	1.8x1.8 m	3085 rooted cuttings	Monthly harvest	200 kg dry flowers, 600 kg

	(Sembaruthi)								dry leaves
8.	<i>Bixa orellana</i> (Annatto)	Organic dye	Bixin	Mexico	1100 seedlings	3x3 m	1100 seedlings	Perennial 1	1 ton dry seed
9.	<i>Andrographis paniculata</i> (Nilavenbu)	Anti diabetic	Andrographolide	-	55,000 seedlings	60x30 cm	55,000	4 Months	2.0 ton dry herbage
10.	<i>Gymnema sylvestre</i> (Sarkarai kolli)	Anti diabetic	Gymnemic acid	-	1000 cuttings	2x2 m	1000	Perennial	1.0 ton dry leaves
11.	<i>Centella asiatica</i> (Vallarai)	Memory enhancer	Asiaticoside	Kayakirti, Majjaposhak Vallabmedha	2.2 lakh runners	30x15 cm	2.2 lakh runners	Perennial	2.5 ton dry leaves
12.	<i>Asparagus racemosus</i> (Shatavri)	Aphrodisiac	Glycosides	-	Root suckers	90x60	19,000 plants	12-14 months	1 ton dry root
13.	<i>Solanum nigrum</i>	Digestive, laxative	Solasodine		Seed	60x45	400 g seed	Perennial	6-8 ton of dry herbage
14.	<i>Swertia chirayita</i>	Anti inflammatory	Amarogentin, Swerchirin	-	Seed	60x60	28,000 plants	1 year	1 ton dry roots
15.	<i>Commiphora wightii</i>	Anti-obesity	Lipids	Marusudha	Cuttings	90x90	10,000 plants	12-14 months	200 kg resin
16.	<i>Plantago ovata</i>	Laxative	-	GI-1, GI-2	Seed	30x15	2.2 lakh seedlings	3 months	150 kg seed
17.	<i>Glycyrrhiza glabra</i>	Refrigerant	Glycyrrizin	Haryana Mulhati	Root suckers	60x45	37,000 plants	12-14 months	2 ton dry root

18.	<i>Chlorophytum borivilianum</i> (Musli)	Energy supplement	Saponin	RC5	500-600 kg seed tubers	60x45	37,000	8 months	1 ton dry root
19.	<i>Rauwolfia serpentina</i>	Anti hypertension	Ajmalicine, serpentine, rauwolfine	RS-1	4kg seed	60x30	55,500 seedlings	3 years	1500 kg dry roots
20.	<i>Stevia rebudiana</i> Herbal spices	Non-calorific sweetener	Stevioside	-	75,000 cuttings	25x60	75,000 plants/hectare	4-5 months (3 years)	6750 kg/ha/year
21.	<i>Rosmarinus officinalis</i> (Rosemary)	Anti-oxidant	Rosemarinic acid	Ooty-1	19,000 rooted cuttings	1.2m x45	19,000 rooted cuttings	Perennial	12-15 ton green herbage
22.	<i>Thymus vulgaris</i>	Digestive	Thymol	Ooty-1	500 g seed	90x30	37000 plants	Perennial	100 kg dry herb
23.	<i>Ocimum basilicum</i> (Sweet basil)	Carminative	Eugenol, linaloel	European , ReUnion	5 kg seed	60x30	55,000 Seedlings	Four months	14 ton green leaves
24.	<i>Salvia officinalis</i> (Sage)	Carminative , eye disorders, anti-oxidant	Linalool acetate	-	4 kg seed	60X60	28,000 plants	Perennial	1.7 ton dry herbage
25.	<i>Ocimum sanctum</i> (Tulsi)	Perfumery cosmetics	Eugenol	CIM-Ayu CIM-Angana CIM-Kanchan	300 g seed	45x45	50,000 seedlings	170 days	10 ton fresh herbage
26.	<i>Lavendula officinalis</i> (Lavender)	Perfumery, cosmetics	Linalyl acetate	Shar-E-Kashmir	14,000 plants	120x60	14,000 plants	3-4 years	200 kg dry biomass
27.	<i>Ocimum gratissimum</i> (Clocimum)	Perfumery, cosmetics	Methyl Eugenol	-	2 kg seeds	45x30	74,000 seedlings	Perennial	20-25 ton green leaves



# Part VI

## Floriculture

### Chapter – A

#### Loose Flowers

**Rose:** *Rosa sp*; Rosaceae

**Varieties:** Edward rose, Andhra red rose and Button rose.

**Climate:** Bright sunshine for minimum of 6 hours is essential for the cultivation of roses. Day temperature of 26<sup>0</sup> C and night temperature of 15<sup>0</sup> C are ideal. It can be grown in the plains of Tamil Nadu where the optimum climate is available.

**Soil:** Well-drained sandy loam with pH of 6 - 7.

**Propagation and planting:** Cuttings with 2-3 buds are dipped in IBA or IAA @ 500 - 1000 ppm. Pits of 45 x 45 x 45 cm are dug at 2.0 x 1.0 m spacing and 10 kg FYM is added to each pit before planting.

**Irrigation:** Once in 2 days until plants establish and once in a week thereafter.

**Nutrition:** After pruning in October and again in July the plants are manured with FYM 10 kg and 6:12:12g/plant of NPK.

**Micronutrients:** Foliar application of 0.2% micronutrient mixture containing 20 g MnSO<sub>4</sub> + 15 g MgSO<sub>4</sub> + 10 g FeSO<sub>4</sub> + 5 g B (2g of the mixture is dissolved in one litre of water) can produce bright coloured flowers.

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100 kg of FYM and applied in pits.

**Pruning:** Cut back the vigorous past season shoots to half the length during October to December. All the weak, diseased, criss-crossing and unproductive shoots are removed. The cut ends should be protected with Bordeaux paste or Copper Oxychloride + Carbaryl 50 WP.

**Growth regulators:** Spray 250ppm of GA<sub>3</sub> (30 days after pruning) during early vegetative stage to increase the flower production.

#### Plant protection

##### Pests:

##### Rose chaffer beetle:

Hand pick Cetonid beetles and destroy during day.

##### White grub :

Set up light to attract *Holotrichia* and *Anomala* spp.

Spray phosalone 35 EC @ 2 ml/lit.

**Red scale:**

Rub off the scales with cotton soaked in kerosene or diesel. Cut and burn the affected branches. Spray malathion 50 EC @ 2 ml/lit at the time of pruning and again during March - April or apply carbofuran 3G @ 5 g/plant or spray fish oil rosin soap @ 25 g/lit or phosalone 35 EC 2 ml/lit or dimethoate 30 EC @ 2.0 ml/lit

**Mealy bug:** Flower caterpillar

***Helicoverpa armigera:***

Spray Ha NPV  $1.5 \times 10^{12}$  PIB/ha. or NPV of *H. armigera* 0.43% AS @ 3.0 ml/lit or 2 % AS @ 1.0 ml per lit

***Spodoptera litura:***

Spray SI NPV  $1.5 \times 10^{12}$  PIB/ha.

**Thrips, aphids and leaf hoppers:**

Spray Neem oil 3 % or spray methyl demeton 25 EC @ 2 ml/lit of water or dimethoate 30 EC @ 2.5 ml/lit

Two Spotted Mite

Spray any one of the following insecticide

Insecticide	Dose
Bifenazate 50%WP	7.5 ml/ 10 lit.
Flufenoxuron 10%DC	5.0 ml/10 lit
Milbemectin 1%EC	5.0 ml/10 lit.

**Diseases:**

**Black spot:** Spray Carbendazim @ 1 g/l twice at fortnightly intervals or Azoxystrobin @ 1g/l

**Powdery mildew:** Spray Carbendazim @ 1 g/l or Wettable sulphur @ 2 g/l or Azoxystrobin @ 1 ml/l

**Crop duration:** The plants will start flowering in the first year and will give economic yield from the second year onwards.

**Season of flowering and harvesting:** Flowering will commence 45 days after pruning. Fully opened flowers are picked early in the morning.

**Yield:** 7.5 t/ha/year.

**Market information**

Crop growing districts	Krishnagiri, Madurai, Dindigul
Major markets in Tamil Nadu	Dindigul, Madurai, Chennai
Preferred varieties and hybrids	Edward rose, Andra red rose and Button rose

**Malligai (Gundumalli): *Jasminum sambac* Ait.; Oleaceae**

**Varieties:** Ramanathapuram Local, Single Mogra, Double Mogra, Iruvatchi, Arka Aradhana.

**Climate:** Warm summer, mild winter, moderate rainfall and sunny days.

**Soil:** Well drained loamy or red loamy fertile soil.

**Propagation:** Semi hard wood cuttings (15 - 20 cm long).

**Field preparation and planting:** Soil is well pulverized upto a good depth. Rooted cuttings are planted in a spacing of 1.25 x 1.25 m (6400 plants/ha) during June to November in pits of 30 x 30 x 30 cm size.

**Nutrition:** FYM @ 10 kg/pit is applied before planting. NPK @ 60:120:120 g/plant/year is applied in 2 equal splits during November (after pruning) and June-July along with 10 kg FYM per plant.

**Micronutrients:** Foliar spray of ZnSO<sub>4</sub> 0.25% + MgSO<sub>4</sub> 0.5% + FeSO<sub>4</sub> 0.5% (In case of expression of micronutrient deficiency, spraying should be done at fortnightly intervals until the chlorotic symptoms disappear).

**Irrigation:** Provided immediately after planting followed by weekly irrigation depending upon weather conditions.

**Pruning:** Prune the bushes at 50 cm height from ground level during last week of November every year.

**Plant protection**

**Pests**

**Bud worm:**

Spray profenofos 50 EC @ 1 ml/lit or thiacloprid 240 SC @ 1 ml /lit

**Avoid using synthetic pyrethroids (in particular lambda cyhalothrin ) as it may cause resurgence of mites**

**Blossom midge:**

**Red spider mite:** Spray wettable sulphur 50 WP @ 2 g/l or Propargite 57 % EC @ 2ml/l or Fenazaquin 10 % EC @ 2 ml/l

**Nematode:** Test the soil for nematode infection. Apply 10 g of Phorate granules near root zone and irrigate.

**Diseases**

**Yellowing of leaves:** It is caused by 3 major factors viz., iron deficiency, nematode infection and root rot disease.

**Root rot:** Soil drenching with Trifloxystrobin + Tebuconazole @ 0.75 g/litre or Difenoconazole @ 0.5g/l.

**Alternaria leaf spot:** Foliar application of Mancozeb @ 2.5 g/l or azoxystrobin @ 1g/l

Soil application of *Pseudomonas fluorescens* @ 25 g/m<sup>2</sup> and foliar application of *P. fluorescens* @ 5 g/l at monthly intervals after planting.

**Harvesting:** Flowering season is March - October. Fully developed unopened flower buds should be picked in the morning. For concrete extraction, fully opened flowers are harvested.

**Yield:** Flowers: 8 - 9 t/ha; concrete recovery: 0.14 - 0.19%.

### **Precision production technology**

**Main field preparation:** Ploughing with chisel, disc, rotovator and cultivator and levelling with tractor drawn leveller. Pits of 45 cm<sup>3</sup> size are dug.

**Spacing:** 1.2 x 1.0 m (8333 plants/ha).

**Herbicide application:** Pre emergence application of Pendimethalin @ 2ml/l.

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100kg of FYM and applied in pits.

**Media consortia:** 5kg FYM + 500g Neem cake + 100g Vermicompost are applied per pit at the time of planting.

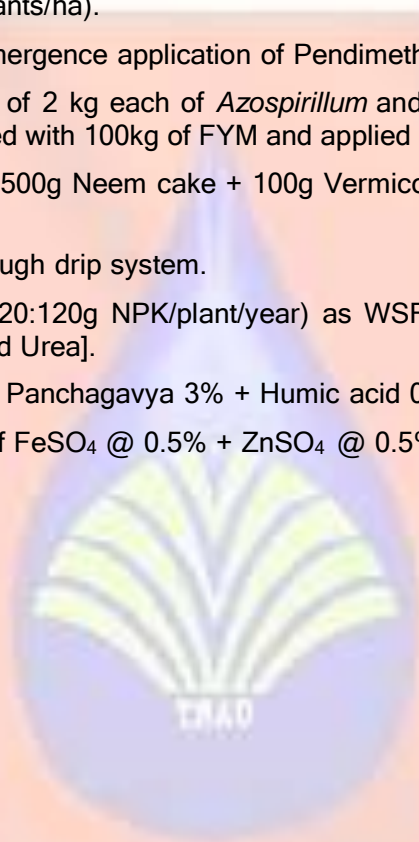
**Irrigation:** Once in 3 days through drip system.

**Fertigation:** 100% RDF (60:120:120g NPK/plant/year) as WSF [Polyfeed (19:19:19), Potassium Nitrate (13:0:45) and Urea].

**Biostimulants:** Foliar spray of Panchagavya 3% + Humic acid 0.4% at monthly intervals.

**Micronutrients:** Foliar spray of FeSO<sub>4</sub> @ 0.5% + ZnSO<sub>4</sub> @ 0.5% at monthly intervals.

**Yield:** 12 t/ha.



**Mullai:** *Jasminum auriculatum* (Vahle.); Oleaceae

**Varieties:** CO 1, CO 2 and Parimullai.

**Climate:** Warm summer, mild winter, moderate rainfall and sunny days.

**Soil:** Well drained loamy or red loamy fertile soil.

**Season of planting:** June to November.

**Propagation:** Semi hard wood cuttings (15 - 20 cm long).

**Field preparation and planting:** Soil is well pulverized upto a good depth. Rooted cuttings are planted in 30 x 30 x 30 cm size pits dug at 1.5 x 1.5 m spacing (4400 plants per ha).

**Nutrition:** FYM @ 10 kg/pit is applied before planting. NPK @ 120:240:120 g/plant/year is applied in 6 splits at bimonthly intervals. The first split dose should be given immediately after pruning.

**Micronutrients:** Foliar spray of  $\text{ZnSO}_4$  @ 0.25% +  $\text{MgSO}_4$  @ 0.5% +  $\text{FeSO}_4$  @ 0.5% (In case of expression of micronutrient deficiency, spraying should be done at fortnightly intervals until the chlorotic symptoms disappear).

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100 kg of FYM and applied in pits.

**Irrigation:** Provided immediately after planting followed by weekly irrigation depending upon weather conditions.

**Pruning:** The bushes should be pruned at 45 cm height from ground level during the last week of January.

#### **Plant protection**

##### **Pests**

**Bud worm:** Spray Profenofos 50 EC @ 1 ml/lit or Thiochlorid 240 SC @ 2 ml/l

**Red spider mite:** Spray Wettable Sulphur 50 WP @ 2 g/l or Propargite 57 % EC @ 2ml/l or Fenazaquin 10 % EC @ 2 ml/l

**Harvesting:** Flowering season is April to November. Fully developed unopened flower buds should be picked in the morning.

**Yield:** Flowers: 10 t/ha; concrete recovery: 0.25 - 0.28%.

**Jathi Malli (PITCHI): *Jasminum grandiflorum* L.; Oleaceae**

**Varieties:** CO 1, CO 2 and Arka Surabhi.

**Climate:** Warm summer, mild winter, moderate rainfall and sunny days.

**Soil:** Well drained loamy or red loamy fertile soil.

**Season of planting:** June - November.

**Propagation:** Terminal cuttings (12.5 - 15 cm long).

**Field preparation and Planting:** Soil is well pulverized upto a good depth. Rooted cuttings are planted at 2.0 x 1.5 m spacing (3350 plants/ha) in pits of size 30 x 30 x 30 cm.

**Nutrition:** FYM @ 10 kg/pit is applied before planting. NPK @ 60:120:120 g/plant/year is applied in 2 equal splits during December (after pruning) and June-July.

**Micronutrients:** Foliar spray of ZnSO<sub>4</sub> 0.25% + MgSO<sub>4</sub> 0.5% + FeSO<sub>4</sub> 0.5% (In case of expression of micronutrient deficiency, spraying should be done at fortnightly intervals until the chlorotic symptoms disappear).

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100kg of FYM and applied in pits.

**Irrigation:** Provided immediately after planting followed by weekly irrigation depending upon weather conditions.

**Pruning:** Prune the bushes at 45 cm height from ground level during the last week of December.

**Plant protection:**

**Pests**

**Bud worm:** Spray Profenofos 50 EC @ 1 ml/lit or Thiochlorid 240 SC @ 2 ml/l

**Holotricha beetle:** Install light trap to attract the adults immediately after summer rain.

**Red spider mite:** Spray wettable sulphur 50 WP @ 2 g/l or Propargite 57 % EC @ 2ml/l or Fenazaquin 10 % EC @ 2 ml/l

**Diseases**

**Leaf spot:** Spraying of Mancozeb @ 2.5g/l from the onset of monsoon at monthly intervals

**Season of flowering and harvest:** Flowering season is May to October. Fully developed unopened flower buds are picked in the morning for fresh flower trade. For oil extraction, open flowers are to be picked before 10 a.m.

**Yield:** Flowers: 11 t/ha; concrete recovery: 0.25 - 0.32 %.



**Crossandra: *Crossandra infundibuliformis* L.; Acanthaceae**

**Varieties:** Tetraploid types - Orange, Lutea Yellow, Sebaculis Red.

Triploid types - Delhi Crossandra.

**Climate:** It requires a temperature of 30 - 35°C for growth. It is shade tolerant to some extent but susceptible to low temperature and frost.

**Soil:** Well drained sandy loam and red soils with pH of 6 - 7.5 are ideal. Soil is to be tested for nematodes before planting.

**Propagation:**

Tetraploids: Propagated through seeds. Seed rate is 5kg/ha. 60 day old seedlings are transplanted in the main field.

Triploids: Propagated through terminal cuttings of 10 - 15 cm length (41,700 cuttings/ha)

**Preparation of field:** Land is ploughed thrice and FYM at 25 t/ha is incorporated. Ridges are formed 60 cm apart. Dip the roots of seedlings in Carbendazim (1 g/l of water) and plant on one side of the ridge at 30 cm spacing.

**Spacing:**

Tetraploid : 60 x 30 cm / 60 x 60 cm (for seed production).

Delhi Crossandra : 60 x 40 cm

**Nutrition:**

Tetraploids: Apply FYM 25 t/ha as basal and NPK at 75, 50 and 125 kg/ha as top dressing three months after planting. Repeat NPK application at the same dose at half yearly intervals for two more years (Instead of applying N at 75 kg/ha, N at 60 kg/ha + *Azospirillum* 2 kg/ha can also be applied).

Delhi Crossandra: Apply FYM 25 t/ha, Gypsum 100 kg/ha and P & K at 50 and 100 kg/ha respectively as basal dose. Top dressing is done 30 days after planting with neem cake 250 kg and N 40 kg/ha. Apply N P K @ 40:20:60 kg/ha 90 days after planting and repeat this dose at quarterly intervals for a period of two years.

**For both Tetraploids & Delhi Crossandra:**

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100 kg of FYM and applied.

**Growth regulators:** Spray Ascorbic acid 1000 ppm (1 g/lit of water) before flowering.

**Irrigation:** Once in a week depending upon the weather conditions.

**Plant protection**

**Pests**

**Aphids:** Spray Dimethoate 30 EC @ 2 ml/l.

**Nematode:** Avoid planting crossandra in nematode infested fields. To control nematodes, apply of Phorate or Carbofuran 3 G @ 1 kg a.i./ha a week after planting and the same may be repeated six months after planting.

**Diseases**

**Wilt:** Soil drenching with Carbendazim 1 g/lit or Trifloxystrobin + tebuconazole @ 0.75 g/litre

**Crop duration:** 3 years including ratoon crop.

**Harvest:** Flowering will start a month after transplanting. Fully opened flowers are picked once in two days.

**Yield:**

Tetraploid varieties : 2 t/ha/year

Delhi Crossandra : 2.8 t/ha/year.

Trade Mark of TNAU



## **Chrysanthemum: *Dendranthema grandiflora* Tzeuleu; Asteraceae**

**Varieties:** CO 1, CO 2, MDU 1, Indira, Red Gold.

**Climate:** Tropical and subtropical climatic conditions are ideal. However, the best temperature for growing chrysanthemum is 20-28°C for day and 15-20°C for night. Since chrysanthemum is a short day plant, planting should be done such that flowering coincides with short day conditions. Under Tamil Nadu conditions, it is planted during April - May so that it flowers during September - December.

**Soil:** Well drained red loamy soil with pH of 6 to 7.

**Propagation and planting:** Commercial propagation is through terminal cuttings (5-7 cm long) or suckers. Planting during June - July at 30 x 30 cm spacing on one side of ridges (1,11,000 plants/ha).

### **Nutrition:**

Recommended dose - 25 t FYM and 125:120: 25 kg NPK/ha.

Basal application - half of N + entire P and K; top dressing - half of N applied 30 days after planting.

**Pinching:** Done 4 weeks after planting to induce lateral branches.

**Desuckering:** Remove the side suckers periodically.

**Micronutrients:** Foliar spray of ZnSO<sub>4</sub> 0.25% + MgSO<sub>4</sub> 0.5%.

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100 kg of FYM and applied.

**Growth regulators:** Spray GA<sub>3</sub> @ 50 ppm on 30, 45 and 60 days after planting.

**Irrigation:** Twice a week in the first month and subsequently at weekly intervals depending upon the weather conditions.

### **Plant protection**

#### **Pests:**

**Thrips, aphids and leaf eating caterpillars:** Spray Acetamiprid @ 0.3 g/l or Indoxacarb @ 1 ml/l

#### **Diseases**

**Root rot:** Soil drenching with Copper oxychloride 2.5 g/lit or Trifloxystrobin + Tebuconazole @ 0.75 g/litre or Difenoconazole @ 0.5ml/l

**Leaf spot:** Foliar application of Mancozeb @ 2.5g/l or Azoxystrobin @ 1g/l

**Duration:** 6 - 8 months for main crop and 4 months for ratoon crop

**Harvest:** Pick the flowers from 3<sup>rd</sup> month onwards at 4 days interval. Harvesting is done at 3/4 to full open stage for nearby markets and 1/2 open stage for distant markets.

**Yield:** 20 t/ha from main crop; 10 t/ha from ratoon crop.

**Marigold (African marigold): *Tagetes erecta* L.; Asteraceae**

**Varieties:** Pusa Narangi Gaiinda, Pusa Basanthi Gaiinda (IARI varieties) and MDU 1 (TNAU variety).

**Climate:** Year round production is possible under tropical and sub-tropical conditions.

**Soil:** Well drained loamy soil with pH of 7.0 to 7.5.

**Propagation and planting:** Propagated through seeds. Seed rate is 1.5 kg /ha. 25 - 30 day old seedlings are transplanted in the field on one side of ridges at 45 x 35 cm spacing.

Treat the seeds with *Azospirillum* (200 g in 50 ml of rice gruel) before sowing.

**Irrigation:** Once in a week or as and when necessary. Water stagnation should be avoided.

**Nutrition:** Apply 45:90:75 kg NPK/ha as basal and 45 kg N/ha as top dressing 45 days after planting.

**Crop duration:** 130 - 150 days.

**Harvest:** Flowers are picked once in 3 days beginning from 60 days after planting.

**Yield:** 18 t/ha.

**Precision production technology**

**Hybrid:** L3 hybrid (cultivated for xanthophyll extraction).

**Seeds and sowing:** Sown throughout the year. Seed rate is 100 g/acre. Seeds are sown in pro trays and 20 day old seedlings are transplanted on raised beds at 90 x 22.5 cm spacing to accommodate 44,400 plants/ha. Treat the seedlings with *Pseudomonas fluorescens* @ 0.5% before planting.

**Fertigation:** Recommended Dose of Fertilizer (RDF) is 90: 90:75 kg NPK/ha. 75% RDF is applied through fertigation [Water Soluble Fertilizer (WSF) application through drip irrigation]. Water Soluble Fertilizers such as Polyfeed (19:19:19), Potassium Nitrate (13:0:45) and Urea (46% N) can be used.

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and Phosphobacteria per ha at the time of planting. Biofertilizers are to be mixed with 100kg of FYM and applied.

**Micronutrients:** Foliar spray of FeSO<sub>4</sub> 0.5% + ZnSO<sub>4</sub> 0.5% on 30<sup>th</sup> and 45<sup>th</sup> day after transplanting.

**Biostimulants:** Spray Humic acid @ 0.2% on 30 & 45 days after transplanting.

**Plant protection**

**Pests:**

**Cut worms and *Helicoverpa armigera***

Spray spinosad 45 SC @ 0.75ml/litre. Spinosad 45 SC is quickly biodegradable and is accepted by the importers

**Mealy bug:** Spray Prophenophos @ 2ml/l Fish oil rosin soap @ 25 g/l

**Bud borer:** Spray Spinosad @ 0.75 ml / l

**Leaf miner / thrips:** Spray Fipronil @ 1.5ml/l

**Red spider Mite:** Spray Abamectin 1.9 EC @ 0.5 ml/l or Fenazaquin @ 2 ml/l or Exodus (natural lactones) @ 2 ml/l

**Diseases:**

**Leaf spot :** Foliar application of Hexaconazole @1ml/litre or Mancozeb @ 2g/litre

**Yield:** Flowers : 30 - 35 t/ha.  
Xanthophyll : 1.7 - 1.9 g/kg of fresh flowers.

Trade Mark of TNAU



**Tuberose: *Polianthes tuberosa* L.; Amaryllidaceae**

**Varieties:**

Single – Calcutta Single, Mexican Single, Phule Rajani, Prajwal, Rajat Rekha, Shringar, Khahikuchi Single, Hyderabad Single, Pune Single, Arka Nirantra.

Double - Calcutta Double, Hyderabad Double, Pearl Double, Swarna Rekha, Suvasini, Vaibhav.

**Climate:** Tropical conditions with a temperature range of 28 to 30°C.

**Soil:** Well drained sandy loam to clay loamy soil with a pH of 6.5 - 7.5.

**Propagation and Planting:** Bulbs are used for commercial propagation. Bulbs of 25-30g weight are planted (1,12,000 bulbs/ha) on the sides of ridges at 45 x 20 cm spacing during June – July at a depth of 2.5 cm. Bulbs are planted after 30 days of harvest. Dip the bulbs in 5000 ppm CCC (5 g/l) before planting to increase the yield.

**Manuring**

FYM : 25 t/ha

N: P:K : 200:200:200 kg/ha

Full P and K can be applied during the final preparation of plots, while N can be applied in 3 equal split doses *i.e.*, at the final preparation of plot, 60 and 90 days after planting of bulbs.

**Micronutrients:** Foliar spray of ZnSO<sub>4</sub> 0.5% + FeSO<sub>4</sub> 0.2% + Boric acid 0.1%.

**Growth regulators:** Foliar application of GA<sub>3</sub> at 50 to 100 ppm thrice at 40, 55 and 60 days after planting.

**Plant protection:**

**Pests**

**Thrips:** Spray Dimethoate @ 1.5 ml/lit or Fipronil 5 % SC @ 1.5 ml/ l

**Aphids:** Spray Dimethoate @ 1.5 ml/lit or Imidacloprid @ 1.5ml/l

**Root knot nematode:** Apply Carbofuran 3 G @ 1 g/plant near the root zone and irrigate immediately.

**Foliar nematode:** Soak bulbs in neem seed kernel extract (NSKE) overnight before planting

**Diseases**

**Basal rot (or) stem rot:** Soil drenching with Carbendazim @ 0.1 %

**Crop duration:** 2 ½ to 3 years

**Harvest:**

**For Loose flower and concrete extraction:** Individual florets are plucked during early morning hours before 8 am daily, when they start to open.

**For cut flower:** Whole spike is cut leaving 4 to 6 cm from the base.

**Yield:**

Loose flowers: 14 -15 t/ha; Cut flower: 2 - 3 lakhs spikes/ha/year; Bulbs & bulblets: 20 -25 t/ha (at the end of 3<sup>rd</sup> year).

Concrete recovery: 0.08 - 0.11 %



**Nerium: *Nerium indicum* Mill.; Apocynaceae**

**Varieties:**

Tall types : Single Rose, Single White, Single Red, Double types.

Dwarf types : Petite Salmon, Petite Pink.

**Climate:** Tropical and subtropical conditions.

**Soil:** Red lateritic or black or loamy soils with adequate drainage.

**Propagation and planting:** Hard or semi hard wood cuttings of 60 cm length are used for propagation. Rooted cuttings are planted during June - July in 30 x 30 x 30 cm pits dug at 2 x 2 m spacing and filled with FYM, red earth and top soil.

**Nutrition:** FYM @ 20 t /ha is applied in 2 equal splits during January and August.

**Pruning:**

1<sup>st</sup> year- remove one third of old mature stems near ground level.

2<sup>nd</sup> year- remove one half of the remaining old stems and cut back long new shoots.

3<sup>rd</sup> year- remove remaining old stems and cut back long new shoots.

**Biofertilizers:** Soil application of 2 kg each of *Azospirillum* and *Phosphobacteria* per ha at the time of planting. It is to be mixed with 100kg of FYM and applied in pits.

**Irrigation:** The plants are irrigated once in 10 - 15 days depending on the weather conditions.

**Plant protection**

**Pests:**

**Leaf Caterpillar:** Spray Phosalone 35 EC @ 1 ml/l or.

**Flowering season:** Throughout the year; peak flowering from April to August.

**Harvest:** Flowering begins 4 months after planting.

**Yield:** 100 - 125 kg of flowers/ha/day.

**Golden Rod: *Solidago spp*; Asteraceae**

**Varieties:** Ballardii, Golden Gate, Golden Wing, Monte D' oro, Monte Solo, Peter Pan, Straehlen Krone, Super and Tara Gold.

**Climate:** Grown under varied climatic conditions; cooler climate gives high quality cut flower.

**Soil:** Sandy loam and red loam soils with proper drainage.

**Planting season:** Throughout the year.

**Propagation:** Commercially propagated through division of clumps or suckers.

**Planting:** Soil is ploughed to fine tilth, flat beds are formed and suckers are planted at 45 x 45 cm spacing.

**Irrigation:** Once in three days depending on weather conditions.

**Nutrition:** 5 t FYM + NPK @ 140:175:150 kg/ha as basal and half the dose applied after every harvest.

**Weed management:** Hand weeding done as and when required.

**Plant protection**

**Pests**

**Lace bugs:** Spray Malathion @ 1 ml/l.

**Diseases**

**Powdery mildew:** Spray Wettable Sulphur 2g/l or Azoxystrobin @ 1m/l.

**Leaf Spot:** Spray Copper Oxychloride 3g/l or Hexaconazole @ 1ml/l or Mancozeb @ 2g/l.

**Root rot:** Soil drenching with Carbendazim @ 1g/l.

**Harvesting:**

First harvest : 75 days after planting.

Harvesting stage : When 25 % of the flowers have opened.

Crop duration : 2 years.

**Yield:** 3 lakh stems/ha/crop

## Chapter B

### Cut flowers

**Cut Rose: *Rosa* sp.; Rosaceae**

**Varieties:**

**Red** - First Red, Grand Gala, Red Corvette, Tajmahal.

**Yellow** - Aalsmeer Gold, Gold Strike, Skyline.

**Pink** - Noblesse, Flirt, Vivaldi.

**Orange** - Movie Star, Miracle, Tropical Amazon.

**White** - Ice Berg, Polo, Holly Wood, Avalanche, Tineke, Aloynica, Biyanka.

**Soil:** Fertile loamy soil with pH of 6 - 7.

**Climate:**

Protected cultivation: Day temperature of 25 to 28°C and night temperature not below 15°C; relative humidity of 60-65%.

Open field cultivation: Moderately cooler places (like Hosur) and sub tropical climatic conditions (foot hills) are suitable.

**Propagation:** Cut roses are commercially propagated by 'T' budding on Briar rootstock.

**Field preparation and planting:** Prepare the soil by repeated ploughing. Roses can be planted on beds or ridges and furrows. One year old budded plants are planted. While planting, keep the budded portion 5 cm above the soil. Plant in such a manner that the budded branch is oriented towards the centre of the bed.

**Spacing:**

Protected cultivation : 40 X 15 cm (7 plants/m<sup>2</sup>).

Open field cultivation : 60 x 60 cm (27,777 plants/ha) to 60 x 75 cm (22,222 plants/ha).

**Irrigation:**

Protected cultivation : Drip irrigation with fertigation

Open field cultivation : Irrigate once in 5 to 7 days depending upon the soil moisture.

**Nutrition:**

The following fertigation schedule can be adopted for an area of 1000 m<sup>2</sup>.

Crop stage	Fertilizers	Dosage	Time interval (No. of days)
First 15 days after planting	-	-	-
15-45 days after planting (establishment of plants)	Ammonium Nitrate (NH <sub>4</sub> NO <sub>3</sub> ) (21: 0 : 0)	Each 1 kg	2
	Mono Ammonium Phosphate (12-61-0)		
	Mono Potassium Phosphate (0-52-34)		
	Calcium Nitrate (CaNO <sub>3</sub> ) (15.5% N, 18.8% Ca)		
46-90 days after planting	Ammonium Nitrate (NH <sub>4</sub> NO <sub>3</sub> ) (21 : 0: 0)	Each 2 kg	2
	Mono Ammonium Phosphate (12-61-0)		
	Mono Potassium Phosphate (0-52-34)		
	Calcium Nitrate (CaNO <sub>3</sub> ) (15.5% N, 18.8% Ca)	Each 100 g	
	Copper, Zinc, Boron, Sulphur, EDTA, EDTHA		
	Magnesium Sulphate (MgSO <sub>4</sub> )		
91-116 days after planting (flower bud formation to harvest)	Ammonium Nitrate (NH <sub>4</sub> NO <sub>3</sub> ) (21: 0:0)	Each 3 kg	2
	Mono Ammonium Phosphate (12:61:0)		
	Mono Potassium Phosphate (0-52-34)		
	Calcium Nitrate (15.5% N, 18.8% Ca)		
	Copper, Zinc, Boron, Sulphur, EDTA, EDTHA	Each 100 g	
	Magnesium Sulphate (MgSO <sub>4</sub> )	1 kg	

### Special practices:

**Training:** Early training is essential for plants under polyhouse conditions. Some of the first growth which consists of blind shoots must not be cut or bent, but left upright. Buds appearing at early stages are removed. The second growth will come to flower again in four to five weeks. By then, the plants will be 50 to 60 cm high, which is necessary to have enough growing speed in the plant and to have enough foliage for bending.

**Bending:** The first bending (basal formation) is done on 35<sup>th</sup> day after planting. The main shoot is bent down so that lateral branches grow. The second bending is done after 2 years to strengthen the plants.

**Shoot thinning:** Periodically remove unproductive shoots and water suckers.

**Pruning:** Pruning is followed only under open conditions during the months of March and October.

**Pinching:** Pinching is done to regulate flowering. Most of the commercial cultivars take about five-and-a-half to six weeks from pinching to produce flowers during summer and about eight weeks during winter.

**Plant protection:****Pests:**

**Rose chafer beetle:** Hand pick Cetonid beetles and destroy during the day time. Set up light traps to attract *Holotrichia* and *Anomala* spp. Spray Hostothion @ 2 ml/l.

**Red scale:** Rub off the scales with cotton soaked in kerosene or diesel. Cut and burn the affected branches. Spray Malathion 50 EC @ 2 ml/l at the time of pruning and again during March - April or apply Carbofuran 3G @ 5 g/plant or spray fish oil rosin soap @ 25 g/l.

**Mealy bug:** Spray Dimethoate @ 2 ml/l or Profenophos @ 2 ml/l or Fish oil rosin soap @ 25 g/l.

**Flower caterpillar:**

***Helicoverpa armigera*:** Spray Ha NPV 1.5 x 10<sup>12</sup> PIB/ha or Spinosad @ 0.75 ml/l.

***Spodoptera litura*:** Spray SI NPV 1.5 x 10<sup>12</sup> PIB/ha or Spinosad @ 0.75 ml/l.

**Bud worm:** Spray Profenophos 50 EC @ 1 ml/l or Thiochlorid 240 SC @ 2 ml/l.

**Thrips, aphids and leaf hoppers:** Spray Acetamiprid @ 0.3 g/l or Carbofuran 3G @ 5 g/plant. Spray Neem oil @ 3 % or Phosalone 35 EC @ 2 ml/l.

**Diseases:**

**Black spot:** Spray Carbendazim @ 1 g/l or Azoxystrobin @ 1ml/l twice at fortnightly intervals.

**Powdery mildew:** Spray Carbendazim @1 g/l or Wettable Sulphur at 2 g/l or Azoxystrobin @ 1 ml/l.

**Harvest:** Harvest the buds at tight bud stage with 60-90 cm long stems. Ensure that the foliage in the cut stem is healthy.

**Yield:** Under poly house: 1<sup>st</sup> year: 100-120 flowers/m<sup>2</sup>  
2<sup>nd</sup> year: 200-240 flowers/m<sup>2</sup>  
3<sup>rd</sup> year: 300-360 flowers/m<sup>2</sup>

## Cut Chrysanthemum: *Dendranthema grandiflora*; Asteraceae

### Varieties:

**Standard types:** Bonfire Orange, Bonfire Yellow.

**Spray types:** Reagan Yellow, Reagan White, Nanako, etc.,

**Climate:** Cut chrysanthemums are grown under polyhouses with the following environmental conditions.

Temperature : 16 - 25°C

Relative humidity : 70 - 85 %

CO<sub>2</sub> : 600 - 900 ppm

Photoperiod : Long day conditions with 13 hours light & 11 hours darkness during vegetative stage (upto 4-5 weeks from planting) and short day conditions with 10 hours light & 14 hours darkness during flower bud initiation stage.

**Soil:** Well drained sandy loam soil with good texture and aeration or growing medium made of 1: 1: 2 of soil, compost and cocopeat with pH of 5.5 to 6.5.

**Propagation:** Terminal cuttings and tissue culture plants are used. Terminal cuttings are widely used for commercial cultivation. Cuttings of 5-7 cm length are taken from healthy stock plants and are induced to root by treating with IBA (1000 ppm).

**Planting:** Beds of 1 m width, 0.3 m height and convenient length are formed. Nets (with cell size depending on the spacing adopted) are placed on the beds and planting is done.

**Spacing:** 15 x 15 cm (45 plants/m<sup>2</sup>) or 10 x 15 cm (67 plants/m<sup>2</sup>).

**Irrigation:** Drip irrigation with 8-9 litres of water/m<sup>2</sup>/day.

### Nutrition:

Basal application of DAP - 50 g/m<sup>2</sup>

Weekly schedule - from 3<sup>rd</sup> week after planting

Fertilizer	Quantity (g/m <sup>2</sup> )	
	Monday	Wednesday
19-19-19	3.0	1.0
KNO <sub>3</sub>	3.0	1.0
CAN	2.0	1.0
Ammonium nitrate	2.0	1.0
MgSO <sub>4</sub>	2.0	1.0

### Special practices

**Pinching:** First pinching - 3 weeks after planting; 2<sup>nd</sup> pinching - 5 weeks after planting.

**Disbudding:** In spray varieties, only the large apical bud is removed and the lateral buds are retained. In standard varieties, the lateral buds are removed and only apical buds are allowed to develop.



**Light regulation:** Chrysanthemum is very much influenced by light and hence photoperiod should be regulated. (Photoperiod should be regulated as detailed under 'climate')

**Growth regulators:** Spray GA<sub>3</sub> (50 ppm) at 30, 45 and 60 days after planting to increase flower stem length.

**Weed management:** Weeding and hoeing are done manually as and when required.

### **Plant protection**

#### **Pests**

**Leaf miner:** Spray Imidacloprid @ 0.5 ml/l or Acetamiprid @ 0.3 g/l.

**Thrips:** Spray Fipronil @ 1.0 ml/l. Keep Yellow Sticky Trap 10 nos. for 100 sq.m area.

**Aphids:** Spray Methyl demeton @ 2 ml/l .

**Red spider mite:** Spray Abamectin 1.9 EC @ 0.5 ml/l or Propargite @ 2 ml/l.

#### **Diseases**

**White Rust:** Spray Azoxystrobin @ 1ml/l or Trifloxystrobin + Tebuconazole @ 0.75 g/l.

**Leaf spot:** Spray Macozeb @ 2g/l or Azoxystrobin @ 2 ml/l or Difenoconazole @ 0.5ml/l.

**Wilt:** Soil drenching with Carbendazim @ 1 g/l or Trifloxystrobin + Tebuconazole @ 0.75 g/l.

**Powdery mildew:** Spray Wettable Sulphur @ 2g/l or Azoxystrobin @ 1ml/l.

#### **Harvest index:**

Standard types - Flowers are harvested when 2 - 3 rows of rays florets are perpendicular to the flower stalk.

Spray types - When 50% flowers have shown colour for distant markets; when two flowers have opened and others have shown colour for local markets.

#### **Yield:**

**Standard types:** 67 flower stems/m<sup>2</sup>

Spray types: 260 flower stems/m<sup>2</sup>



**Carnation: *Dianthus caryophyllus*; Caryophyllaceae**

**Varieties:**

**Red** - Domingo, Master, Gaudina, Leopardii, Big Red, Taureg, Guapo, Aicardii

**White** - Baltico, White Liberty, Emotion, White Dona, Lisa

**Pink** - Dona, Charmant, Dumas, Pink Dover, Bizet

**Light pink** - Charmant, Cipro Big Mama, Dona, Golem

**Yellow** - Diana, Kiro, Soto, Salamanca, Liberty

**Orange** - Solar, Star, Folgore

**Double** - Malaga, Star, Athena, Happy Golem

**Growing environment:** Naturally ventilated aerodynamic steel frame structure.

**Climate:** Cool climate with day temperature of 18-24°C and night temperature of 10-15°C; relative humidity of 70 -75 %.

**Soil:** Well drained red loamy soil with pH of 5.5 - 6.5.

**Propagation:**

Terminal stem cuttings

**Field preparation and planting:**

Fumigation - Dazomet @ 30g/m<sup>2</sup> or H<sub>2</sub>O<sub>2</sub> @ 300 ml/m<sup>2</sup>.

Bed size: 100 cm width, 30 cm height, convenient length with 40 cm foot path.

**Spacing:** 6 row planting - 15x15cm (25 plants/m<sup>2</sup>).

4 row planting - 15x15cm (22 plants/m<sup>2</sup>).

**Irrigation:** Drip system with drippers at 30 cm spacing (5-6 l/m<sup>2</sup>/day).

**Nutrition:**

The following fertigation schedule can be adopted for intensive production under polyhouse conditions.

Nutrients	Quantity (g/m <sup>2</sup> /week)	
	Till bud formation	Bud formation to harvest
<b>Tank-A (Monday and Thursday)</b>		
Ammonium Nitrate	3.0g	2.0 g
19:19:19	3.0 g	2.0 g
Magnesium Sulphate	2.5 g	2.5 g
Boron	1.0 g	1.0 g
Trace elements / micronutrients	1.0 g	1.0 g
<b>Tank – B (Tuesday and Friday)</b>		
Potassium Nitrate	5.0 g	5.0 g
Calcium Nitrate	8.0 g	9.0 g

## Special practices

### Netting for plant support: 4 layers

1<sup>st</sup> layer : 7.5 x 7.5 cm

2<sup>nd</sup> layer : 10 x 10 cm

3<sup>rd</sup> layer : 12.5 x 12.5 cm

4<sup>th</sup> layer : 15 x 15 cm

### Pinching:

- ♣ Depending upon the need of crop spread, single, one and a half or double pinch method is adopted.
- ♣ Ideal time for pinching is early morning.
- ♣ When the plant attains 5 nodes, the first pinch is given. This is called 'single pinch'. This would give rise to six lateral shoots.
- ♣ With a 'one and half pinch', 2-3 of these lateral shoots are pinched again. For the 'double pinch', all the lateral shoots are pinched off.

**Disbudding:** In standard carnations, side buds should be removed whereas in spray carnations, the terminal bud has to be removed.

### Plant protection

#### Pests

**Thrips:** Spray Dimethoate @ 2 ml/l or Fipronil @ 1.5 ml/l

#### Red spider mites

Release coccinellid beetle *Stethorus pauperculus* and predatory mite *Amblyseius sp* @ 10 mites /plant or spray abamectin 1.8 EC @ 0.5 ml/lit of water or Spiromesifen @ 0.8 ml/l or

Hexythiazox @ 1.5 ml/l

#### Diseases

**Fusarium wilt:** Soil drenching with Carbendazim @ 0.1 % or Difenoconazole @ 0.05 % or *Pseudomonas fluorescens* as soil application @ 25 g/m<sup>2</sup> and foliar application @ 0.5 % at monthly intervals or soil drenching with *Bacillus amyloliquefaciens* @ 0.5 % at monthly intervals

**Alternaria leaf spot:** *Bacillus subtilis* as soil application @ 25 g/m<sup>2</sup> followed by foliar application @ 0.5 % at monthly intervals

#### Physiological disorder

**Calyx splitting:** Spray borax @ 1 g/l at fortnightly intervals till flower bud appearance and at weekly intervals thereafter.

**Harvest:** Flowering starts 110-120 days after planting.

#### Stages of harvest

Standard types - paint brush stage

Spray types - when two flowers are open and the remaining flower buds show colour

**Yield:** 15 flowers/plant (350 - 375 flowers stems/m<sup>2</sup>) in 2 years period

**\*Precision production techniques for carnation**

S.No.	Cultural Practice	Recommendation
1.	Fumigation	Dazomet @ 30 g/m <sup>2</sup>
2.	Media consortium	10:1:1 ratio of 30 kg/m <sup>2</sup> of consortium with 25 kg of Farm Yard Manure, 2.5 kg of vermicompost, 2.5 kg of cocopeat with the biofertilizers Azospirillum, Phosphobacteria, VAM and the biocontrol agents <i>Trichoderma viridae</i> , <i>Pseudomonas fluorescens</i> each @ 20 g/m <sup>2</sup> at bimonthly intervals
3.	Planting density	15 x 15 cm with 25 plants/m <sup>2</sup>
4.	Planting stage and pinching level	30 day old rooted cuttings and single pinching at the 5 <sup>th</sup> node
5.	Precooling	4° C for 4 hours
6.	Pulsing solution	Sucrose 10 % + Citric acid 100 ppm + 8-Hydroxy Quinoline 400 ppm for 24 hours duration
7.	Holding solution	Sucrose 5 % + Citric acid 50 ppm + Benzyl Adenine 75 ppm
8.	Wrapping and packaging techniques	Polyethylene sleeves 50 gauge thickness + CFB with 4 % vent

\* The precision production techniques are to be followed along with the cultural practices recommended for the conventional system.



**Anthurium: *Anthurium andreanum*; Araceae**

**Varieties:**

- Red** : Temptation, Tropical Red, Red Dragon, Verdun Red, Flame, Mauritius Red .
- Orange** : Mauritius Orange, Peach, Casino, Sunshine Orange, Nitta.
- White** : Acropolis, Linda de Mol, Mauritius White, Lima, Manoa Mist.
- Pink** : Abe Pink, Candy Stripe, Passion.
- Green** : Midori, Esmaralda.
- Bicoloured** : Titicaca, Jewel, Akapana, Cardinal.
- Others** : Fantasia (cream with pink veins), Chocos, Chicos (chocolate brownish red).

**Growing environment:** 75% shade net house with 70 - 80% relative humidity, day temperature of 24 - 28°C and night temperature of 15 - 22°C.

**Growing media:** Porous organic media such as leaf mould and cocopeat is ideal. A mixture of 1 part each of coir pith, leaf mould, cattle manure, coarse sand, brick pieces, charcoal, neem cake and coconut husk pieces is highly suitable.

**Propagation:** Propagated through tissue culture or suckers. Tissue culture plants are widely used for commercial cultivation.

**Planting:** Grown in pots or raised beds. Tissue culture plants of 15 cm height with 4-6 leaves are ideal for planting.

**Irrigation:** Mist or over head sprinkler to provide water and to improve relative humidity.

**Nutrition:**

**Pot cultivation** - Foliar application of 0.2% of NPK @ 30:10:10 during vegetative stage and 10:20:20 during flowering stage is adopted for pot cultivation. Fertigation can be adopted for raised bed cultivation.

**Raised bed cultivation** - For the first 6 months spray plants with a solution of cow dung and DAP @ 250 ml/plant (10 kg of cow dung + 2 kg of DAP dissolved in 200 l of water and the decanted solution is used for spraying). After 6 months fertigation is adopted with the following schedule.

Fertilizer	Quantity (g/100m <sup>2</sup> )
<b>Schedule 'A' - Weekly once</b>	
Calcium Nitrate	250
Potassium Nitrate	150
Micro nutrients	50
<b>Schedule 'B' - Weekly once</b>	
Mono Ammonium Phosphate	250
Potassium Nitrate	100
Magnesium Sulphate	50

### Special practices

**Leaf pruning:** Leaf pruning retaining 4-6 leaves per plant has to be taken up at regular intervals to avoid disease problem and to promote flowering.

### Plant protection

#### Pests

**Aphids** : Spray Dimethoate @ 3 l/l

**Scale insects:** Spray Malathion @ 1 ml/l

**Spider mites** : Spray Wettable sulphur @ 3 g/l or Propargite @ 2 ml/l

**Thrips** : Spray Fipronil @ 1.5 ml/l

#### Diseases

**Anthracnose:** Spray Carbendazim @ 1g/l

**Leaf spot** : Spray Carbendazim @ 1 g/l or Mancozeb @ 2g/l

**Root rot** : Soil drenching with Captan @ 2g/l

**Bacterial wilt:** Spray Streptomycin sulphate @ 0.1g/l

**Harvesting:** Plants start flowering from 6-8 months after planting. Harvesting is done at 1/3 colour change on the spadix (i.e. opening of 1/3 of true flowers on spadix) or the angle between the spathe and spadix should be 45 °C.

**Yield:** 7- 9 flowers/plant/year.





## **Dendrobium Orchid: *Dendrobium sp.*; Orchidaceae**

**Varieties:** Sonia 17, Sonia 28, Emma White, Sakura Pink.

**Growing environment:** 75% shade net house with 70 - 80% humidity, day temperature of 21 - 29°C and night temperature of 18 to 21°C is ideal for growing this tropical orchid. In high rainfall zones, the shade net house should be provided with a rainshelter.

**Growing media:** Most common potting mixture consists of charcoal, broken pieces of bricks and tiles, coconut husk and fiber.

**Propagation:** Division of clumps, keikis, back bulbs and tissue culture plants.

Containers and support : perforated earthen pots are ideal and the plants are staked with bamboo sticks.

**Irrigation:** Mist or overhead sprinkler to provide water and to maintain humidity.

**Nutrients:** Foliar application of NPK 20:10:10 @ 0.2% at weekly intervals starting from 30 days after planting.

**Growth regulators:** Foliar application of GA<sub>3</sub> 50 ppm at bimonthly intervals starting from 30 days after planting.

**Pests:**

**Snail and slug:** Hand pick and destroy

**Post harvest handling:**

Pulsing	:	8-HQC 500 ppm + Sucrose 5% for 12 hrs
Holding solution	:	AgNO <sub>3</sub> 25 ppm + 8-HQC 400 ppm + Sucrose 5%
Wrapping material	:	50 gauge polythene with base of spikes dipped in 8-HQC 25 ppm

**Harvest:** Harvesting the spike when 75 per cent of the flowers are open and remaining buds are unopen.

**Yield:** 8 - 10 spikes/plant/year.

**Pests:**

**Snail and Slug:** Hand pick and destroy them immediately.

**Diseases:**

### **1. Bacterial soft and Brown rot (*Ervinia spp.*)**

Foliar application with Streptomycin Sulphate @ 0.5 g + Copper Oxy Chloride @ 2 g/l.

### **2. Bacterial Brown spot (*Acidovorax sp.*)**

Foliar application with Streptomycin Sulphate @ 0.5 g + Copper Oxy Chloride @ 2 g/l.

### **3. Blackrot (*Pythium sp.* and *Phytophthora sp.*)**

Foliar application of Metalaxyl 2 g / lit. (or) Dimethomorph 50% WP 0.5 g / lit.

### **4. Anthracnose** - Foliar application of Thiophanate Methyl 2 g / l (or) Difenconazole 0.5 ml/l

## **Lilium: *Lilium* sp.; Liliaceae**

### **Varieties:**

**Asiatic hybrids :** Dreamland (yellow), Brunello (orange), Novona (white), Pollyanna (yellow), Yellow Giant (yellow), Vivaldi (pink), Black Out (Deep red)

**Oriental hybrids:** Star Gazer (Pink & white), Nerostar, Siberia, Acapulco (cyclamen pink) and Casablanca

**Eastern lily (*L. longiflorum*):** Elegant Lady, Ace, Snow Queen, White, American, Croft and Harbor

**Climate:** Liliums are best grown in green houses. Day temperature of 18-22°C and night temperature of 10-15°C are ideal.

**Soil:** Well drained sterile medium (preferably leaf mould, cocopeat and FYM in equal parts) with pH 5.5 to 6.5 is ideal. Fumigate the beds with Dazomet @ 30g/m<sup>2</sup>.

**Propagation:** Liliums are commercially propagated through bulbs. A six week cold storage period at 2°C to 5°C is needed to break dormancy. Bulbs can be stored at - 2°C up to one year.

**Spacing:** 20 x 15 cm, 15 x 15 cm or 15 x 10 cm (plant density varies between 30 and 60/m<sup>2</sup> depending on cultivar and bulb size)

**Irrigation:** 6 - 8 litres/m<sup>2</sup>/day during summer and 5 - 6 litres/m<sup>2</sup>/day during winter

### **Nutrition:**

The following fertigation schedule can be adopted.

Nutrients	Quantity (g/m <sup>2</sup> /week)	
	Asiatic	Oriental
Calcium Nitrate	2.5	2.5
19:19:19	0.5	0.5
Potassium Nitrate	2.2	2.3
Micronutrient mixture	1.2	1.2

**Crop support:** Supporting plants with nylon mesh is advisable.

### **Plant protection:**

#### **Pests:**

**Aphids:** Apply Imidacloprid 17.8 % SL @ 1 ml/l or Dimethoate 30 EC @ 2 ml/l

**Mites:** Spray Wettable sulphur @ 1.5 g/l or Abamectin @ 0.4 ml/l or Propargite @ 2 ml/l.

**Thrips:** Spray Methyl demeton 25EC @ 2 ml/ or Dimethoate 30EC @ 2ml/l

#### **Diseases:**

**Grey mould:** Spray Zineb @ 2g/l

**Bulb and scale rot:** Soil drenching with Carbendazim @ 1g/l or Difenconazole @ 0.5ml/l

**Foot rot & Root rot:** Soil drenching with Metalaxyl @ 0.1%

**Harvest:** Harvesting is done when lower most bud shows colour (colour breaking stage) but is not open.

**Crop duration:**

Asiatic hybrids : 8 - 10 weeks

Oriental hybrids : 14 - 16 weeks

**Yield:** The average yield is 30 - 40 flower stems/m<sup>2</sup>

Trade Mark of TNAU



## **Gladiolus: *Gladiolus* spp; Iridaceae**

**Varieties:** Tropic Sea, White Prosperity, Priscilla, Summer Sunshine, Pusa Swarnima, Jackson Ville Gold, KKL.1, Archana, Basant Bahar, Indrani, Kalima, Kohra, Aarti, Arka Kesar, Darshan, Dhiraj, Agnirekha, Archana, Bindiya, Shree Ganesh

**Climate:** Subtropical and temperate climatic conditions are suitable. The crop performs well under a temperature range of 27 - 30°C. It requires full exposure to sunlight and performs well with long day conditions of 12 to 14 hour photoperiod.

**Soil:** Well drained sandy loam soil rich in organic matter with pH of 6 to 7.

**Propagation:** Commercial propagation is through corms. Cold storage of corms at 3 to 7°C for 3 months or treatment with Ethrel (1000ppm) or GA<sub>3</sub> (100ppm) or Thiourea (500 ppm) is adopted for breaking corm dormancy.

**Field preparation and planting:** Beds of size 6 x 2 m are prepared and corms are planted at a depth of 5 cm adopting a spacing of 40 x 25 cm (88,888 plants/ha) or 25 x 25 cm (1,60,000 plants/ha).

**Planting season:** October for plains and March-April for hills.

**Irrigation:** Irrigate at 7-10 day intervals in sandy soils and at less frequent intervals in heavy soils. Irrigation should be withheld at least 4-6 weeks before lifting of corms.

**Nutrition:** 120 kg N, 150 kg P<sub>2</sub>O<sub>5</sub> and 150 kg K<sub>2</sub>O per hectare is recommended, of which 60 kg N and entire dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O is applied as basal dose. The remaining N is given in two split doses, 30 and 60 days after planting.

### **Special practices:**

**Staking:** Large flowered varieties should be staked to avoid lodging.

### **Plant protection**

#### **Pests**

Thrips: Spray Dimethoate 30 EC @ 2 ml/l or Fenitrothion 50 EC @ 2 ml/l or Malathion 50 EC @ 2 ml/l or apply Aldicarb 10G @ 5 g/m<sup>2</sup>

Semi loopier and Helicoverpa: Methyl Demeton 25 EC or Dimethoate 30 EC @ 2 ml/l

#### **Diseases**

**Leaf spot:** Foliar application of Carbendazim @ 1 g/l or Mancozeb @ 2 g/l

**Core or spongy rot:** Foliar application of Benomyl @ 1 kg/ha

**Bacterial scab blight and spots:** Dipping the corms in 1:100 Mercuric chloride solution for 12 hours before planting.

**Harvesting of spikes:** Gladiolus takes 110-120 days to produce spikes. While harvesting, at least four basal leaves should be retained on the plant to ensure proper development of corms and cormels.

**Yield:** 2.0 - 2.5 lakh flower stalks/ha/crop.

**Gerbera: *Gerbera jamesonii*; Compositae**

**Varieties:**

Red	: Ruby Red, Sangria
Yellow	: Doni, Supernova, Mammut, Talasa
Rose	: Rosalin, Salvatore
Pink	: Pink Elegance, Marmara, Esmara
Orange	: Carrera, Goliath, Marasol
Cream	: Farida, Dalma, Snow Flake, Winter Queen

**Climate:** Production of quality flowers requires shade house (50%) or naturally ventilated polyhouse. Day temperature of 22-25°C and night temperature of 12-16°C are ideal.

**Soil:** Well drained, rich, light, neutral or slightly alkaline soil with pH range of 5.5 - 7.0.

**Propagation:** Commercially propagated through division of suckers and tissue culture plants.

**Field preparation and planting:** Soil fumigation with Formaldehyde (100 ml in 5 l/m<sup>2</sup>) or Dazomet (30 g/m<sup>2</sup>) is recommended to control soil borne pathogens (*Phytophthora*, *Fusarium* and *Pythium*). Raised beds of 1-2 m width and 30 cm height are prepared. Growing media consisting of FYM: sand: cocopeat/paddy husk (2:1:1) is ideal.

**Spacing:** 40 x 30 cm or 30 x 30 cm

**Irrigation:** Drip irrigation with 500-700 ml of water/day/plant

**Nutrition:** Fertigation is adopted from 3<sup>rd</sup> week after planting as per the following schedule.

Fertilizer	Quantity (g/500m <sup>2</sup> )
<b>A tank (Monday, Wednesday, Friday)</b>	
Calcium Nitrate	700
Pottasium Nitrate ( 13:0:46)	400
Fe EDTA / sulphate	20
<b>B tank (Tuesday, Thursday, Saturday)</b>	
Mono Ammonium Phosphate (12:61:0)	300
Sulphate of Potash (0:0:50)	700
Magnesium Sulphate	700
Manganese Sulphate	5
Zinc Sulphate	3
Copper Sulphate	3
Molybdenum (Sodium Molybdate)	1
Boron (Borax)	3

**Special practices**

**Leaf pruning:** Remove old leaves periodically

**Plant protection**

**Pests**

**Aphids:** Apply Imidacloprid 17.8 % SL @ 1 ml/l or Dimethoate 30 EC @ 2 ml/l

**Whitefly:** Spray Imidacloprid 17.8 % SL @ 2 ml/l or Dimethoate 30 EC @ 2 ml/l

**Thrips:** Spray Fipronil @ 2 ml/l or Dimethoate 30 EC @ 2 ml/l

**Red spider mite:** Spray Abamectin 1.9 EC @ 0.4 ml/l or Propargite @ 1 ml/l

**Nematode:**

Soil application of *Bacillus subtilis* (BbV 57) or *Pseudomonas fluorescens* @ 2.5 kg/ha at the time of planting for the management of root knot nematode.

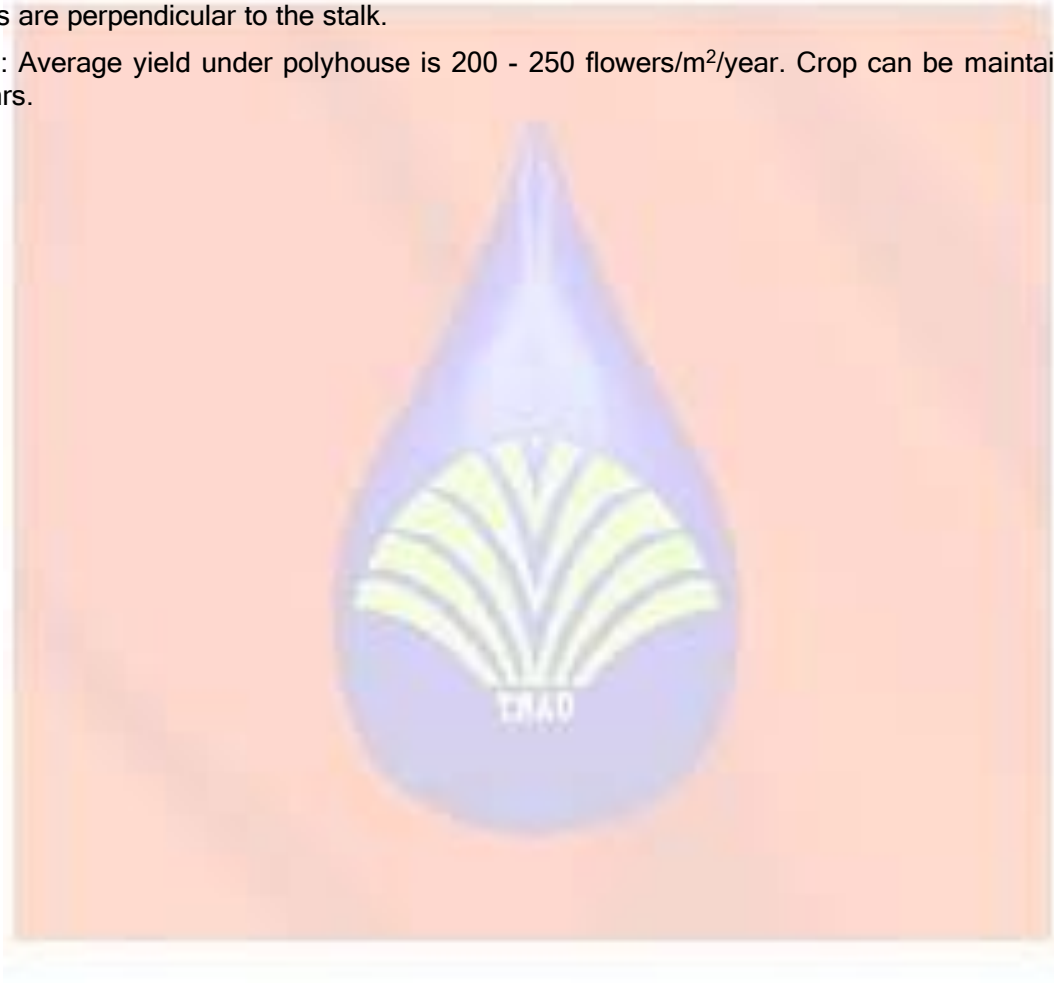
**Diseases:**

**Flower bud rot:** Spray copper oxychloride @ 2 g/l

**Powdery mildew:** Spray wettable Sulphur @ 2g/l or Azoxystrobin @ 1g/l

**Harvest:** Flowering starts 3 months after planting. Flowers are harvested when 2-3 rows of ray florets are perpendicular to the stalk.

**Yield:** Average yield under polyhouse is 200 - 250 flowers/m<sup>2</sup>/year. Crop can be maintained for 2 years.





**China Aster: *Callistephus chinensis*; Asteraceae**

**Varieties:** Kamini, Poornima, Shashank, Violet Cushion, Phule Ganesh White, Phule Ganesh Pink, Phule Ganesh Violet, Phule Ganesh Purple.

**Climate:** Prefers cooler climates with day temperature of 20-30°C, night temperature of 15-17°C and relative humidity of 50-60%. Bright sunlight is required for growth and flowering.

**Soil:** Open sunny locations with well drained red loamy soils with pH of 6.0 to 7.0

**Planting Season:** Throughout the year under mild climatic conditions (like Bangalore)

**Propagation and planting:** Propagated through seeds; seed rate is 2.5 - 3.0 kg/ha. 30-45 day old seedlings are transplanted in raised beds of 120 x 60 x 10 cm size.

**Nutrition:** FYM @ 10-15 t/ha is applied during field preparation. NPK recommendation is 180:60:60 kg/ha of which 90:60:60 kg/ha is applied as basal and 90 kg/ha of N is applied as top dressing 40 days after transplanting.

**Irrigation:** Irrigate once in 7 - 10 days depending upon the weather conditions.

**Pinching:** Pinching of growing tips is done 30 days after transplanting to induce lateral shoots.

**Plant protection**

**Pests**

**Semilooper:** Spray Quinalphos @ 1.0 ml/l or Carbaryl @ 1g/l

**Leaf miner:** Spray Monochrotophos @ 0.5 ml/l or Imidacloprid @ 0.5 ml/l

**Diseases**

**Collar and root rot:** Soil drenching with Copper oxychloride @ 2.5 g/l

**Wilt (*Fusarium* sp.):** Soil drenching with Carbendazim 1 g/l

**Harvesting:**

For cut flower : Flowers along with stalks or whole plants are harvested

For loose flower: Individual flowers are harvested with short stems attached

**Yield:** 18 - 20 t/ha.

## Trade Mark of TNAU



## PART VII - PARTICULARS OF IMPROVED VARIETIES OF HORTICULTURAL CROPS

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
<b>A. Fruits</b>				
<b>Mango</b>	PKM.1	Perennial	500 fruits/tree (100 kg/tree)	A high yielder selected from a hybrid (Chinnaswarnareka x Neelum). Regular bearer, fruit is big and sweet in taste.
	PKM.2	Perennial	It yields higher than Neelum and Mulgoa. Each fruit weighs 650-700g	A high yielder selected from a hybrid (Neelum x Mulgoa). Mid season variety, fruit is big and sweet in taste.
	Paiyur.1	Perennial	8.92 t/ha	Dwarf tree, suitable for close planting (400 trees/ha); regular bearer; medium long fruits, oval yellow skin and good taste and keeping quality.
<b>Banana</b>	CO 1	13 - 14 months	22 t/ha	A multiple cross involving Ladan (AAB) as female parent and <i>Musa bulbisiana</i> (BB) and Kadali (AA) as male parents. Akin to hill banana Virupakshi; retains the flavour and taste of Virupakshi and suited to plains.
<b>Sapota</b>	CO 1	Perennial	12 - 20 kg/tree	It is a hybrid between Cricket ball and Oval; small size with sweet taste
	CO 2	Perennial	16 - 25 kg/tree	It is a pure line selection from Baramasi; round shape; bigger than Co.1
	CO 3	Perennial	157kg /tree	It is a hybrid between Cricket Ball and Vavilavalasa. Fruit weight is 133 g. The trees are highly suitable for high density planting. Under high-density planting system it yields 40-50t/ha
	PKM.1	Perennial	236 kg/tree (3500 fruits/tree)	Clonal selection from Guthi; dwarf statured and adaptable to southern and central districts.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	PKM.2	Perennial	80 kg/tree	Hybrid between Guthi and Kirtibarthi. Fruits are bigger in size, oval shaped. Higher TSS.
	PKM.3	Perennial	14 t/ha	Hybrid between Guthi and Cricket ball. Suitable for high density planting. Tolerant to leaf spot and leaf webber.
	PKM.4	Perennial	20.08 t/ha	Open pollinated clone of PKM 1. Distinguishably spindle shaped fruits. Suitable for high density planting The flesh has a light pink colour with pleasant flavour.
	PKM.(Sa) 5	Perennial	18.70t/ha	Selection from OP seedlings of Virudhunagar, Compact tree canopy, cluster bearer, oval shaped fruits, coppery brown flesh, High TSS -25.5 <sup>0</sup> brix Suitable for vertisol and drought areas.
<b>Papaya</b>	CO 1	2.5 years	200 t/ha/2 years	It is a selection from Ranchi. A choice round fruit, dwarf type suited exclusively for table purpose with yellow flesh and good quality.
	CO 2	2.5 years	200 t/ha/2 years Papain 500kg/ha/2 years	A pure line selection suitable for papain as well as table purpose; medium tall variety large sized fruit with yellow flesh.
	CO 3	2.5 years	120 - 150 t/ha/2 years	It involves the parents Co.2 and Sunrise Solo. It is a hermaphrodite type with red flesh and sweet taste exclusively suitable for table purpose. It is a medium tall variety with small sized fruits.
	CO 4	2.5 years	200 t/ha/2 years	It is a hybrid derivative from a cross between Co.1 x Washington. It has purple pigmentation on the stem, petiole, flower stalk etc. Fruits are round with purple tinged yellow flesh. Tree medium tall, suitable for home and kitchen gardens; a table purpose variety.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
	CO 5	2.5 years	Papain 1200 kg/ha/2 year	It is a pure line selection from Washington variety, medium tall with purple pigmentation all over the plant surface; fruits are large, weighs 2 to 2.5 kg/fruit. It gives the highest papain yield of 15 g/fruit. Exclusively suitable for papain extraction only. Not recommended for table use.
	CO 6	2 years	80 - 100 fruits/year	Selection from a giant papaya. Dioecious. Suitable for papain extraction and also for table purposes. Dwarf in stature.
<b>Papaya</b>	CO 7	2 years	140 t/ha/ year	Gynodioecious. Parents involved are Pusa Delicious, Co.3, CP 75 and Coorg Honeydew. Red fleshed. Fruits oblong with an attractive and firm red flesh.
	CO 8	2 years	200-230 t /ha	Dioecious, derived through improvement of CO.2, <b>red pulped</b> , suitable for dessert, papain and processing
<b>Guava</b>	TRY (G) 1	Perennial	16.3 t/ ha	Selection from germplasm, Off season bearing, shiny greenish yellow fruit with desirable aroma, high TSS (10 <sup>0</sup> Brix) & ascorbic acid (180.8 mg/ 100 g edible part), resistant to fruit fly and tolerant to mealy bug, scale, mite and wilt, drought and sodicity tolerant.
<b>Pomegranate</b>	CO 1	Perennial	50 fruits/bush	It is a pure line selection. It is quick growing, high yielding and with attractive fruit colour both exterior and interior. It has soft seeds, with sweet taste and bright pink colour.
	YCD.1	Perennial	60 - 70 fruits/bush	Soft - seeded; clonal selection from local varieties. 20% more than the local. The colour of the pulp is purple. Keeps well for about 5 - 7 days at cold temperature.
<b>Jack</b>	Palur.1	Perennial	80 fruits/tree/yearweighing 900 kg	Clonal selection from Panikkan kuppan local. Suitable for high density planting. Yield fruits in off season also (Nov - Dec). Regular bearing season April - June.

Crop	Name of Variety	Duration (Days)	Yield	Special Attributes
<b>Jack</b>	PLR 2	Perennial	100 - 115 fruits / ha 1600 - 1900 kg / ha	Clonal selection from Pathirakkotai Local, Good quality and bigger sized fruits, highly palatable and edible flakes
	PPI.1	Perennial	107 fruits/tree/year weighing 1018 kg	Clonal selection from Millagumoodu local. Suitable for commercial planting and in Home gardens.
<b>Apple</b>	KKI.1	Perennial	22 t/ha	Selection from Parlin's Beauty. Best adapted to warm winter conditions prevailing in Kodaikanal hills.
<b>Amla</b>	BSR.1	Perennial	155 kg fruits/tree/year	Selection from Thimbam local type. Fruits contain more flesh, less phenol and high ascorbic acid content.
<b>Avocado</b>	TKD.1	Perennial	26.4 t/ha	Suitable for high density planting. Fruits are dark green coloured, round shaped and medium in size.
<b>Fig</b>	Yercaud Timla	Perennial	4000 Nos. per tree per year	It is drought tolerant, high yield, fruits are large and reddish purple in colour.
<b>Custard apple</b>	APK. 1	Perennial	14.9 kg/tree	Clonal selection. Suited to rainfed conditions. Fruit weight 210 g. Sweet in taste.
<b>Manila Tamarind</b>	PKM(MT) 1	Perennial	79 kg/tree/year	Open pollinated selection from Soolakarai, regular and cluster bearere, 30 % higher yield compared to local , suits well for sandy, alkaline & saline soil.
<b>Vegetables</b>				
<b>Tomato</b>	CO 1	135	36.0	A pureline selection isolated from American variety "Pearl Harbour". Round fruits, light green when unripe and red at ripening, bears in clusters.
	CO 2	145	42.0	It is a selection from a Russian introduction. Fruits ovate, large and flat.
	CO 3	110	50.0	CO.3 (Marutham) was evolved through induced mutation by treating the seed of CO.1 tomato (IM 39) with EMS. Dwarf plants fruits globular and red; bears in clusters of 4 - 5 fruits. Suitable for summer.
	PKM1	135	32.0	It is an induced mutant from a local variety called Annanji. Determinate plants; fruits flattish with ridges. Suited for long distance transport.
	Paiyur1	130	32.0	It is a hybrid derivative of a cross between Pusa Ruby and CO.3 (Marutham).A hybrid derivative



				suitable for irrigated and rainfed conditions of Dharmapuri district. Fruits are round, smooth fleshy and suitable for long distance transport.
	COTH1	110 - 115	95.9	F <sub>1</sub> hybrid developed by crossing IHR 709 x LE 812. Plants are semi determinate. Fruits are medium sized, bright red, smooth, round to slightly oblong and born in clusters of 4 - 5.
	COTH 2	110-120	90.2	F <sub>1</sub> hybrid developed by crossing LCR2 x CLN 2123A. Semi determinate. Fruits are smooth, round to slightly oblong, medium sized. Resistant to leaf curl virus.
	TNAU Tomato Hybrid CO3	145-150	96.2	F <sub>1</sub> hybrid developed by crossing HN2xCLN 2123A semi determinate. Fruits are medium sized, smooth round borne in clusters of 3-5. Resistant to leaf curl virus and moderately resistant to root knot nematode.
<b>Brinjal</b>	CO 1	100	24.0	It is a pureline selection. Fruits light green with white - base and oblong. Medium sized fruits (50-60g); good keeping quality.
	MDU1	135	34.0	A selection from Kallampati local type near Madurai. Fruits round, bright purple and weight 280 g.
	PKM1	150	34.0	It is an induced mutant of a local type called 'Puzhuthi kathiri'. Fruits are medium sized, 45 - 65g; drought tolerant and can withstand long distance transport.
	CO 2	150	35.0	It is a pureline selection from the local variety 'Varikkathiri' of Negamum, Coimbatore district. Fruits are oblong with brown stripes. Suitable for Periyar and Coimbatore districts.
	KKM1	130 - 135	37.0	KKM1 is a pure line selection from Kulathur local near Tirunelveli. Fruits egg shaped, milkywhite , borne in clusters of 2 - 4.
	COBH 1	120-130	56.0	It is a F <sub>1</sub> hybrid between EP 45 x CO.2 released from HCRI, Coimbatore. Fruits are slightly oblong, glossy violet.
	PPI 1	185	45.0	PPI 1 is a single line selection (PPI (B) 1) from Karungal local type Vazhuthunangai. Fruits are oblong, pale green and moderately resistant to shoot and fruit borer and wilt

	COBH 2	120-130	58-60	F1 hybrid developed by crossing EP65xPusa Uttam. Fruits are medium sized, oblong in shape, dark violet, weighing 55 to 60g.
	PLR (BR) 2	145	38.0	Single plant selection from Sevanthampatti local. Fruits are oval in shape, dark purple with pink tinge and glossy
	TNAU Brinjal VRM 1	140-150	40-45	Pureline selection. Fruits are oval in shape, glossy pink with green tinge at the distal end.
<b>Bhendi</b>	CO 1	90	14.0	CO 1 is a pureline selection from the 'Red Wonder' introduced from Hyderabad. Plants medium tall; pods pink, long tender and less fibrous; tolerant to yellow vein mosaic.
	CO 2	90	16.51	It is a F1 hybrid between A.E. 180 and Pusa Sawani. Fruits fairly long with hairy surface.
	CO 3	90	16 - 18	It is high yielding F1 hybrid between Parbhani Kranti x MDU.1 (Hy.8). Fruits medium sized and dark green . Moderately resistant to yellow vein mosaic disease.
	COBhH 1	120	22.1	F <sub>1</sub> hybrid developed by crossing Varsha Uphar x PA 4(T) Dark green long fruits, slender, less fibrous and sparsely pubescent. Resistant to YVMV disease.
<b>Chilli</b>	CO 1	210	2.1	It is a reselection from Sattur Samba [CA (p) 247]. Fruits long and red at ripening; seed content 55%; samba type.
	CO 2	210	2.2	CO 2 is a selection from Nambiyur local 'Gundu' type of Erode district of Tamil Nadu [CA (p) 63]. Fruits oblong and bright red on ripening; seed content 60%, gundu type
	K1	210	1.8	K1 is a pure line selection from local Sattur Samba developed at Agricultural Research Station, Kovilpatti. Plants bushy; pods green; long samba type; dark red on ripening.
	K2	210	1.98	A hybrid derivative of the cross between B.70 A (Assam type) x Sattur Samba. Plants tall, compact, pods long and bright red on ripening; samba type; high seed content.

	PMK.1	200	2.36	It is a hybrid derivative of a cross CO.2 x Ramanathapuram gundu (Local) and released from the Agricultural Research Station, Paramakudi. Suitable for semi-dry condition. Fruits contain high capsaicin 0.36%, gundu type.
	PKM 1	180	Dry pod yield 3.08	This is a hybrid derivative of the cross between AC. No. 1797 x CO.1 selected in F4 generation and fixed by selfing and released from the Horticultural College and Research Institute, Periyakulam. It is suitable for cultivation under irrigated conditions. Bold pods, which are dark red in color. The number of pods per plant is 204 with 85 seeds per fruit.
	MDU.1	215	1.8	It is an induced mutant from K.1 chillies by using 30 KR of gamma rays. Determinate growth. Fruits borne in clusters of 4 - 9. Fruits are long, dark red and shiny.
	CO 3	165	3 - 3.5	CO 3 is a selection from an open pollinated type introduced from Sri Lanka (CA, 856). Fruits long, slender and dark green. Suitable for export.
	PLR1	210	18.4 (green chilli)	Pureline selection [CA (Q) 8] from Kanchengadu local. Suitable for green chilli.
	CO 4	165	2.3 (green chilli)	It is a pureline selection made from an open pollinated type introduced from Sri Lanka released from the Horticultural College and Research Institute, Coimbatore. Vegetable chilli, fruits are dark green, less pungent and suitable for high density planting
	TNAU Chilli Hybrid Co1	180 days	28.1 (green chilli) 6.74 (dry chilli)	F <sub>1</sub> hybrid developed by crossing Selection 1 x CA97. Fruits are long, smooth and dark green. It possesses 0.58% capsaicin. Suitable for green and dry chilli. Moderately resistant to fruit rot.
<b>Pumpkin</b>	CO 1	175	30.0	It is a selection from local type. Fruits are globular, large sized (8 - 10 kg); light pink skin and yellow flesh..
	CO 2	135	23.0	CO 2 is a selection from a local type. Fruits small (1.5 kg), flattish round, light brown skin and yellow flesh.
<b>Snake</b>	CO 1	135	16.0	It is a pureline selection from one of the types

<b>gourd</b>				collected from Alangulam, Tirunelveli district. Fruits long (160 - 180 cm) green with white stripes, each weighs 500 -750 g, smooth flesh of less fibre; moderately resistant to powdery mildew.
	PKM1	145	26.0	PKM1 is an induced mutant from H.375. Fruits dark green with white stripes; each weighs 700 g; suitable for growing all through the year.
	MDU1	143	32.0	Hybrid between Panri pudal x Selection 1. Vine-less spreading with moderate branching; flowers in 56 days; fruits are short (40 cm) and weighs 550 g.
	CO 2	105	36.0	CO 2 is a pureline selection from a local type of Coimbatore district. Fruits are short and stout weighing 400 to 600 g, light green to white. Does not require pandal.
	PLR (SG)1	135	35.0	It is a pure line selection from white long type. Fruits are white, long, excellent cooking quality, less fibre and do not twist due to maturity.
	PLR (SG) 2	130	35.0	Selection. Fruits are plumpy, fleshy and white, less fibre.
<b>Ribbed gourd</b>	CO 1	125	14.0	CO 1 is a selection from the type collected from Aduthurai. Fruits long (60 - 75 cm) light green and weighs 300 g each.
	CO 2	120	25.0	It is a selection from a germplasm type. Fruits are very long (1 m) green and fleshy.
	PKM.1	160	28.0	PKM.1 is an induced mutant from the type H.160. Fruits long, dark green with shallow grooves.
<b>Bottle gourd</b>	CO 1	135	36.0	A selection from a germplasm type. Fruits round at the base and bottleneck at the top, light green, each weighs 2 kg.
	TNAU Bottle gourd Hybrid CO	100 - 110	79.03	F <sub>1</sub> hybrid developed by crossing NDBG 121 x Arka Bahar. Fruits are cylindrical, without crook neck, medium sized (0.95-1.00 kg) and suitable for nuclear family. Suitable for bower system of cultivation.

	1			
<b>Bitter gourd</b>	CO 1	115	14.0	CO 1 is a selection from a local type collected from Thudiyalur (Long Green). Fruits green, 30 - 35 cm long, 100 - 200 g each.
	MDU.1	140	32.0	It is an induced mutant developed by gamma irradiation to local cultivar (MC 103). Fruits green and each weighs 410 g.
	COBgoH 1	120	44.0	COBgoH 1 is a F1 hybrid developed by a crossing MC.84 x MDU.1. Fruits creamy white and weigh 300g each.
<b>Ash gourd</b>	CO 1	150	25.0	It is a selection from a local type from Tamil Nadu. Fruits globular, green, large, oblong - oval in shape, ash coated, weighing 6 - 8 kg.
	CO2	120	20.0	CO2 is a selection from Coimbatore local. Small fruited, weighing 2-3 kg. Fruits are oblong or cylindrical and compressed on both sides
	TNAU Ash gourd Hybrid CO 1	130 - 135	91.82	F <sub>1</sub> hybrid between PAG 3 x CO 2. Fruits are oblong and medium sized and suitable for small family.
<b>Coccinia</b>	TNAU Coccinia CO1 1	Perennial	83.09 (per/year)	Clonal selection from Anaikatti type. Fruits are long, green with white stripes, less seeded and sweet (4.5° Brix). Suitable for culinary purpose.
<b>Cucumber</b>	CO 1	100	25 - 28	CO 1 is a selection from a local type of Kanyakumari District. Ripe fruits are bright yellow with greenish yellow intermitant stripes.
<b>Watermelon</b>	PKM.1	120	37.0	A selection from a local type. Suitable for arid, semi-arid, irrigated conditions; pulp pink in colour; high TSS (9.2° Brix).
<b>Butter Beans</b>	KKL.1	140	3.47	KKL 1 Butter beans are a selection from a type collected from Vilpatti. White seed; good cooking



				quality, suitable for hilly regions (1200 - 2000 m)
<b>French Bean</b>	TKD.1	90	5.6 green pods 2.78 dry seeds	Pole type selected from germplasm population at Horticultural Research Station, Thadiyankudisai. Pods are less fibrous. Seeds turn white on maturity.
	YCD.1	105	9.7 green pods 6.3 dry seeds	A pure line selection from a local indigenous type collected from Shevroy hill ranges of Tamil Nadu. Plants are semi dwarf and bushy. Pods are slightly flat, long, broad and robust.
<b>Peas</b>	Ooty 1	90	12.1	It is a pureline selection (PS-33-1). Plants dwarf. Pods long and dark green.
	Pole type Ooty 1	80	33.7	Pure line selection. Plants grow to 2m tall. Pods are fleshy and stringless.
<b>Dolichos Bean</b>	CO 1	210	18 green pods	CO 1 is a pureline selection ( <i>Dolichos lablab</i> var. <i>typicus</i> ) from a type collected under All India Co-ordinated Vegetable Improvement Project. Pods are dark green, flattish and slightly curled, tender and fleshy.
<b>Moringa Beans</b>	KKL 1	140 - 160	7 green pods	A pureline selection from local type collected from Pallangi village of Kodaikanal taluk. Pods are fleshy and thick skinned.
<b>Vegetable cowpea</b>	TNAU Vegetable Cowpea PKM -1	125 -130	25 green pods	Pureline selection, Semi trailing with very long pod(40-45cm) green pod yield 25 t/ha.
<b>Annual Moringa</b>	PKM.1	2.5 years	52.8	Pure line selection from Eppodumvendran of Tirunelveli district. Pods are 70 cm long weighs about 150 g.
	PKM 2	2.5 years	96.0	PKM 2 is a hybrid derivative developed by cross between MP31 (Eppodumvendran local) x MP28 (Arasaradi local) at Horticultural College and Research Institute, Periyakulam. Pods are 120 cm, long weighs about 370 g.
<b>Radish</b>	CO 1	45	22.0	Selection from germplasm type (RS 44). Roots milky



				white, less fibrous; suitable for growing throughout the year; set seed in plains.
<b>Beetroot</b>	Ooty.1	120 - 130(direct sown) 135 -150 (transplanted)	31.45	Ooty.1 is a selection from the local type. Roots are blood red colour with thin skin and good quality.
<b>Garlic</b>	Ooty.1	120 - 130	17.1	Clonal selection from the germplasm assembled at Horticultural Research Station, Ooty. Bigger bulbs weighing 30 - 40 g each.
<b>Palak</b>	Ooty.1	2 years	15 (leaves)	Higher carotene content. Rich in vitamins.
<b>Cauliflower</b>	Ooty.1	110 - 120	46.4	It is a selection from OP progenies of local types and released from Horticultural Research Station, Ooty. Compact uniform curds with attractive creamy white colour. Curd is free from ricyness and have good keeping quality.
<b>Sweet potato</b>	CO 1	135	28.0	CO 1 is a clonal selection (IB 3) from a type collected from Tiruchirapalli district. Tolerant to root weevil; tubers with light pink skin and white flesh; starch content 24%
	CO 2	115	32.0	Clonal selection (IB 81) of seedling progeny obtained from open pollinated seeds of a type (IB 37) in germplasm bank. Tubers with light pink skin and white flesh; starch content 30%; tolerant to root weevil.
	CO 3	110	42.0	Seedling clone (IB 2837) obtained from the seeds of random mating population of IB 758. Tolerant to root weevil; tubers - light pink skin and orange flesh; high carotene content.
	CO CIP-1	95 - 100	32.0	It is a clonal progeny of IB 90-10-20. Short duration, resistant to root weevil, high market value.
<b>Tapioca</b>	CO 1	270	30.0	CO 1 is a clonal selection from a local type (ME 7) collected from Tiruchirapalli district. Tuber with whitish brown skin and white flesh; starch content

				35%; field tolerance to mosaic virus; suitable for consumption and industries.
	CO 2	240-270	36.0	Clonal selection (ME 167). Branching type, flowers easily. Tubers with whitish grey and skin and creamy white flesh; starch 34.5%; moderately tolerant to mosaic virus; suitable for consumption and industries.
	CO (TP) 4	240	50.0	Shorter crop duration, erect with branching habit, high starch (40%) and suitable for irrigated and rainfed cultivation
	CO 3	240	43.0	Clonal selection (ME 120-1) from seedling progenies of open pollinated seeds obtained from IITA, Ibadan, Nigeria. Shorter crop duration, branching type; high starch - 36% suitable for irrigated and rainfed cultivation..
	TNAU CTCRI Co (Tp)5	275-300	38.0	An exotic germplasm introduced from CIAT, Cali, Colombia (MNga-1). Exotic germplasm introduced from CIAT, Colombia. Tubers are long cylindrical, white flesh. It contains 28% starch. Resistant to cassava mosaic disease.
<b>Dioscorea</b>	CO 1	240 - 255	44.8	Tubers are bigger with white flesh.
<b>Coleus</b>	CO 1	180 - 190	31.93	CO 1 is a clonal selection from local type introduced from Tenkasi. Tubers have 21.5% starch.
<b>Onion</b>	CO 2	65	12.0	CO 2 is a selection from a germplasm type C.S. 911. Bulbs bigger (10 - 15 g) and crimson in colour; photo-insensitive type.
	CO 3	65	16.0	Clonal selection from open pollinated progenies of C.S. 450. Bulbs light pink, bold (10-15 g) bulbs store well for 120 days.
	CO 4	65	19.0	Hybrid derivative of the cross AC863 x CO.3. Bulbs light pink, bold (12-15 g) with better consumers' appeal; bulbs store well for 150 days.
	CO(On) 5(Seed propagat	90	Seed yield 300 kg/ha Bulb yield 18.9	High yielding variety developed by mass pedigree method of selection. Bulbs redish pink, bold, 80-90 g/cluster

	ed)			
<b>Amaranthus</b>	CO 1	20-25	7.0	It is a selection from a type collected from Tirunelveli ( <i>Amaranthus dubius</i> Mart exThell.). Can be grown throughout the year (25 days - Mulaikeerai) (50 - 60 days for Thandukeerai)
	CO 3	90	31.0	It is a selection from the local type. Plants dwarf; clipping type.
	CO 4	90	2.5 t grains	CO 4 is a green cum grain type from <i>A. hypochondriacus</i> L. A grain amaranthus type, seeds are rich in protein (19.55 %) and aminoacid like lysine (7.5 mg per 100 g) can be substituted for minor millet like Ragi and Thenai
	CO 5	120	10 Mulaikeerai 30 Thandukeerai	CO 5 is a single plant selection from germplasm (A 166-1). Single plant selection from A-166-1. Double coloured type with dual purpose. Suitable for container cultivation.
<b>C. Spices and Condiments</b>				
<b>Coriander</b>	CO 2	90-100	400-500 and 600-800 kg of grains/ha under dry and irrigated conditions respectively.	It is a dual purpose variety suitable for saline, alkaline and drought prone areas.
	CO 3	85 - 95	650 kg grains/ha	Dual purpose, suitable for irrigated and rainfed condition & field tolerant to powdery mildew, wilt & grain mould.
<b>Tamarind</b>	PKM.1	Perennial	263.3 kg/tree	Bear fruits in clusters of 3 - 7 and the fruits are characteristically semicircular in shape. 39% pulp recovery.
<b>Turmeric</b>	BSR.2	240 - 250	32. 7 t fresh rhizome/ha	Medium statured. Resistant to scale insects.
<b>Fennel</b>	CO 1	210 - 220200-215	566 kg/ha grain	Suited for growing in plains as well as in lower hill slopes under irrigated and rainfed conditions. It can be grown as border crop with other long duration crops, and as intercrop in young plantation of

<b>Fenugreek</b>	CO 1	80 - 90	600 kg of grains/ha	Dual purpose, early maturing, tolerant to root rot disease.
	CO 2	85 - 95	480 kg bf grains/ha	Suitable for kharif & Rabi season, short duration, dual purpose, field tolerant to root rot disease.
<b>Cinnamon</b>	YCD.1	Perennial	3800 kg dried leaves per ha 359.75 kg quills per ha	Quills of sweet and light pungent.
<b>D. Plantation Crops</b>				
<b>Cashew</b>	VRI.1	Perennial	7 kg nuts/tree/year	A high yielder bearing good quality nuts suitable for
	VRI.2	Perennial	8 kg nuts/tree/year	A seedling selection, bearing high jaggery percentage of perfect flowers, with medium sized nuts and high shelling percentage (28%). Variability in seedling
	VRI.3	Perennial	14.19 kg nuts/tree/year	Larger nuts. Shelling - 29.1 %
<b>Palmyrah</b>	SVPR.1	Perennial	298 lit padaneer per palm/year 140 fruits/palm/year	It is semi dwarf, high jaggery content of 144 g/lit, high recovery of 13.16%, high brix value 13.3°C
<b>Betelvine</b>	SGM(BV)-2	2-2.5 years	49 lakh leaves/ha	Vines are straight with more branches, leaves are dark green in colour. Resistant to nematode and scales. They have mild pungency with good checking quality.
<b>Coriander</b>	CO(CR)-4	65-70	600 kg/ha of grains	Early maturing, suitable for both rainfed & irrigation condition, field tolerant to wilt & grain mould
<b>Turmeric</b>	CO -2	250-260	42 tonns fresh rhizome /ha	High curcumin content (4.02%), highly resistant to rhizome rot, field tolerant to thrips, shoot borer, leaf folder & scale insects
<b>Cinnamon</b>	PPI (ci) - 1	Perennial	248.42 kg of quills & 731.58 kg of chips/ha	Tolerant to drought, suitable for coppicing with an interval of 18-24 months, adopted at lower elevation
<b>Cashew</b>	VRI-4	Perennial	18.10 kg nuts/tree/year	Medium size nuts, shelling -285% suitable for low rainfall tracts.

<b>Betelvine</b>	SGM-1	2-2.5 years	65 lakh leaves / ha	Vines are dwarf vigorous, bushy in growth. Leaves posses attractive yellowish green colour with desirable pungency. Moderately resistant to wilt.
	SGM-2	2-2.5 years	49 lakh leaves/ha	Vines are straight with more branches, leaves are dark green in colour. Resistant to nematode and scales. They have mild pungency.
<b>E. Commercial Flowers</b>				
<b>Hybrid Rose</b>	YCD 1 1985	Perennial	100-120 flowers/bush/year	<ul style="list-style-type: none"> <li>- Suitable for hilly regions of above 1500 m elevation</li> <li>- It is a free bloomer, good for bedding and decorative purposes</li> <li>- Flowers medium sized (7-8 cm diameter)</li> <li>- Mostly bears in clusters</li> <li>- The colour of the flowers is pleasing yellow</li> </ul>
	YCD 2 1991	Perennial	150 - 200 Nos/bush/year	<ul style="list-style-type: none"> <li>- Suitable for 1000 - 2000 m elevation</li> <li>- Unopened flower bud is bright yellow with a scarlet red tinge at the tip and the fully opened flower is in pleasing scarlet colour</li> </ul>
<b>Mullai (<i>J. auriculatum</i>)</b>	Parimullai 1972	Perennial	8 t/ha	<ul style="list-style-type: none"> <li>- A selection from a medium point type</li> <li>- Resistant to gall mite</li> <li>- Medium long corolla tube</li> <li>- Buds are white with moderate corolla tube length (1.25 cm) The concrete recovery is 0.29</li> </ul>
	CO 1 Mullai 1980	Perennial	10 t/ha	<ul style="list-style-type: none"> <li>- It is a secondary clonal selection from a local type</li> <li>- It has bold flower buds with long corolla tube (1.50 cm) than Parimullai.</li> <li>- It enables easy tying in garland making</li> <li>- Suitable for fresh flower marketing</li> <li>- Concrete recovery is 0.34 per cent</li> </ul>
	CO 2 Mullai 1988	Perennial	11.1 t/ha	<ul style="list-style-type: none"> <li>- It is a clonal selection with long corolla tube (1.70 cm) and longer bud</li> </ul>

<b>Pitchi</b> <i>J. grandiflorum</i>	CO 1 (Pitchi) 1980	Perennial	11 t/ha	<ul style="list-style-type: none"> <li>- It is a secondary clonal selection with long corolla tube</li> <li>- Flower buds have pink tinch</li> </ul>
	CO 2 (Pitchi) 1991	Perennial	11.68 t/ha	<ul style="list-style-type: none"> <li>- It is an induced mutant (IM 3) developed by treating the vegetative cuttings of CO 1 Pitchi with gamma ray @ 1.5 kR</li> <li>- The flower bud is 4.41 cm in length and the variety is amenable for earlier and quicker tying of buds in garland making</li> </ul>
<b>Chrysanthemum</b>	CO 1 1985	180-220	16.7 t/ha	<ul style="list-style-type: none"> <li>- It is a selection made from Hosur</li> <li>- Flowers are medium sized (2.5 g) and attractive canary yellow in colour</li> <li>- The flowers have thick, sturdy stalks, which are all an added</li> </ul>
	CO 2 1989	190	20 t/ha	<ul style="list-style-type: none"> <li>- It is a clonal selection and the flowers are rhodamine purple in colour</li> </ul>
	MDU 1 1985	180-200	30.6 t/ha	<ul style="list-style-type: none"> <li>- It is a selection and an early flowering type</li> <li>- The flowers are large and attractive sulphur yellow in colour with a diameter of 3.90 cm.</li> </ul>
<b>Marigold</b>	MDU 1 1986		41.54 t/ha	<ul style="list-style-type: none"> <li>- It is a selection and the plants are medium tall with moderate branching habit</li> <li>- The flowers are large with a stalk length of 8.39 cm with the light orange colour petals</li> </ul>



<b>Gerbera</b>	YCD1 1992	Perennial	60 flowers/plant/year	<ul style="list-style-type: none"> <li>- It is a clonal selection and the flowers are double in form with cherry red colour</li> <li>- Free from the disorders like bent neck, petal necrosis (during vase life) and temporary wilting in field are absent</li> <li>- Plants flower earlier (within 45 days after planting) and produce about 60 flowers per plant per year</li> <li>- Flowers have a retentivity of 8 days on the plant with a vase life of 7 days</li> </ul>
	YCD 2 1995	Perennial	80 flowers/plant/year	<ul style="list-style-type: none"> <li>- It is a cut flower variety and rosy pink in colour and the flowers have a vase life of 15 days in hills and 10 days in plains</li> </ul>
<b>Hibiscus</b>	CO 1 Thilagam	Perennial	3000 flowers/bush/year	<ul style="list-style-type: none"> <li>- It is an inter-generic hybrid between <i>Hibiscus rosasinensis</i> and <i>Malvaviscus arboreus</i></li> <li>- It is a woody perennial shrub with an erect</li> </ul>
	CO 2 (Punnagai)	Perennial	1000 flowers/bush/year	<ul style="list-style-type: none"> <li>- It was evolved by selection from the open pollinated seedlings of 'Chandrika' variety</li> <li>- The plants are semi spreading, growing upto</li> </ul>
	CO 3	Perennial	1300 flowers/bush/year	<ul style="list-style-type: none"> <li>- It is a clonal hybrid between Bright Yellow and Red Gold cultivars</li> <li>- It is floriferous and Apricot yellow in colour</li> </ul>
<b>Gladiolus</b>	KKL1	Perennial	21.1 t/ha	<ul style="list-style-type: none"> <li>- It is an improved selection from the cv. American Beauty</li> <li>- Mean spike length is 89.4 cm and the average</li> </ul>
<b>Barlaria</b>	CO 1	Perennial	9.4 t/ha	<ul style="list-style-type: none"> <li>- It is a clonal selection from the local type</li> <li>- It produces flowers early</li> </ul>
<b>Medicinal &amp; Aromatic Crops</b>				
<b>Geranium</b>	KKL-1	6 years	45.8t herbage /ha/year	Vigorously growing plant with palmately lobed and yellowish dark green leaves. Oil yield 54.4 kg/ha/year.
<b>Rosemary</b>	Ooty-1	12 years	12.4 t leaves per ha/year	High rosemary oil content 0.9 %. Suitable for dry farming in high and middle elevation. Resistant to leaf

<b>Thyme</b>	Ooty-1	7-8 years	10.7 t/ha green leaves /year	High thymoil content 0.7 %. Suitable for dry farming in high and middle elevation. Resistant to leaf blight
<b>Senna</b>	KKM-1	5-6 months	918 kg green leaves/ha 352 kg pod/ha	Selection from Thenkalam local (Thirunelveli), recording 38.5 per cent higher leaf yield and 69.88 per cent higher



## Trade Mark of TNAU



# Part VIII

## Drip irrigation for fruit crops

Drip irrigation offers scope for enormous savings in water usage and it is the most useful system to boost horticultural production in areas with limited water resources. Research work carried out at TNAU indicates the saving in irrigation water ranges from nearly 40 to 68 per cent with an additional yield benefit of 14-98 per cent over the conventional irrigation methods. Drip irrigation can be thought of in rainfed areas with meager water resources available during the periods other than the rainy seasons. Most of the fruit crops require drip irrigation during the period of flowering to fruit development in order to increase the fruit set and improve the fruit size reflecting on final yield. However, the drip irrigation has to be dispensed 10 – 15 days before the expected harvesting period in order to improve the sweetness of the fruits. Daily water requirement of various fruit crops are given below:

Crops	Water requirement (lit/day/plant)
Mango	30-50
Banana	20-25
Citrus	22-30
Guava	22-30
Sapota	20-30
Amla	15-25
Grapes	15-25
Papaya	15-25

For the young tree which are in their pre bearing stage, 1/3rd of the recommended dose of water may be given and slowly increased to reach the above level during full bearing.

# Part IX

## Organic Cultural Practices

### 1.FRUIT CROPS

Organic farming is a method of farming which avoids or largely excludes the use of harmful chemicals such as chemical fertilizers, pesticides and herbicides and use of natural resources such as organic matter, minerals and microbes to maintain the environment clean, ecological balance and to provide stability to the production level without polluting soil, water and air. Organic farming system relies on large-scale application of animal wastes or farm yard manure, compost, crop rotation, crop residues, green manure, vermicompost, bio-fertilisers, VAM, bio-pesticides and biological control. The primary requirement for organic manuring sources are presented below:

#### 1.Farm yard manure

S.No.	Crop	First year (kg/tree)	Annual increase (kg/tree)	6th year onwards (kg/tree)
1.	Mango	10.00	10.00	50.00
2.	Sapota	10.00	10.00	50.00
3.	Citrus	10.00	5.00	30.00
4.	Guava	10.00	5.00	30.00
5.	Grapes	50.00	50.00	100.00 3rd year onwards
6.	Papaya	10.00	5.00	30.00

Besides FYM the following quantity of organic manures may be recommended (kg/tree)

Neem cake	0.5	0.5	3.5
Compost	0.5	0.5	3.5
Green leaf manure	0.5	0.5	3.5

#### Bio fertilizers

S.No.	Particulars	First year(kg/tree)	Annual increase (kg/tree)	6th year onwards (kg/tree)
-------	-------------	---------------------	---------------------------	----------------------------

1.	VAM	0.200	0.200	1.0
2.	Azospirillum	0.05	0.025	0.2
3.	Phosphobacteria	0.05	0.025	0.2

Trade Mark of TNAU





## II VEGETABLES

### Seed treatment

Seed treatment with *Trichoderma viride* @ 4 g or *Pseudomonas fluorescens* 10 g/kg of seeds. Seed treatment with *Azospirillum* @ 200 g/kg of seeds.

### Nursery

Apply 10 kg of FYM, neem cake 50 g, *Azospirillum* 5g, Phosphobacteria 5g and VAM 60g/m<sup>2</sup>.

### Main field

Seedling dip with *Azospirillum* (400 g)

Apply *Azospirillum* @ 2kg, Phosphobacteria @ 2 kg and VAM @ 4 kg/ha

FYM 25 t/ha; composted coirpith 10 t/ha.

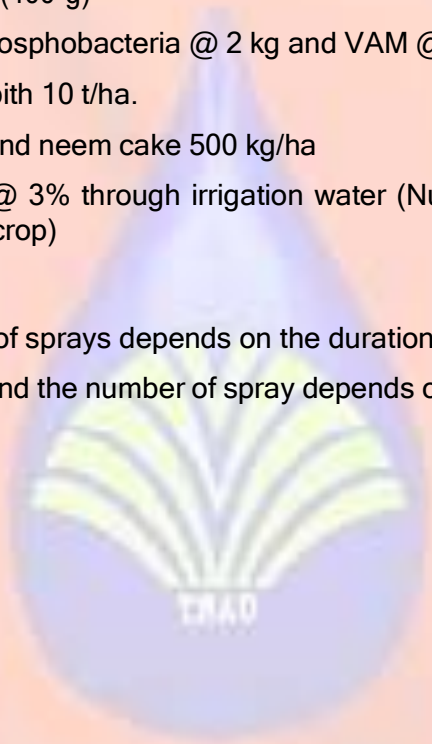
Vermi compost @ 2 tonnes, and neem cake 500 kg/ha

Application of Panchakavya @ 3% through irrigation water (Number of application and interval based on duration of crop)

### Foliar spray

Panchakavya @ 3% number of sprays depends on the duration of the crop.

Moringa leaf extract @ 10% and the number of spray depends on the duration of the crop.



# Part X

## Protected Cultivation in Vegetables (for Information)

### I. Tomato

**Greenhouse structure:** Low cost polyhouse with natural ventilation

**Hybrids:** SH 7711

**Nursery:** Protrays Soil: Compost:Cocopeat (1:1:1) + *Azospirillum* (50 g/sq.m) + Phosphobacteria (50 g/sq.m) + VAM (200 g/sq. met.).

**Growing medium:** Soil:Compost :Cocopeat (2:1:1)

**Irrigation regime:** 20 KPa (Kilo Pascals)

**Integrated Nutrient Management (INM)**

- a) Basal 50 Kg/ha K (MOP) + *Azospirillum* (10 g/m<sup>2</sup>) + Phosphobacteria (10 g/m<sup>2</sup>) + VAM (50 g/m<sup>2</sup>).
- b) Fertigation @ 250:250:250 Kg NPK /ha with water-soluble fertilizers.

**Mulching:** Black polyethylene mulch 50-micron (200 gauges) thickness.

**Training:** The plants have to be trained to 2 stems using rope or string.

**Duration:** 180 days including nursery period of 25 days.

**Yield:** 140-150 t/ha.

### II. CAPSICUM (BELL PEPPER / SWEET PEPPER)

**Greenhouse structure:** Low cost polyhouse with natural ventilation

**Hybrids:** Indra

**Nursery:** Protrays, Soil:Compost:Cocopeat (1:1:1)

**Growing medium:** Soil:Compost:Cocopeat (2:1:1)

**Irrigation regime:** 20 KPa (Kilo Pascals)

Trade Mark of TNAU



### **Integrated Nutrient Management (INM)**

- a). Basal 50 Kg/ha NPK with straight fertilizers
- b). Fertigation @ 150:150:150 Kg/ha NPK with water soluble fertilizers. **Mulching:** Black polyethylene mulch 50 micron (200 gauge) thickness. **Training:** The plants have to be trained to 4 stems using rope or string. **Duration:** 180 days including nursery period of 35-40 days. **Yield:** 120-130 t/ha.



# Part XI

## Seed Production Technology of Horticultural Crops

### TOMATO

**Season :** November - March; June - July

**Seed rate:** 300 g/ha.

#### Pre-sowing seed treatment

- Seed fortification with 1000 ppm gelatin or 2 %  $\text{KNO}_3$  or 200 ppm salicylic acid (soaking in double the volume for 12 h) followed by coating with carbendazim (2 g / kg) + imidachloprid (6 g / kg) + polymer (20 g / kg of seed in 40 ml of water). (or)
- Coating with white red polykote (6 g / kg of seed) + *Pseudomonas fluorescens* (10 g / kg), *Trichoderma viride* (4 g / kg) + DAP (4 g / kg) + MN mixture (20 g / kg). (or)
- Soak the seeds in 50 per cent coconut water for 12 h.

#### Nursery treatment:

For controlling the nematodes, the nursery should be drenched with Metham sodium @ 28 ml/sq.m. (VEPAM) 15 days before sowing, and with Copper oxychloride @ 2.5 g/lit after 7 days to prevent damping off.

#### Age of seedling:

25 - 30 days.

#### Spacing:

CO 1	: 60 x 60 cm
PKM 1	: 75 x 60 cm
CO 2	: 80 x 75 cm
Pusa Ruby	: 80 x 70 cm
CO 3	: 60 x 30 cm

#### Fertilizers:

Basal: FYM - 25 t/ha, 75: 100: 100 NPK kg/ha

Top dressing: At the time of flowering with 75 kg N.

#### Foliar application:

NAA @ 20 ppm at 65 and 75 days after transplanting.

## Trade Mark of TNAU





**Harvest:**

Seeds attain physiological maturity 30 – 35 days after flowering. Fully matured, red, ripened and healthy fruits alone should be harvested. First 7 - 8 pickings should be used for seed extraction.

**Seed extraction:**

Well-matured fruits are crushed and made into pulp. For every 1 kg of pulp 25 - 30 ml of commercial HCl acid should be added and left for 30 min. with constant stirring. At the end of 30 min. the seeds are washed for 3 - 4 times with water and shade dried for one day followed by mild sun drying to reduce the moisture content to 7 - 8%

**Grading:**

Seeds are graded with BSS : 12 x 12 wire mesh (2.1 mm) sieve.

**Seed yield:**

150 kg/ha

**Storage:**

Seeds dried to 7 - 8 % moisture are treated with carbendazim 50 % WP @ 2 g / kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + Arappu leaf powder @ 5:4:1) @ 3 g/kg seed or with white polykote @ 6 g + carbendazim 2 g + Dimethoate 5 ml / kg of seeds using 5 ml water. The treated seeds can be stored upto 12 months in aluminium foil pouches.

**BRINJAL****Season:**

June - July.

**Seed rate:**

450 g/ha.

**Nursery preparation:**

For controlling the nematodes, the nursery should be drenched with Metham sodium @ 28ml/sq.m.(VEPAM) 15 days before sowing and drenched with Fytolan @ 2.5 g/lit of water 7 days after sowing against damping off disease.

**Age of seedling :**

30 - 35 days.

**Fertilizers**

Basal: FYM: 25 t/ha ; 50 : 75 : 75 kg NPK/ha

Top dressing: 50 kg N/ha just before flowering.

**Spacing:**

75 x 60 cm.

**Foliar application:**

At 65 and 75 days after transplanting , NAA @ 20 ppm is sprayed against flower drop.

**Harvest:**

Seeds attain physiological maturity 40 - 45 days after flowering. The symptom of harvestable maturity is turning of the skin colour of the fruit from green to bright yellow. Medium size fruits yield more quantity and quality seeds than big or small fruits. Fruits harvested in the first five pickings alone can be used for seed purpose.

**Seed extraction:**

The well-ripened fruits are cut into 4 - 6 pieces and softened by soaking in water overnight. During seed extraction the floaters are removed.

**Grading:**

Seeds are graded with 5/64" round perforated metal sieve or BSS 12 x 12 wire mesh sieve (2.1 mm).

**Seed Yield:**

250 kg/ha

**Storage:**

Seeds treated with carbendazim 50 % WP @ 2 g /kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be stored upto 1 year in cloth bag and upto 2 years in moisture vapour proof containers.

**BHENDI****Season:**

March, April and May.

**Seed rate:**

8 - 10 kg/ha.

**Pre-sowing seed treatment**

Sand matrix priming at 60 % water holding capacity for 3 h.

**Spacing:**

60 x 20 cm.

**Fertilizers:**

Basal: FYM : 25 t/ha; 40 : 50 : 30 Kg NPK kg / ha

Top dressing: 20 kg N / ha.

i) 10 kg N/ha at first flowering

ii) 10 kg N/ha 10 days after flowering.

#### **Water Management**

Drip fertigation with recommended P (50 kg/ha) as basal application, N and K as drip fertigation.

#### **Foliar application:**

Commencing with first flowering DAP 0.5 % is sprayed thrice at 10 days interval to enhance the yield of good quality seeds.

#### **Harvest:**

Seed attains physiological maturation 28 - 30 days after anthesis. The pods are harvested as picking when they dry and turn brown and develop hairline cracks along the ridges.

In bhendi, first formed two pickings can be used for vegetable purpose and the next 6 pickings can be used for seed purpose.

#### **Seed extraction:**

Harvested pods are dried in the sun for 2 - 3 days and seeds are extracted either using machine thresher or manually by beating with pliable bamboo stick.

#### **Grading:**

Seeds are graded with 10/64" round perforated metal sieve or BSS 6 x 6 wire mesh sieve (4.2 mm).

#### **Upgrading :**

Empty seeds and are removed by water floatation technique, where sinkers are selected as good seeds and are dried well to lower moisture level of 8 per cent.

#### **Seed Yield:**

700 kg/ha

#### **Pre-storage seed treatment:**

Seeds dried to 8 % moisture content are treated with carbendazim 50 %WP @ 2 g /kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed.

#### **Seed storage:**

Seed treatment with carbendazim @ 2g/kg + imidachloprid @ 1 ml / kg.

Treated seeds can be stored upto 15 months in cloth bag and 24 months in moisture vapour proof containers.

## **CHILLIES**

**Season:**

June - July ; November - December

**Seed rate:**

1 kg/ha.

Trade Mark of TNAU



**Pre-sowing seed treatment**

- Seed fortification with 1000 ppm gelatin or 2 %  $\text{KNO}_3$  or 200 ppm salicylic acid (soaking in equal the volume for 12 h) followed by coating with carbendazim (2 g / kg) + imidachloprid (6 g / kg) + polymer (20 g / kg) of seed in 40 ml of water.

**Nursery treatment:**

For controlling the nematodes, the nursery should be drenched with Metham sodium @ 28 ml/sq.m.(VEPAM) 15 days before sowing and drenched with copper oxychloride @2.5 g/lit after 7 days, to prevent damping off.

**Age of seedling:**

35 - 40 days.

**Spacing:**

60 x 30 cm.

**Fertilizer**

Basal: FYM: 25 t/ha, 70:70 kg PK/ha.

Top dressing : 50 kg N 15 days after transplanting, 50 kg N 45 days after transplanting and 40 kg N 90 days after transplanting.

**Foliar application:**

At 65 and 75 days after transplanting NAA @ 20 ppm is sprayed to prevent flower drop.

**Harvest:**

Seeds attain physiological maturity 40 - 45 days after flowering. The fruits are harvested when they turn to capsicum red in colour. Fruits obtained from first 5 to 6 pickings alone are used for seed extraction.

**Seed extraction:**

Dried fruits are filled in gunny or cloth bag and threshed with a pliable bamboo stick or chilli seed extractor may be used for seed extraction.

**Grading:**

Seeds are graded with BSS 8 x 8 wire mesh sieve or 8/64" round perforated metal sieve (3.1 mm).

**Seed yield:**

350 - 400 kg/ha

**Storage:**

- Seeds dried to 7 - 8 % moisture content and treated with carbendazim 50 % WP @ 2 g / kg seed or Halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g / kg seed can be stored upto 10 months in cloth bag and upto 18 months in moisture vapour proof containers.

- Intact pods can also be stored upto 20 months.

Trade Mark of TNAU





## **PUMPKIN**

### **Season:**

June - July and January - February.

### **Seed rate:**

1 kg/ha.

### **Spacing:**

Pit size : 45 x 45 cm at a distance of 2.5 x 2.0 m.

### **Fertilizer:**

FYM :10 kg/ pit. NPK mixture (6:12:12) is applied @ 100 g per pit as basal and 30 days after sowing, nitrogen is applied @ 10 g N/pit as top dressing.

### **Foliar application:**

Spraying maleic hydrazide @ 400 ppm at 2 leaf stage and 5 leaf stage or ethrel @ 250 ppm for four times at weekly interval commencing from 15<sup>th</sup> day after sowing enhances the female flower production.

### **Harvest:**

Seeds attain physiological maturity 16 weeks after flowering. The fruits are harvested when surface turned waxy and shiny. At full maturity, the fruit colour changes to yellow or orange yellow accompanying with drying of fruit stalk.

### **Seed extraction:**

Fruits weighing less than 1.5 kg should not be used for seed extraction. Fruits are cut and seeds with pulp are scooped out and seeds are separated by washing with water and dried.

### **Grading:**

Seeds are graded with BSS 4 x 4 wire mesh sieve (6.2 mm) or 16/64" round perforated metal sieve.

### **Seed yield:**

250-300 kg/ha

### **Storage:**

Seeds dried to 7 - 8 % moisture content and treated with carbendazim 50 % WP @ 2 g / kg seed or halogen formulation (Bleaching powder + CaCO<sub>3</sub> + arappu leaf powder @ 5:4:1) @ 3 g/kg can be stored for 10 months in cloth bag and 18 months in moisture vapour proof container.

## **SNAKE GOURD**

### **Season:**

June - July and January - February.

### **Pre-sowing treatment:**

The seeds are pre-germinated by incubating the seed for 4 days in between gunnies after soaking in double the volume of water for 4 h. Then, pre-sprouted seeds are separated and used for sowing.

**Seed rate:**

1.5 kg/ha.

**Spacing:**

Pits are dug to the size of 45 x 45 cm at a distance of 2.5 x 2.0 m

**Manuring**

FYM 10 kg/ pit.

NPK mixture (6:12:12) @10g per pit is applied as basal and 10 g N/pit as top dressing on 30 days after sowing.

**Foliar application:**

Spraying maleic hydrazide @ 400 ppm or ethrel at 250 ppm at 2 leaf and 5 leaf stages enhances female flower production.

**Harvest:**

Fruits at initiation of yellow to orange colouration are harvested for seed extraction.

**Seed extraction:**

Fruits are cut and seeds with pulp are scooped out and seeds are separated by washing with water and are dried to 7- 8 % moisture content.

**Grading:**

The immature seeds can be removed as water floaters during wet extraction. Seeds are graded with 16/64" round hole sieve or BSS 4 x 4 (6.2 mm) for homogenizing the lot.

**Seed yield:**

300-350 kg/ha

**Storage:**

Seeds dried to 7 - 8 % moisture content and dry dressed with carbendazim 50 % WP @ 2 g / kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @5:4:1) @ 3 g/kg seed and stored in cloth bag upto 10 months and more than 18 months in moisture vapour proof containers.

**BITTER GOURD**

**Season:**

June-July and January-February.

**Seed rate:**

2.5 kg/ha.

**Pre-sowing treatment:**

The seeds are pre-germinated by incubating the seed for 4 days in between gunnies after soaking in double the volume of water for 4 h. Then, pre-sprouted seeds are separated and used for sowing.

The seeds are hydroprimed for 24 h using seed to water ratio of 1:4 to enhance seedling emergence.

**Foliar application:**

Ethrel @ 250 ppm (i.e., 2.5 ml of ethrel in 10 liters of water) is sprayed for four times starting from 15 days after sowing and followed in weekly intervals, to increase the number of female flowers.

**Spacing**

Pit size: 45 x 45 x 45 cm at a distance of 2.5 x 2 metres

**Fertilizer:**

10 kg FYM and 13 g urea, 72 g super phosphate and 19 g potash / pit is recommended, where urea is applied as two split doses @ 22 g/pit at flowering stage (20 days after flowering) and another 18 g of urea along with 5 g potash/pit, at 40 days after flowering.

**Harvest:**

The fruits which turn yellowish orange are harvested in different pickings at 5 to 7 days interval. After harvest, the fruits can be stored for 1 or 2 days for over ripening, to facilitate easy seed extraction.

**Seed extraction:**

The fruits are split open longitudinally and the seeds are collected along with the pulp. The pulp is crushed with hands and washed with excess quantity of water to remove the pulp. The extracted seeds are dried to 6 - 7% moisture content.

**Grading:**

Seeds are graded with BSS 4 x 4 wire mesh sieve.

**Seed Yield:**

250-300 kg/ha.

**Storage:**

Seeds dried to 6 - 7% moisture content and treated with carbendazim 50 % WP @ 2g /kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be safely stored in 700 gauge polythene bag for one to two years.

## **BOTTLE GOURD**

### **Season:**

June - July and January - February.

### **Seed rate:**

3 kg/ha.

### **Spacing:**

Pit size : 45 x 45 cm at a distance of 2.5 x 2 m

### **Foliar application:**

Spraying maleic hydrazide @ 400 ppm or ethrel at 250 ppm at 2 leaf stage and 5 leaf stage enhances the female flower production and seed yield.

### **Harvest:**

Fruits attain physiological maturity at 65 days after anthesis (the skin of the fruit become woody rough and turn dull in colour). Fruits weighing less than 50 g should be rejected as it contains higher percentage of immature seeds.

### **Seed extraction:**

Matured fruits are cut vertically and seeds are scooped and cleaned.

### **Grading:**

Seeds are graded with 16/64" round perforated metal sieves or BSS 4 x 4 wire mesh sieve (6.2 mm).

### **Seed yield:**

250 kg/ha

### **Storage:**

Seeds dried to 8 % moisture content and treated with carbendazim 50 % WP @ 2 g / kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be stored upto 1 year in cloth bag and 2 years in moisture vapour proof containers.

## **ASH GOURD**

### **Season:**

June - July and January - February.

### **Seed rate:**

2.5 kg/ha.

### **Pre-sowing seed treatment**

Hydropriming for 24 h with seed to water ratio of 1:4.

### **Spacing:**

Pit size of 45 x 45 cm at a distance of 2 x 1.5 m

**Fertilizer:**

FYM 10 kg/ pit is applied along with 100 g of NPK mixture (6:12:12) per pit as basal and 10 g N/pit as top dress on 30 days after sowing.

**Foliar application:**

Application of maleic hydrazide @ 400 ppm or ethrel at 250 ppm at 2 leaf stage and 5 leaf stage enhances female flower production.

**Harvest:**

Seeds attain physiological maturity at 80 - 85 days after anthesis when fruit stalk becomes dry and ashy coat on the fruit surface is prominent. Under sized fruits should be rejected.



**Seed yield:**

250-300 kg/ha.

**Fruit storage:**

Matured fruits can also be stored over sand bed at ambient condition.

**Seed extraction:**

Fresh fruits can be used for extraction. The fruits are cut into longitudinal bits and the scooped seeds are allowed for close fermentation in polythene bags for 72 h and repeatedly washed for 4-5 times with water. On fresh extraction immature seeds can be removed as floaters. The extracted seeds are dried under shade and followed by sun drying to reduce the moisture content to 7 %.

**Grading:**

Seeds are graded using 16/64" diameter round perforated metal sieves or BSS 4 x 4 wire mesh sieve (6.2 mm).

**Seed storage:**

Processed seeds weighing not less than 10 g/100 seeds at 10 % moisture content should be dried to 8 % moisture content and treated with carbendazim 50 % WP @ 2 g /kg seed or halogen formulation (Bleaching powder + CaCO<sub>3</sub> + arappu leaf powder @ 5:4:1) @ 3 g/kg seed for extended storage and packed in moisture vapour proof containers.

**CUCUMBER :****Season:**

June - July (or) January - February.

**Seed rate:**

2.5 kg/ha.

**Pre-sowing seed treatment**

Treat the seed with *Trichoderma viride* @ 4 g / kg or *Pseudomonas fluorescens* @ 10 g/kg or carbendazim 2 g / kg.

**Spacing:**

Sowing on one side of channel with the spacing of 0.6 m between hills.

**Fertilizer:**

Apply FYM 40 t/ha as basal and 35 kg of N/ha as top dress on 30 days after sowing.

**Foliar application:**

Application of maleic hydrazide @ 400 ppm or ethrel at 250 ppm at 2 leaf stage and 5 leaf stage enhances female lower production.



## Trade Mark of TNAU



**Physiological maturity :**

35 days after anthesis

**Extraction technique :**

Store the fruit for five days after ripening and extract the seed using commercial HCl @ 30 ml / kg of seed mass for 30 minutes.

**Pre-storage seed treatment:**

Halogen mixture @ 3 g / kg of seed in 700 gauge polythene bag.

**CLUSTER BEAN**

**Season:**

June - July (irrigated)

**Seed rate:**

10 kg/ha

**Pre-sowing treatment:**

- ❖ Seed treatment with carbendazim 50 % WP @ 2 g/kg.
- ❖ Seed fortification with GA<sub>3</sub> 200 ppm (or) 1 % ZnSO<sub>4</sub> (or) 2 % arappu extract for 3 h in seed to solution ratio of 1:0.3
- ❖ Seed pelleting with *Rhizobium* @ 50 g / kg of seed

**Spacing:**

45 x 20 cm. Seeds are dibbled @ 2 seeds/hole on the sides of the ridges.

**Foliar application:**

Spraying DAP 2 % at 50 % flowering stage to improve the seed set.

**Harvest:**

Seed attains physiological maturity at 55 - 60 days after anthesis and reaches harvestable maturity at 60 - 65 days. The harvest is done by two staggered pickings as soon as the pods turn brown in colour.

**Grading:**

Seed are graded with 10/64" round perforated metal sieve or BSS 6 x 6 wire mesh sieve (4.2 mm).

**Seed yield:**

900-1000 kg/ha

**Storage:**

Seeds dried to 8 % moisture content and treated with carbendazim 50 % WP @ 2 g / kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be safely stored in moisture vapour proof container for two years.

**VEGETABLE COWPEA****Season:**

June - July and February - March.

**Seed rate:**

20 kg/ha

**Spacing:**

45 x 20 cm.

**Fertilizers:**

FYM : 25 t/ha along with 25:50:0 kg NPK/ha is applied as basal.

**Foliar application:**

2% DAP (Supernatant solution) is sprayed at 50% flowering. Tendril clipping enhances flowering and fruit yield.

**Harvest:**

The seed matures 25 – 30 days after flowering (fruit become straw yellow colour). The fruits are harvested in pickings with an interval of 15 days. The early pickings upto 4 can be used for seed extraction.

**Seed extraction:**

Seeds are extracted manually by beating with pliable bamboo stick.

**Grading:**

Seeds are graded with 12/64" round perforated metal sieve or BSS 5x5 wire mesh (4.8 mm).

**Seed yield:**

500 kg/ ha

**Storage:**

Seeds treated with carbendazim 50 % WP @ 2 g /kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g / kg seed can be stored upto 8 months in cloth bag and 16 months in moisture vapour proof container provided there is no bruchid infestation.

## **DOLICHOS LAB LAB (Bush type)**

### **Season:**

October - November

### **Seed rate:**

25 kg/ha

### **Spacing:**

60 x 20 cm.

### **Fertilizers:**

Basal : FYM : 25 t/ha, 25 : 50 : 0 kg NPK/ha.

### **Foliar application:**

NAA @ 20 ppm is sprayed at 65 and 75 days after sowing to reduce the flower drop.

### **Pre-harvest sanitation spray:**

Five days prior to harvest of water may be sprayed to reduce the egg laying by bruchids.

### **Harvest:**

The pods are harvested when the colour changes to straw yellow. Last two pickings can be used for vegetables.

### **Seed extraction:**

Seeds are extracted manually by beating with pliable bamboo stick.

### **Grading:**

Seeds are graded with 18/64" round perforated metal sieve or BSS 3x3 wire mesh sieve (7.2 mm).

### **Seed yield:**

600 kg/ha

### **Storage:**

Seeds treated with carbendazim 50 % WP @ 2 g /kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be stored upto 8 months in cloth bag and 16 months in moisture vapour proof container provided there is no bruchid infestation.

## **CORIANDER**

### **Pre-sowing seed treatment**

Fortification with  $\text{KH}_2\text{PO}_4$  @ 1% for 16 h + polymer coating @ 3ml  $\text{kg}^{-1}$  + Imidachloprid @ 2 ml  $\text{kg}^{-1}$  + *Trichoderma viride* @ 4 g  $\text{kg}^{-1}$  + *Azospirillum* @ 100 g  $\text{kg}^{-1}$ .

**Foliar spray :** 0.5 %  $\text{FeSO}_4$  at 30 and 45 DAS

**Physiological maturity :**

45 days after anthesis. Colour change from green to light olive brown.

Trade Mark of TNAU



**Harvesting :**

Should be done between 45 and 52 days after anthesis before the occurrence of shattering.

**Pre-storage seed treatment**

Halogen formulation @ 3ml kg<sup>-1</sup> of seed and emamectin benzoate (2 ppm) + carbendazim @ 2 g kg<sup>-1</sup>.

**Storage container**

Seeds store well in high density polyethylene bag.

**Grading:**

Seeds graded with 25 / 64" round perforated metal sieve.

**Storage:**

Scarified seed treated with 4 g / kg of chlorine based halogen mixture can be stored in cloth bag.

**ANNUAL MORINGA****Season:**

July- October

**Seed rate:**

0.5 kg/ ha

**Spacing:**

3 x 3 m.

**Sowing:**

2 to 3 seeds/pit.

**Fertilizers:**

**Basal:** FYM: 15 kg/pit, 100:200:50 g NPK/tree. N applied in 3 split doses at flower initiation, flowering and fruit development stage.

**Foliar application:**

3 - 4 sprays of NAA @ 20 ppm is given at flowering at 10 days interval to reduce flower drop.

**Physiological maturity:**

Seed attains physiological maturity 70 days after anthesis with a colour change of pod from green to brown. Fruits can be harvested from 70-75 days after anthesis and delayed harvest leads to shattering and loss in seed quality.

**Grading:**

Seed are graded with 24/64" round perforated metal sieve.



**Seed yield:**

100 kg/ha

**Storage:**

Seed treated with carbendazim 50 % WP @ 2 g /kg seed and halogen formulation (bleaching powder + CaCO<sub>3</sub> + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be stored in cloth bag for one year.

**BELLARY ONION**

Trade Mark of TNAU

**Season:**

May - June

**Pre-sowing seed treatment**

Sand matrix priming with 80 % water holding capacity for 24 h drying back to original moisture content

**Seed rate:**

6 - 8 kg of graded seed/ha.

**Transplanting:**

Seedlings of 35 - 40 days may be transplanted in the main field on both sides of the ridges.

**Spacing:**

20 x 10 cm.

**Fertilizer application:**

FYM : 25 t/ha.

Application	N	P	K
Basal kg /ha	30	60	30
Top dress (30 <sup>th</sup> day) kg / ha	30	-	-

**Harvest:**

Well-matured bulbs are harvested at 110 - 115 days.

**Bulb grading:**

Medium sized bulbs weighing 40 - 50 g or bulbs with > 2.1 cm diameter are selected.

**Bulb treatment:**

The top 1/3<sup>rd</sup> of the bulb is removed and treated with fungicides either carbendazim or mancozeb at 20 g in 10 lit of water for 5 - 10 minutes.

**Bulb sowing:**

The treated bulbs are sown on the ridges during October - November.

**Spacing:**

50 x 20 cm.

Trade Mark of TNAU



**Harvest:**

The umbels are harvested during March when 50 % of the seeds in umbels turn into black colour, to prevent the shattering loss.

**Seed extraction:**

The umbels are dried under sun and the seeds are extracted by beating with pliable sticks.

**Seed grading:**

The seeds are graded by using BSS 10 x 10 wire mesh sieve (2.5 mm) or 6/64" round perforated metal sieve.

**Seed yield:**

500 - 600 kg/ha.

**Seed storage:**

Seeds are dried to reduce the moisture content to 6 - 8 % and treated with carbendazim 50 % WP @ 2 g /kg seed or halogen formulation (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and stored in polythene bags.

**AMARANTHUS****Season:**

June - July.

**Seed rate:**

2.5 kg/ha.

**Pre sowing seed treatment:**

The seeds are soaked in ethrel 200 ppm for 12 hours to enhance germination.

**Spacing:**

45 x 20 cm.

**Fertilizers**

Basal : FYM : 25t/ha: 40 : 40 : 20 kg NPK/ ha .

**Foliar spray:**

Spray DAP 2% at flowering and 10 days after first spray to improve seed yield and quality.

**Harvest:**

Seed attains physiological maturity 35 – 45 days after flowering when glumes turn brown in colour and seeds turn black.

**Seed extraction:**

Seeds are extracted by beating with pliable bamboo sticks and dried to 7 – 8 % moisture content.

**Grading:**

Seeds are graded with BSS 22 x 22 sieve.

**Seed yield:**

200 kg/ha

**Storage:**

Graded seeds are treated with carbendazim 50 % WP @ 2 g /kg of seeds or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be stored for 10 months in cloth bag and 18 months in moisture vapour proof containers.

**GRAIN AMARANTH****Season:**

June - July and October - November

**Seed rate:**

2.5 kg/ha.

**Sowing method:**

Direct sowing or transplanting after 12 days of nursery period

**Spacing:**

45 x 15 cm.

**Fertilizers**

Basal : FYM : 25t/ha: 50 : 30 : 30 kg NPK / ha

**Foliar spray:**

Foliar application of DAP 2% @ flowering and 10 days after first spray improved seed yield and quality.

**Harvest:**

Seed attains maturity 30 days after 50 % anthesis when spikes turn yellow in colour and seeds turn orange white.

**Seed extraction:**

Seeds are extracted by beating with pliable bamboo sticks and dried to 7 – 8 % moisture content.

**Grading:**

Seeds are graded using BSS 22 x 22 sieve.

**Seed yield:**

200 kg/ha

**Storage:**

Graded seeds are treated with halogen mixture @ 3 g / kg of seed or carbendazim 2 g + imidachloprid 100 mg kg<sup>-1</sup>, can be stored for 10 months in cloth bag and 18 months in moisture vapour proof containers.

**PALAK****Pre-sowing seed treatment**

Dormancy breaking : Soaking seeds in 2 % KNO<sub>3</sub> solution for 3 h (or) by leaching in running water for 3 h.

**Foliar application**

2 % DAP at first and 50 % flowering is sprayed along with single leaf cutting at 35 DAS to increase seed yield.

**Physiological maturity**

Seeds attain physiological maturity 49 days after anthesis.

**Seed grading:**

Seeds are graded using BSS 8 x 8 sieve.

**Seed storage**

Seeds can be treated with carbendazim @ 2 g + halogen mixture @ 3 g / kg of seeds and can be stored in aluminum foil pouches.

**CARROT****Season:**

July - February in hill areas.

**Pre-sowing seed treatment**

Soak the seeds for 36 h with the seed to water ratio of 1:6 and dry back to original moisture content.

**Seed rate:**

4 kg/ha

**Plant Protection**

Root knot nematodes, *Meloidogyne spp.* can be prevented by application of neem cake @ 1t / ha at planting.

**Root to seed method:**

Stecklings weighing 150g and above can be used for planting. Stecklings having low weight reduces the seed yield and seed quality.

**Fertilizers**

Basal :FYM : 25 t/ha 50 : 50 : 10 kg NPK/ha

**Top dressing:**

50 kg N prior to flowering (30 days after stecklings planting)

**Harvest:**

Seeds in the umbel mature 7 weeks after anthesis. Splitting of schizocarp into two mericarp occurs at this time. Delayed harvest results in shattering.

**Grading:**

BSS 12 x 12 wire mesh sieve.

**Seed yield:**

700-800 kg/ha

**Storage:**

Seeds are dried to 8% moisture content and treated with carbendazim 50 % WP @ 2 g /kg of seeds or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and packed in 700 gauge polythene bag.

**RADISH****Season:**

Hill: March - April, Plain : September - October

**Seed rate:**

10 kg/ha

**Spacing:**

30 x10 cm

**Root to seed method:**

When the roots are fully matured, the crop is harvested. True to type roots are selected and transplanted in a well-prepared field.

**Seed to seed method:**

Seeds are sown in well-prepared land. On 45<sup>th</sup> day, the roots are lifted out and then transplanted by giving one-third cut at the top.

**Fertilizers**

Basal: FYM: 25 t/ha: 50:25:50 kg NPK/ha.

Top dressing: 50 kg N just before flowering.



**Foliar spray:**

DAP @ 2 kg/ha is sprayed thrice at 10 days interval during flowering to reduce flower drop.

**Harvest:**

Seeds attain physiological maturity 35 - 40 days after anthesis. The pods are harvested when dried and turn to creamy straw colour. Drying of pods intact in the plant enables a single harvest and does not affect quality.

**Seed extraction:**

The seeds are extracted manually by threshing with a pliable bamboo stick.

**Grading:**

Seeds are graded by using 8/64" sieve or BSS 8 x 8 wire mesh sieve.

**Seed yield:**

600-700 kg/ha

**Storage:**

Seeds are treated with carbendazim 50 % WP @ 2 g /kg seed or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and packed in cloth bags.

**CAULIFLOWER****Pre sowing seed treatment:**

Seeds are soaked in water for 72 h with change of water for every 24 h to leach out the inhibitors present on the seed coat.

**Foliar application:**

Foliar application of DAP 2% at 30 days after curd formation as supplementary nutrition increases the yield of good quality seeds.

**Harvest:**

Seed matures 7 weeks after flowering. Delayed harvest reduces germination significantly.

**Seed grading**

Empty seeds are removed by density grading (using seed blower).

**Seed yield:**

150 kg/ha

**Storage:**

Seeds treated with carbendazim 50 % WP @ 2 g /kg of seeds or halogen formulation (Bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be stored for 10 months in cloth bag.

## Trade Mark of TNAU



## **PAPAYA**

### **Pre sowing seed treatment:**

Seeds soaked in 100 ppm GA<sub>3</sub> for 16 hours or in 2% fresh arappu leaf extract or 1% pungam leaf extract or pelleting with arappu leaf powder improve the initial seed quality .

### **Optimum depth of sowing:**

Sow seeds at 1 cm depth for better germination and seedling growth.

### **Seed extraction:**

There is no correlation between fruit size and seed yield and quality. Hence, all ripened fruits can be used for seed extraction.

### **Grading:**

Seeds are graded with BSS 6 x 6 wire mesh sieve (4.2 mm).

### **Storage:**

Seeds are dried to 8-10% moisture and treated with carbendazim 50 % WP @ 2 g /kg or halogen formulation (bleaching powder + CaCO<sub>3</sub> + arappu leaf powder @ 5:4:1) @ 3 g/kg and packed in cloth bag to maintain viability upto 5 months.

### **Invigouration of old seeds:**

Stored seeds can be invigourated by soaking them in dilute solution of disodium phosphate (10<sup>-4</sup> M) adopting 1:8 seed to solution ratio for 4 hours followed by drying back to original moisture content.

### **BER:**

#### **Flowering season**

June - July

#### **Fruiting season**

September- October

### **Seed extraction**

Manual removal or water soaking for one week.

### **Physiological maturity:**

Seeds of ber attain physiological maturity 12 to 13 weeks after anthesis. It is indicated by yellowish red colour of fruit pericarp.

### **Grading:**

Stones can be size graded using 22/64" round perforated metal sieve or stone grading done with 20% sodium chloride removes ill filled and empty stones. Seeds graded with 25 / 64" round perforated metal sieve.

### **Germination improvement:**

The stones soaked in thiourea @ 2 % for 24 hours enhances the germination.

Trade Mark of TNAU



**Storage:**

Ber stones can be stored upto 30 months in 700 gauge polythene bag without any treatment under ambient conditions. Scarified seed treated with chlorine based halogen mixture @ 4 g / kg of seed can be stored in cloth bag.

**AMLA:****Flowering season**

January - February

**Fruiting season**

November - February

**Pre sowing seed treatment:**

Fresh seeds are stratified in sand moistened to 60% with  $\text{KNO}_3$  @ 5 g/lit kept at 5°C for 10 days to remove the morphophysiological dormancy. Dry storage of fresh seeds for 10 months can also remove this dormancy.

**Harvest:**

Seeds attain physiological maturity 22 to 24 weeks after breaking fruit dormancy of 5 months when the fruit colour turns to yellowish green and seed colour turns to chestnut brown.

**Seed extraction:**

Amla seeds can be extracted by soaking the fruits in 30% brine solution during night followed by drying during the day and repeated for 3 days. The mesocarp following soaking in brine solution remained fresh and can be used for pickle/byproducts preparation.

**Grading:**

Using 8/64" round perforated metal sieve with maximum seed recovery can be used to process seeds. The size-graded seeds can be further upgraded by density grading using water to remove the light weight empty seeds.

**Storage:**

Seed treated with carbendazim 50 % WP @ 2 g /kg seed and halogen formulation (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed can be stored upto 18 months in cloth bag and at 24 months in moisture proof container. Seeds can also be treated with carbendazim @ 4 g + carbaryl 400 mg / kg and packed in 700 gauge polythene bag and stored in 5°C.

**JAMUN:****Flowering season**

June

**Fruiting season**

July - August

**Harvest:**

Jamun seeds attain physiological maturity 11 weeks after anthesis when the fruit colour changes to purplish black.

**Seed extraction:**

The collected fruits are heaped for one day and squeezed. Seeds will come out easily.

**Grading:**

Fresh seed can be size graded using 20/64" round perforated metal sieve with maximum seed recovery.

**Storage:**

It is a recalcitrant seed and will lose viability upon storage due to desiccation (drying). When stored seeds are to be used for sowing, the dead seeds can be removed by density grading using water. The seeds lose viability completely within one month in tropical condition when the moisture content of seed falls below 20%. The critical moisture for safe storage is around 45%. Packing of seeds in polythene bags containing 2% moist sand stored at 10°C in refrigerator storage prolongs viability upto 3 months.

**BIXA ORELLANA****Flowering season**

June - September

**Fruiting season**

August - October

**Harvesting**

October - December

**Pre sowing seed treatment:**

Scarification with conc.  $\text{H}_2\text{SO}_4$  @ 100 ml / kg of seed for 15 min. followed by soaking in  $\text{GA}_3$  100 ppm or KCl 0.5 % or coconut water 25 % for 6 hrs

**Flowering induction :**

$\text{GA}_3$  100 ppm is sprayed to induce flowering.

**Harvesting:**

Seed attains maturity 84 DAA (October to December) and fruit collection from top of crown gave high quality seed

**Seed extraction:**

Beating with pliable sticks

**Grading:**

Seeds graded with BSS 6 x 6 and selection of red colour seed improve the quality.

**Storage:**



Seeds treated with carendazim 50 % WP @ 2 g / kg and packed in 700 gauge polythene bag preserves the viability upto one year.

Trade Mark of TNAU



## MEDICINAL PLANTS

### GYMNEMA:

#### Pre sowing seed treatment:

Leaching the seeds in tap water for 12 hrs followed by soaking in  $\text{KNO}_3$  @ 2 g/lit for 6 hours recorded higher germination.

#### Physiological maturity:

Seeds attain physiological maturity 100 days after anthesis with colour change of pods from green to dark brown. The seeds shatter totally within two days.

#### Grading:

Density grading using South Decota air blower at 0.5" water pressure improves seed germination.

#### Storage:

Seed treatment with carbendazim 50 % WP @ 2 g /kg of seeds or halogen formulation (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and packed in moisture vapour proof container prolongs viability.

### SENNA

#### Season:

November - December and June - July.

#### Pre sowing seed treatment:

Hard seededness can be effectively overcome by acid scarification with commercial sulphuric acid @ 100 ml/kg seed for 10 minutes

#### Physiological maturity:

Seeds attain physiological maturity at 40 days after anthesis associated with colour change of pods from green to brown.

#### Grading:

Seed are graded with 8/64" round perforated metal sieve.

#### Storage:

Seed treatment with carbendazim 50 % WP @ 2 g /kg of seeds or halogen formulation (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and packed in moisture vapour proof container prolongs the viability upto 15 months.

### PERIWINKLE

#### Pre sowing seed treatment :

Seed soaking in  $\text{GA}_3$  600 ppm for 12 hrs (or)  $\text{KNO}_3$  1 % for 24 hours

#### Physiological maturity:

Seeds attain physiological maturity 40 days after anthesis with a change of pod colour from green to brown with yellow translucent seeds.

**Grading:**

Seeds are graded with 4/64" round perforated metal sieve

**Storage:**

Seed treatment with carbendazim 50 % WP @ 2 g /kg of seeds or halogen formulation (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and packed in moisture vapour proof container prolongs viability upto 15 months.

Trade Mark of TNAU

**ROSELLE****Physiological, maturity:**

Seeds attain physiological maturity at 40 days after anthesis.

**Grading:**

Seeds are graded with 7/64" round perforated metal sieve (2.8 mm).

**Storage:**

Seed treatment with carbendazim 50 % WP @ 2 g /kg of seeds or halogen formulation (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and packed in moisture vapour proof container, prolong the viability upto 15 months.

**AMBRETTE****Pre-sowing seed treatment:**

Dormancy breaking by soaking seeds in hot water at 100°C for 30 minutes

**Spacing:**

60 x 45 cm

**Fertilizer recommendation:**

150 : 60 : 60 kg NPK / ha

**Harvest:**

Seed attains physiological maturity at 35 DAA (days after anthesis) when the pod colour changes from green to brown. The seeds harvested from first five pickings can be used for seed purpose.

**Grading:**

Seeds are graded with BSS 8 x 8 sieve size

**ASHWAGANDHA****Germination improvement:**

Mechanical scarification of seeds with sand for six minutes followed by soaking in  $\text{GA}_3$  500 ppm solution for five hours significantly improved the germination of seeds.

**Harvest:**

Seeds attain physiological maturity at 35 days after anthesis when the colour of seeds changes from orange to deep red. Harvestable maturity of seed attains at 42 days after anthesis.

Trade Mark of TNAU



### **KALMEGH – *Andrographis paniculata***

#### **Pre sowing seed treatment:**

Seed soaking in GA<sub>3</sub> @ 200 ppm for 3 hrs.

#### **Harvest :**

Seeds attained physiological maturity 30 DAA which coincided with the change of pod colour from light green to light brown with brown seeds.

#### **Storage**

Seed treatment with halogen mixture @ 3 g / kg of seed and stored in 700 gauge polythene bag

### **GLORY LILY – *Gloriosa superba***

#### **Pre-sowing treatment :**

The seeds are soaked in hot water for 40 minutes for germination improvement.

#### **Foliar spray :**

GA<sub>3</sub> @ 100 ppm is sprayed at 10<sup>th</sup> and 20<sup>th</sup> DAA.

#### **Harvest :**

Seeds attain physiological maturity 63 - 70 DAA with the change of seed colour to deep yellowish orange.

### **AROMATIC PLANTS PALMAROSA**

#### **Germination improvement:**

Leaching of fluffs in running water for 8 hours followed by soaking in KNO<sub>3</sub> at 0.5% for 6 hours recorded maximum germination.

#### **Harvest:**

Seeds attain physiological maturity at 40<sup>th</sup> day after 50% flowering when the fluff (seed) moisture is around 20%.

#### **Grading:**

Density grading using South Decota air blower at 0.5" water pressure improves seed germination.

#### **Storage:**

Seed treatment with carbendazim 50 % WP @ 2 g /Kg of seeds or halogen formulation (bleaching powder + CaCO<sub>3</sub> + arappu leaf powder @ 5:4:1) @ 3 g/kg seed and packed in moisture vapour proof container prolongs viability.

Storing of fluffs in 700 gauge polyethylene bags after seed treatment with carbendazim 50 % WP @ 2 g /kg of seeds and halogen formulation (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 3 g/kg seed maintains the shelf life of fluffs upto 10 months and shelf life can be prolonged in moisture vapour proof containers.

## **FLOWER CROPS**

### **MARIGOLD**

#### **Fertilizer:**

NPK @ 125:125:50 kg/ha

#### **Spacing:**

60 x 40 cm

#### **Foliar spray:**

DAP @ 1% can be sprayed at second and fourth week after transplanting to improve flowering.

#### **Harvest:**

Seeds attain physiological maturity at 35 days after anthesis associated with drying of petals.

#### **Grading:**

Density grading adopting water floatation technique or grading with specific gravity separator and selection of first three grades for seed purpose.

#### **Storage:**

Seed treatment with iodine based halogen mixture @ 3 g/kg seed and packed in aluminium foil pouches prolongs viability.

### **GAILLARDIA**

#### **Germination improvement:**

Seed treatment in conc. sulphuric acid for 30 seconds followed by soaking in  $\text{GA}_3$  200 ppm for 16 hours.

#### **Harvest:**

Seeds attain physiological maturity at 40th day after anthesis.

#### **Grading:**

Seeds are graded with BSS 8 x 8 sieves

#### **Storage:**

Seed treatment with chlorine based halogen mixture (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 2 g/kg seed and packed in aluminium foil pouch prolongs viability.

### **ZINNIA**

#### **Germination improvement:**

Seed soaking in  $\text{GA}_3$  100ppm for 16 hours .



**Harvest:**

Seeds attain physiological maturity at 40 days after anthesis .

**Grading:**

Seeds are graded with BSS 8 x 8 sieves

Trade Mark of TNAU



**Storage:**

Seed treatment with chlorine based halogen mixture (bleaching powder +  $\text{CaCO}_3$  + arappu leaf powder @ 5:4:1) @ 2 g/kg seed and packed in aluminium foil pouch prolongs viability.

**CHINA ASTER****Pre-sowing treatment :**

Fortification with 0.25 %  $\text{ZnSO}_4$  or 1 % hibiscus leaf extract for 2 hours

**Harvest :**

Seeds attained physiological maturity at 40 days after anthesis .

**Storage :**

Seeds are treated with Iodine based halogen @ 3 g / kg and stored in 700 gauge polythene bag for 6 months

**PETUNIA****Pre sowing seed treatment:**

Fortification with  $\text{GA}_3$  100 ppm (or) moringa leaf extract 2 % for 16 h (or)  $\text{KH}_2\text{PO}_4$  2 % for 16 hours

**Age of the seedling for transplanting :**

The seeds are first sown in primary nursery (pot) and after 16 day the seedlings are transplanted to raised nursery and after 24 days transplanted to main field.

**Spacing :**

75 x 60 cm

**Fertilizer :**

125 : 75 : 150 kg NPK / ha

**Foliar spray :**

$\text{MgSO}_4$  @ 2 % spraying at 50 % flowering stage

**Physiological maturity :**

Seeds attain physiological maturity at 25 days after anthesis and it is associated with browning of pod and seed

**Harvest :**

Pods are harvested in pickings on alternate days and upto 20 pickings pods can be used for seed extraction.

**Grading:**

Seeds are density graded with acetone and sinkers are selected for sowing.

**Storage:**

Seeds are treated with halogen mixture @3 g/kg or diflubenzuron @ 1 ppm / kg and packed in aluminium foil poly laminated pouch.

Trade Mark of TNAU



## SEED CERTIFICATION STANDARDS FOR FOUNDATION / BREEDER SEEDS

Sl.No.	Crop	Field standards					Seed Standards					WSS
		ID	OT	PS	OWP	DD	OCS	ODV	PP	GER	MC	
1.	Brinjal varieties	200	0.10	-	-	0.10	0	-	98	70	8	150
2.	Brinjal hybrids PL	200	0.01	-	-	0.10	0	-	98	70	8	15
3.	Bhendi	400	0.10	-	0.00	-	0	10.00	99	65	10	1000
4.	Tomato varieties	50	0.10	-	-	0.10	5	-	98	70	8	70
5.	Tomato hybrids PL	200	0.01	0.05	-	0.10	5	-	98	70	8	7
6.	Chilies	400	0.10	-	-	0.10	5	-	98	60	8	150
7.	Cluster beans	10	0.10	-	-	0.10	10	10.00	98	70	9	1000
8.	French beans	10	0.10	-	-	0.10	0	5.00	98	75	9	1000
9.	Indian beans	10	0.10	-	-	0.10	0	5.00	98	75	9	1000
10.	Bitter gourd	1000	0.10	-	0.00	-	0	5.00	98	60	7	1000
11.	Ash gourd	1000	0.10	-	-	-	0	-	98	60	7	1000
12.	Bottle gourd	1500	0.01	-	-	-	0	-	98	60	7	1000
13.	Pumpkin	1000	0.10	-	-	-	0	-	98	60	7	1000
14.	Ridge gourd	1000	0.10	-	-	-	0	5.00	98	60	7	1000
15.	Snake gourd	1000	0.10	-	0.00	-	0	-	98	60	7	1000
16.	Watermelon	1500	0.01	-	0.00	-	0	5.00	98	60	7	1000
17.	Amaranthus	400	0.10	-	0.01	-	5	10.00	95	70	8	70

PL-Parental lines of hybrid; ID-Isolation distance (Meter); OT-Off-type plants (%); PS-Pollen shedders (%); OWP-Objectionable weed plant (%) DD-Designated diseased plants (%); OCS-Other crop seeds (No./kg); ODV-Other distinguishable varieties; PP-Physical purity (%); GER-Germination (%); MC-Moisture content (%); WSS-Weight of submitted sample (Gram)

## Germination and purity standards

Sl. No.	Variety	Germination minimum	Purity minimum
1	Cowpea	75	98
2	Cluster beans	70	98
3	Field beans	75	98
4	Beans	75	98
5	Ladies finger	65	99
6	Bitter gourd	60	99
7	Sponge gourd	60	99
8	Bottle gourd	60	99
9	Cucumber	60	99
10	Snake gourd	60	99
11	Watermelon	60	99
12	Pumpkin	60	99
13	Cauliflower	65	98
14	Cabbage	70	98
15	Knol-khol	70	98
16	Carrot	60	95
17	Radish	70	98
18	Brinjal	70	98
19	Tomato	70	98
20	Chilies	60	98
21	Capsicum	60	98
22	Greens	70	95
23	Fenugreek	70	98
24	Basella	60	96
25	Onion	70	98

S.No	Name of seed	Max. viability period	
A. Vegetables			
1	Onion	6	Months
2	Beans, Pea, Cowpea	1	Year
3	Brinjal, Tomato, Chillies, Capsicum, Cucumber, Squashes, Pumpkin, Carrot, Radish, Turnip, Cole crops.	1.5	Years
4	Bhendi, Lettuce, Amaranthus, Methi, Beet root, Palak.	2	Years
B. Fruits and root stock plants			
1	Lime, Mandarin, Citrus rootstock species	1	Week
2	Mango stones, Litchi, Passion fruit, Butter fruit, Rose apple, Jambulana.	1	Month
3	Papaya, Kirni seeds	3-4	Months
4	Guava	4	Months
5	Watermelon, Musk melon	1	Year
6	Custard apple, Ramphal and other Annona sp.	1.5	Years
C. Plantation and Spices			
1	Clove, Nutmeg, Cinnamon, Curryleaf	1	Month
2	Arecanut, Cashewnut	3	Months
3	Coconut	4	Months
4	Coriander and other annual spices	1	Year
D.Flowers			
1	Aster seeds, Gladioli corms	1	Year
2	Marigold	1.5	Years
3	Other annual flower seeds	1 to 2	years



# Part XII

# IMPORTANT PLANT

# NUTRIENTS, THEIR

# DEFICIENCY SYMPTOMS

# AND REMEDIAL

# MEASURES

## MACRONUTRIENTS

### Nitrogen

**Symptoms:** Chlorosis begins in older leaves. Tips and margins of leaves commonly become yellow first.

Stunted growth.

Early crop maturity and low production.

**Remedial measures:** Spray 500 g of Urea dissolved in 100 lit of water on leaves.

### Phosphorus

## Symptoms

- 1) Older leaves become dark green with purple coloration (due to anthocyanin development) in some species.
- 2) Stunted shoot growth and poor root development.
- 3) Delayed crop maturity.

**Remedial measures:** Use Super phosphate or bone meal in required quantities.

## Potassium

**Symptoms:** Symptoms first appear on recently matured leaves and become pronounced on older leaves. Dark green foliage with necrotic spots appearing on older foliage, typically at tips and margins and entire leaf blade becomes scorched or necrotic.

Slow growth and susceptibility to wilting.

Potassium is important for fruit taste, size and colour.

**Remedial measures:** Spray 500 g of Muriate of Potash or Sulphate of Potash dissolved in 100 lit of water.

## Calcium

**Symptoms:** Reduced growth or even death of apical meristems, often leading to multiple branching in tap root crops.

Young foliage may be abnormal, chlorotic or even 'burned' at tips.

Softening of tissues and cell wall breakdown is common in fruits.

**Remedial measures:** Apply 2 to 4 kg of lime once in two years to each plant.

## Magnesium

**Symptoms:** Deficiency symptoms first appear in older leaves with chlorosis between veins and along margins progressing inward interveinally.

Tips and margins of the leaves turn upwards.

Leaves tend to be brittle and may fall prematurely.

**Remedial measures:** Spray 100 g of Magnesium sulphate in 100 lit of water or apply 25 - 125 kg of Magnesium sulphate to the soil.

### **Sulphur**

**Symptoms:** Symptoms are similar to 'N' deficiency with plants tend to be small and spindly having slender and short stalks.

Young leaves chlorotic, principal veins typically green.

Delayed maturity.

**Remedial measures:** Apply 20 - 25 kg of Sulphur per ha.

**MICRONUTRIENTS:** Like the macronutrients such as Nitrogen, Phosphorous, Potassium, Calcium, Magnesium and Sulphur, a score of micronutrients play a pivotal role in growth, development and reproductory activities of any crop plant.

The micronutrients such as Iron, Manganese, Boron, Copper, Zinc, Molybdenum, Chlorine and Silicon, etc., are extremely essential for sustained growth and productivity. Their essentiality is there for both seasonal and perennial crops, and their shortage quite apparently manifests in visible deficiency symptoms characterised by stunted growth, narrow or little leaves, chlorosis, crinkling, cupping and other leaf deformities, flower drop, alteration of sex of flowers, poor pigmentation and quality, cracking of stem, die back and oozing of gum. Each micronutrient is capable of producing one or more specific deficiency symptoms if it is in short supply to the plant metabolism. Often the complex deficiency symptoms as a result of deficiency of more than two micronutrients are manifested in sensitive crops such as Limes, Sweet Oranges, Mandarins and Lemons, etc.

**Iron:** It is essential for the development of chlorophyll in crops.

**General symptoms:** Young leaves become chlorotic.

The principal veins typically green, with absence of green colour in the finest veins and progress of chlorosis may lead to leaves completely devoid of chlorophyll leading to stunted crop growth.

**Remedial measures:** Spray 250 - 500 g of Ferrous sulphate dissolved in 100 lit of water.

### **Citrus**

**Symptoms:** Pale yellow and small sized leaves, stunted growth and small sized fruits.

**Remedy:** Foliar spray of 0.1 % Ferrous sulphate solution.

**Grapes:** Iron deficiency in grapes is due to the presence of excess Calcium in the soil.

**Symptoms:** Pale yellow small leaves with stunted growth.

**Remedy:** Foliar spray of 0.1% Ferrous sulphate solution.

**Pineapple:** The deficiency is prevalent in the soils with more Calcium and Magnesium.

**Symptoms:** Reddish green leaves.

**Remedy:** 0.1% Ferrous sulphate solution sprayed with an interval of one month.

**Vegetables:** Iron is essential for the initial growth of vegetable crops. So it is essential to apply Iron containing fertilizers at the initial stage of development to avoid iron deficiency in vegetable crops.

Iron deficiency is common in crops like Beans, Cauliflower, Beetroot, Brinjal, Tomato and Tapioca.

**Symptoms:** Pale yellow leaves, drying of leaf tips and in severe deficiency drying of whole leaves may occur.

**Remedy:** Apply 25 kg Ferrous sulphate per ha or spray 0.5 % Ferrous sulphate solution 3 - 4 weeks after sowing/transplanting.

### **Manganese**

**Symptoms:** Intervenal chlorosis seen in younger leaves first.

Dark green bands along midrib and main veins with lighter green areas between the bands.

**Remedy:** Spray lime mixed Manganese sulphate.

### **Boron**

#### **General symptoms**

Stunted growth or death of apical meristems, followed by sprouting of lateral buds.

Leaves, petioles or stems may be thickened, wrinkled, curled and chlorotic.

The fleshy part may show brown flecks, necrosis, cracks or dry rot.

Death of meristems causes reduced flower and fruit set.

Boron is essential for the translocation of sugars in plant system. Its essentiality is obvious in

Potato, Tapioca, Cabbage, Grapes, Citrus, Tomato and Guava.

### **Mango**

**Symptoms:** Drying of leaves. This is more prevalent in the orchards, which are nearer to brick factories.

**Remedy:** Either by soil application of 500g Borax per plant or by spraying 0.1 % Borax solution.

### **Citrus**

#### **Symptoms & Remedy**

Red spots on newly emerged leaves, leaves become dry and brittle.

Spraying 0.3 % Boric Acid.

### **Guava**

**Symptoms:** Splitting of fruits, gummosis at the splitted area, rough skin of the fruits.

**Remedy:** Spraying of 0.1 % Borax solution.

### **Grapes**

**Symptoms:** Small sized fruits. Presence of small sized fruits and large sized fruits in the same bunch is known as “Hen and Chicken” disorder. The fruits are sour in taste.

**Remedy:** Spray of 0.1 % Borax solution.

### **Vegetables**

#### **Cabbage**

**Symptoms:** Leaves become crinkled, rough and brittle. Drying of leaf edges soft spots on the petioles and loose heads.

In hybrid cabbage varieties, heads will not be formed and the leaves become blue in colour.

#### **Cauliflower**

**Symptoms:** Browning of leaf margin in young buds. Pale yellow veins and drying of leaves, the flower heads are long and dried with hollow flower stalk.

#### **Radish**

**Symptoms:** Tip drying, pale yellow leaves at initial stages and bluish green leaves at later stages. The leaves become crinkled and brittle. Early flowering.

#### **Carrot**

**Symptoms:** Wilting of plants despite enough soil moisture in the field. Deformed leaves with pale yellow colour.

## Potato

**Symptoms:** Leaves become small and it resembles virus disease infected plant. 30 - 40 % yield loss and sometimes 100 % loss may occur.

Remedial measures for vegetables to correct Boron deficiency

For Cabbage, Cauliflower, Tomato, Chillies, application of 40 g Borax per cent area in nursery will produce elite seedlings.

Borax 0.6 kg to 1.2 kg per ha is applied as fertilizer in the main field.

For root and tuber crops apply Borax @ 1.2 kg to 3.2 kg/ha

## Coconut

**Symptoms:** Button shedding, hallownut and sometimes fruits without nut.

**Remedy:** Apply Borax 0.6 - 1.2 kg/ha.

**Copper:** Stunted growth, rosetting and dieback of young twigs in fruit trees.

White tipped leaves are early symptoms.

Reproductive growth strongly affected leading to sterility.

## Banana

**Symptoms:** Leaf bud is crinkled and twisted. Delay in flower emergence.

## Coconut

**Symptoms:** Stunted growth, non-splitting of leaves.

## Citrus

**Symptoms:** Die back, splitting of bark, gummosis from fruits and browning of fruits with rough skin.

**Remedial measures:** Foliar application of 0.5% Copper sulphate solution.

**Zinc:** Chlorosis often appears as yellow mottling, between the veins in younger leaves.

Reduced stem growth may cause 'rosette' condition of terminal leaves.

## Mango

**Symptoms:** Stunted growth, leaves small, brittle and interveinal chlorosis, little leaves - rosette appearance.

**Remedial measures:** Two sprays of 1 - 2 % Zinc sulphate, one at the time of flowering and the other at 1 month after the first spray.

## Banana

Excess Phosphorous application leads to the deficiency of Zinc.



**Symptoms:** Narrow leaves with pale yellow colour.

**Remedial measures:** Spray 0.5 % Zinc sulphate or apply 30 g Zinc sulphate per plant.

Trade Mark of TNAU



## **Citrus**

**Symptoms:** Small, narrow, pale yellow leaves. Small fruits with rough skin.

**Remedial measures:** Three sprays of 0.5 % Zinc sulphate at the time of new flush emergence. Apply 50 g of Zinc sulphate per tree.

## **Guava**

**Symptoms:** Interveinal chlorosis, small leaves, rough leaf surface with cracks. Small rough skinned fruits and splitting of fruits.

**Remedial measures:** Spray 0.5 % Zinc sulphate solution 2 times before flowering with the interval of 15 days.

## **Grapes**

**Symptoms:** Small leaves, widened petioles and small sized fruits.

**Correction:** Smear 10 % Zinc sulphate on the pruned stem or spray 1 % Zinc sulphate solution 10 days before flower formation.

## **Vegetables**

### **Beans**

**Symptoms:** Dropping of leaves and flower buds and interveinal chlorosis.

### **Tomato**

**Symptoms:** Stunted growth, thickening of leaves, interveinal chlorosis, shortened internode, dropping of flowers and immature fruits.

### **Radish**

**Symptoms:** Interveinal chlorosis at the initial stage and drying of leaves at later stages.

### **Onion**

**Symptoms:** Tip drying during initial stage and total drying of leaves at later stages.

### **Remedial measures**

Seed treatment with 0.01 % Zinc sulphate.

Spray 0.25 - 0.50 % Zinc sulphate solution in the nursery five weeks after germination. Foliar application of 0.5 % Zinc sulphate in the field.

**Coconut:** Button shedding is the common symptom. The deficiency can be corrected by application of 0.25 % Zinc sulphate per plant.

**Molybdenum:** Chlorotic interveinal mottling of the lower leaves followed by marginal necrosis and infolding of the leaves.

In severe conditions necrosis and wilting of leaves occur.

Flower formation is inhibited, and if flowers do form, they abscise before setting fruits.

### **Cauliflower**

**Symptoms:** Drying of leaves from its edges at initial stages, later stages total drying. Leaves become long and narrow and this disorder is known as 'Whip tail' in Cauliflower.

### **Radish**

**Symptoms:** Pale yellow leaves, wilting of leaves with onward crinkling.

### **Tomato**

**Symptoms:** Interveinal chlorosis, inward crinkling of leaves.

**Remedial measures:** Spray 625 g Ammonium molybdate in 400 lit of water as foliar spray before flowering.

**Chlorine:** Leaves chlorotic and susceptible to wilting.

Deficiency is practically non-existent in nature because even rain water will carry sufficient

Chlorine to provide the required amounts.

**Remedy:** Add Chlorine compound salts to soil.

### **Silicon**

Wilting growth habit may result.

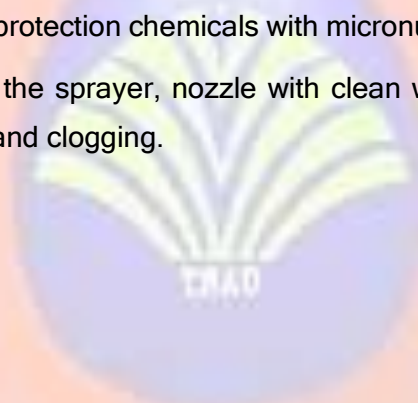
Abnormal accumulation of Fe + Mn may cause necrotic spots. Plants become susceptible to diseases.

**Correction:** Apply Silicon salts to soil.

**Foliar application:** The deficiency of micronutrients can be corrected by either soil or foliar application. Since soil application is often encountered with the problems such as fixation, leaching, inabsorbtion and antagonism, foliar application has been a standard practice of application of micronutrients to plants. Spraying also overcomes the problem of immobility of certain metallic ions inside the plant system. Since the micronutrients are needed in very small

quantity, the spray solution employed for foliar application is normally in terms of parts per million (ppm) and the chemical to be so employed is to be in neutralised form, or else scorching of leaves may occur or may prove toxic to plant system.

- Employ right micronutrients in right concentration by consulting the experts. Mixing of two or more micronutrients to correct multiple micro nutrient deficiency.
- Take up spray preferably to young expanding foliage to ensure effective absorption. Old leaves absorb very little or nil.
- Saline and alkaline water should not be employed for preparing micronutrient spray solution. Pour the spray solution through fine filters or muslin cloth to prevent clogging of nozzle. Ensure fine mist of spray evenly on both surfaces of leaves.
- Avoid spraying during blossom period.
- Spray preferably during morning or evening.
- Do not mix plant protection chemicals with micronutrients.
- Wash and clean the sprayer, nozzle with clean water after spraying to avoid corrosion and clogging.



# Part XIII

# MUSHROOM

# CULTIVATION

Agriculture will continue to be the main strength of Indian economy. With the variety of agricultural crops grown today, we have achieved food security by producing about 240 million tonnes of food grains. However, our struggle to achieve nutritional security is still on. In future, the ever increasing population, depleting agricultural land, changes in environment, water shortage and need for quality food products at competitive rates are going to be the vital issues and secondary agricultural vocations are going to occupy a prominent place to fill the void quality food requirements. The demand for quality food and novel products is increasing with the changes in life style and income. To meet these challenges and to provide food and nutritional security to our people, it is important to diversify the agricultural activities in areas like horticulture. Diversification in any farming systems imparts sustainability. Mushroom are one such component that only impart diversification but also help in addressing the problems of quality food, health and environmental sustainability. The present century is going to be a century of functional foods from synthetic chemicals and mushroom cultivation fits very well into this category and is going to be an important vocation.

Mushrooms represent microbial technology that recycles agricultural residues into food and manure. It is a solid state fermentation system in which crop residues are converted into valuable food rich in microbial protein. These are important source of quality protein, minerals and various novel compounds of medicinal value, do not compete for land and have very high productivity per unit area and time. These are considered to be the highest protein producer per unit area and time due to utilization of vertical space and short crop cycle. Due to their cultivation under controlled conditions the water requirements is less than any other

crop grown in the field and has all the potentials of being a major crop in coming years.

Mushroom farming today is being practiced in more than 100 countries and its production is increasing at an annual rate of 6-7%. In some developed countries of Europe and America, mushroom farming has attained the status of a high-tech industry with very high levels of mechanization and automation.. China leads in mushroom production and china alone is reported to grow more than 20 different types of mushroom at commercial scale and mushroom cultivation has become China's sixth largest industry. The USA is the second largest producer of mushroom sharing 16% of the world output. Presently, three geographical regions- Europe, America and East Asia contribute to about 96% of world mushroom production. With the rise in the income level, the demand for mushrooms at very low costs with the help of seasonal growing, state subsidies and capturing the potential markets in the world with processed mushrooms at costs not remunerative to the growers in other mushroom producing countries.

Commercial production of edible mushrooms represents unique exploitation of the microbial technology for the bio conversion of the agricultural, industrial, forestry and household waste into nutritious food (mushrooms). Our country can emerge as a major player in mushroom production in wake of availability of plenty of agricultural residues and labour. Integrating mushroom cultivation in the existing farming systems will not only supplement the income of the farmers but also will promote proper recycling of agro-residues thereby improving soil health and promoting organic agriculture. In India, mushroom research started in 60s and the cultivation picked up in 70s.

India has varied agro-climate, abundance of agricultural residues and plenty of manpower making it suitable for cultivating different mushrooms. Our country produces about 600 million tonnes of agricultural waste per annum and a major part of it let out to decompose naturally or burnt *in situ*. This can effectively be utilized to produce highly nutritive food such as mushrooms and spent mushroom substrate can be converted into organic manure/Vermi-compost. Mushrooms are grown seasonally as well as in state-of-art environment controlled cropping rooms all the



year round in the commercial units. Mushroom growing is a highly labour oriented venture and labour availability is no constraint in the country and two factors, that is, availabilities of raw materials and labour make mushroom growing economically profitable in India. Moreover, scope for intense diversification by cultivation of other edible mushrooms like Oyster, Shiitake, Milky and other medicinal mushrooms are additional opportunities for Indian growers.

At present, four mushrooms viz., Button mushroom (*Agaricus bisporus*), Oyster Mushroom (*Pleurotus* spp.), Paddy straw mushroom (*Volvariella* spp.) and milky mushroom (*Calocybe indica*) have been recommended for round the year cultivation in India.

The agro wastes of about 600 million tonnes can profitably be utilized for the cultivation of mushrooms. Currently, we are using 0.04% of these residues for producing around 1.2 lakh tonnes of mushrooms of which 85% is button mushroom. India contributes about 3% of the total world button mushroom production. Even if we use 1% of the residues for mushroom production, we can produce 3.0 million tonnes of mushrooms, which will be almost equal to current global button mushroom production (current world production 3.4 million tonnes). To remain competitive it will be important to harness science and modern technologies for solving the problems of production and bio-risk management. Mushroom being an indoor crop, utilizing vertical space offers an solution to shrinking land and better water utility.

Mushrooms have been reported to be capable of transforming agro wastes like paddy straw into protein rich food and have been confirmed to be sources of single cell protein. Mushrooms contain rich source of carbohydrates, proteins, aminoacids and dietary fibre. Vitamins such as riboflavin, niacin and pantothenic acid, and the essential minerals selenium, copper and potassium are abundant in mushrooms. The foremost importance is that mushrooms do not have cholesterol, instead contain ergosterol that act as a precursor for vitamin D synthesis in human body. Mushrooms are believed to help fight against cancer, relieves hypertension, imparts protection from heart diseases. Mushroom crop is in fact a boon that can

solve several problems like the protein malnutrition, unemployment issues and environmental pollution.

Mushrooms are cultivated indoors and do not require arable land and mushroom is a short duration crop with high yield per unit area. For Small farmers and landless workers mushroom cultivation is highly suitable for the economic and social security. This hi-tech horticulture venture relieves the pressure on arable land, because its cultivation is indoors, and is also more suited to the women folk. Mushrooms supplement and complement the nutritional deficiencies and are regarded as the highest producers of protein per unit area and almost 100 times more than the conventional agriculture and animal husbandry.

At present, the annual production of mushroom is around 6,500 tonnes, button mushroom accounts for 4000 tonnes, Oyster accounts for 2000 tonnes and milky mushroom contributes 500 tonnes. During the past two decades, the Mushroom Research and Training Centre of the Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore has made tremendous efforts on transfer of mushroom cultivation technology by imparting trainings. By this way it has contributed for the establishment of about 50 spawn producers and 600 mushroom oyster producers accounting for 5- 6 tonnes / day, 70 button mushroom producers producing 10- 12 tonnes / day and 30 milky mushroom growers contributing 1-1.5 tonnes / day in Tamil Nadu. This account for around 6 per cent of total mushroom production of the country.

## Mushroom varieties/ strains released from TNAU for commercial cultivation

Scientific Name	Variety/ strain name	Place of release
<b>Oyster mushroom</b>		
<i>Pleurotus sajor- caju</i>	M2	Dept. of Plant Pathology, TNAU, Coimbatore
<i>P. citrinopileatus</i>	Co1	Dept. of Plant Pathology, TNAU, Coimbatore
<i>P. djamor</i>	MDU 1	Dept. of Plant Pathology, AC&RI, Madurai
<i>P. eous</i>	APK 1	Regional Research Station, Aruppukottai
<i>P. ostreatus</i>	Ooty 1	Horticultural Research Station, Uthagamandalam
<i>P. florida</i>	Pf	Dept. of Plant Pathology, TNAU, Coimbatore
<i>P. platypus</i>	Pp	Dept. of Plant Pathology, TNAU, Coimbatore
<i>P. flabellatus</i>	MDU 2	Dept. of Plant Pathology, AC&RI, Madurai
<i>Hipsizygus ulmarius</i>	Co2	Dept. of Plant Pathology, TNAU, Coimbatore
<b>Milky mushroom</b>		
<i>Calocybe indica</i>	APK 2	Regional Research Station, Aruppukottai
<i>Tricholoma giganteum</i>	Co3	Dept. of Plant Pathology, TNAU, Coimbatore
<b>Button mushroom</b>		
<i>Agaricus bisporus</i>	Ooty1	Horticultural Research Station, Vijayanagaram
	Ooty 2	Horticultural Research Station, Vijayanagaram

## **Mushroom Cultivation techniques for Oyster and Milky mushroom**

### **I. Spawn production**

#### **Base spawn/ Nucleus spawn:**

Tissue culture technique is used to bring the edible mushroom to pure culture so that the mushroom fungus can further be used to prepare spawn, which is an essential material for mushroom cultivation.

- This nucleus culture is grown on Potato Dextrose Agar medium in test tubes.
- A small tissue from a well-grown mushroom is aseptically transferred to agar medium in a test tube in a culture room.
- The test tubes are incubated under room temperature for 10 days for full white growth of fungal culture. This is called base spawn/ nucleus spawn and further used for preparation of Mother spawn.

#### **Mother spawn:**

Mother spawn is nothing but the mushroom fungus grown on a grain based medium. Among the several substrate materials tested by TNAU, Coimbatore, sorghum grains are the best substrate for excellent growth of the fungus. Well-filled, disease- free sorghum grains are used as substrate for growing the spawn materials. The various steps involving in preparation of mother spawn are listed below here under.

- The sorghum grains are washed in water thoroughly to remove chaffy and damaged grains.
- The grains are half cooked for 30 minutes to soften them.

- The half cooked grains are spread evenly over a hessian cloth on a platform to remove the excess water.
- Calcium carbonate is mixed thoroughly with the cooked, air dried grains @ 20 g / Kg .
- The grains are filled in polypropylene bags up to 3/4th height (approximately 300-330 g / bag),
- A one inch diameter PVC ring is inserted on open end of the bag and plugged with non-absorbent cotton wool.
- The bags are arranged inside an autoclave and sterilize under 20-lbs. pressure for 2 hours.
- The bags after cooling are kept inside the culture room under the UV light. For 20 min.
- After 20 minutes the UV light is put off and the fungal culture is transferred in to the sterilized sorghum bags .
- The inoculated bags are kept in a clean room under room temperature for 10 days for mycelia growth and further use to prepare bed spawn.

### **Bed Spawn**

The method of preparation of bed spawn was same as that of mother spawn. The cooking, filling and sterilization were similar to that of mother spawn. After sterilization, the bags are taken and the fully grown mother spawn is used for inoculation to prepare bed spawn. Thirty bed spawn can be prepared from a single mother spawn. The bags are incubated at room temperature for 10 days for mycelia growth and used as bed spawn.

### **II. Cultivation of Oyster mushroom**

The oyster mushrooms can be grown indoors in a thatched shed where a temperature of 25-30° C and relative humidity of 85-90 per cent is be maintained.

- Paddy straw is used as the raw substrate which has to be soaked in water for 4 h and boiled for 45 minutes or steamed in autoclave for 45 min or by chemical sterilization (soaking in 7-10 g of carbendazim + 120 ml formalin/10 kg substrate /100 lit water in a drum) and shade dried until 65-70 % moisture.
- Cylindrical beds are prepared using 60 x 30 cm polythene bags with a thickness of 80 gauge.
- Paddy straw and spawn are filled as alternate layers in polythene bags and 10-12 holes are made in the beds.
- The bags are placed in the sheds in racks or in hanging rope system. After 15-16 days when the paddy straws in the bags are covered with white mycelial growth, pinheads start emerging where water spray is essential to prevent drying of buds.
- First harvest begins from 3-4 days after pinhead emergence and like wise at 5 -7 days interval three harvests can be done
- Total cropping cycle is around 40- 45 days.
- The average bioefficiency ranges (100- 150 per cent) depending on the variety.

### **III. Cultivation of Milky mushroom**

The milky mushroom requires a temperature of 30-35 ° C and relative humidity of 85-90 per cent. For cultivation of this mushroom two shed are needed.

1. Thatched House ( For spawn running).
2. A sunken poly houses ( For Crooping)

Three feet deep pit is dug out and sides are lined with hollow blocks and semi circular structure is built with GI pipe of L angle and covered with Blue silpauline sheet.

- Paddy straw is processed as in oyster mushroom cultivation and cylindrical beds are prepared with 90x 30 cm polythene bags and stored at 30°C in thatched sheds



- After 18-20 days when the paddy straws in the bags are covered with white mycelial growth, the beds are cut in to two halves and casing soil (autoclaved garden soil) is layered on to the cut halves for 2 cm height and sprayed with water.
- The cased beds are placed in poly houses and the required temperature is maintained.
- The pinheads emerge from the cut halves over the casing soil on 25-26th day.
- First harvest begins on 28th day and like wise three - five harvests can be done. The total cropping cycle is around 45-50 days. The average bioefficiency ranges from 140 - 160 per cent.



### Economics of Spawn Production (100 spawn bags per day)

Sl.No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
<b>A.</b>	<b>Capital investment</b>			
1.	Autoclave	1	40,000	40,000
2.	Boiler (GL drum 100 lit. Capacity)	2	2,500	5,000
3.	Culture room with work table (low cost)	1	15,000	15,000
4.	UV lamp with fittings	1	2,000	2,000
5.	Tube light fittings	1	200	200
6.	Advance for LPG gas	2	3,000	6,000
7.	Spawn storage room	1	22,000	22,000
8.	Bunsen burner	1	150	150
9.	Hear efficient chulah	1	600	600
10.	Glass wares & chemicals			5000
	<b>Total</b>			<b>95,950</b>
<b>B.</b>	<b>Fixed cost</b>			
1.	Interest on capital investment @ 15%			14,392
2.	Depreciation (Item 3 & 7 @ 5%)			1,850
3.	Depreciation (Item 1, 2, 4, 5, 8 & 9, 10-10%)			5,895
	<b>Total</b>			<b>22,137</b>
<b>C.</b>	<b>Recurring cost (100 spawn x 300 days)</b>			
1.	Polypropylene bags	150 Kg	135	20,250
2.	Sorghum grains	8000 Kg	14	1,12,000
3.	Calcium carbonate (commercial grade)	160 Kg	20	3200
4.	Non-absorbent cotton (400 g rolls)	600	110/roll	66,000
5.	Fungicides & Fumigants	--	--	2,000
6.	Electricity & Fuel	--	--	30,000
7.	Labour @ 2 men per day for 300 days	300	320/day	96,000
10.	Miscellaneous	--	--	5000
	<b>Total</b>			<b>3,34,450</b>

#### Total cost of Spawn production / Year (Rs)\_

Working expenditure : **3,34,450**

Total fixed cost : **22,137**

Total Cost : **3,56,587**

#### Income ( Rs.)

By sale of 30,000 spawn bags @ Rs.25 per bag : **7,50,000**

Total cost : **3,56,587**

Net income per year : **3,93,413**

Trade Mark of TNAU



## Economics of Oyster mushroom production (10 Kg/day/300 days)

### Low cost Investment

Sl.No.	Item	Quantity (nos.)	Rate (Rs.)	Total (Rs.)
<b>A.</b>	<b>Capital Investment</b>			
1.	Thatched House ( 15'x 25')	1	25,000	25,000
2.	Chaff cutter (Lever type)	1	1000	1000
3.	Boiler	1	2,000	2,000
4.	Drum	1	1,000	1,000
5.	Spraying systems	1	500	500
6.	Biomass stove		300	300
	<b>Total</b>			<b>29,800</b>
<b>B.</b>	<b>Fixed cost</b>			
1.	Interest on A @ 15%			4470
2.	Depreciation (Item 1 @ 30%)			7500
3.	Depreciation (Item 2,3,4,5 & 6 @ 10%)			480
	<b>Total</b>			<b>12450</b>
<b>C.</b>	<b>Recurring Cost</b>			
1.	Paddy straw cost + transport	3 .5 t	4500	15750
2.	Spawn @ Rs.25 / No.	2000	25	50,000
3.	Polythene bags for bed & packing	25 kg	130	3375
4.	Fungicides, Fumigants & Chemicals	--	--	1,000
5.	Labour @ 1 Per day	300	160/day	48000
6.	Others	--		1,000
	<b>Total</b>			<b>1,19,125</b>

### Total cost of mushroom production / Year (Rs.)

Working expenditure	:	1,19,125
Total fixed cost	:	12,450
<b>Total Cost</b>	:	<b>1,31,575</b>

### Income( Rs.)

By sale of 10 Kg/day @ Rs.90 for 300 days :	2,70,000
Total cost :	1,31,575
Net Income per year :	<b>1,38,425</b>

## Economics of Milky mushroom production (10 Kg/day/300 days)

### Low cost Investment

Sl.No.	Item	Quantity	Rate (Rs.)	Total (Rs.)
<b>A.</b>	<b>Capital Investment</b>			
1	Thatched House ( 15'x 20')	1	20,000	50,000
	Blue Poly house- 20'x50' area (1000 sq.ft)	1	30,000	
2	Chaff cutter (Lever type)	1	1000	1000
3	Boiler	1	2,000	2,000
4	Drum	1	1,000	1,000
5	Spraying systems	1	500	500
6	Biomass stove		300	300
	<b>Total</b>			<b>54,800</b>
<b>B.</b>	<b>Fixed cost</b>			
1	Interest on A @ 15%			8,220
2	Depreciation (Item 1 @ 10%)			5000
3	Depreciation (Item 2,3,4,5, & 6 @ 10%)			480
	<b>Total</b>			<b>13,700</b>
<b>C.</b>	<b>Recurring Cost</b>			
1.	Paddy straw cost +transport	3.5 t	4500	15750
2.	Spawn @ 25 / day	1600	25	40,000
3.	Polythene bags for bed & packing	25 kg	130	3375
4.	Fungicides, Fumigants & Chemicals	--	--	1,000
5.	Labour @ 1 Per day	300	160/day	48000
6.	Others	--		1,000
	<b>Total</b>			<b>1,09,125</b>

### Total cost of mushroom production / Year (Rs.)

Working expenditure : 1,09,125

Total fixed cost : 13,700

Total : **1,22,825**

### Income (Rs.)

By sale of 10 Kg/day @ Rs120 for 300 days : 3,60,000

Total cost : 1,22,825

**Net income per year : 2,37,175**

Trade Mark of TNAU





# Part XIV

## SEASON OF FLOWERING AND FRUITING OF FRUIT CROPS

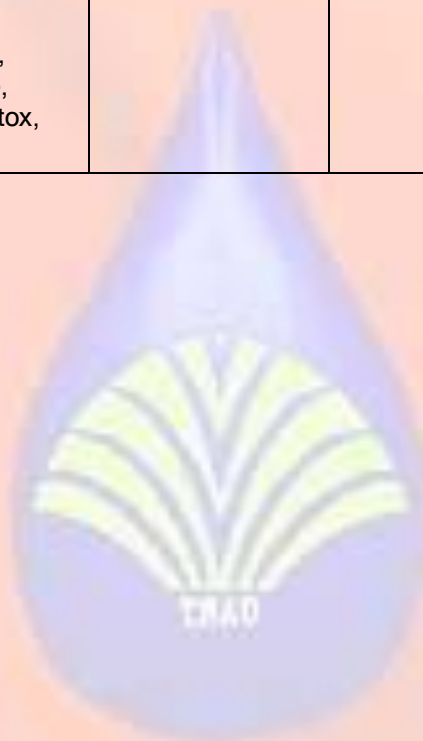
Crop	Season of flowering	Season of fruiting
Mango		
Main season	November - December	April - June
Off season	August - September	January - February
Lime	October - November	January - March
Mandarin	July - August	November - December
Grapes	February - March June - July	April - May August - September
Papaya	Throughout the year	Throughout the year
Sapota	i. June - August ii. October - December iii. March	i. October - December ii. February - April iii. July
Guava	i. April - May ii. July - August iii. October - December	i. August - September ii. November - December iii. January - March
Pineapple	September - October	March - June
Jack		
Main season	September - October	March - June
Off season	May - June	October - December
Pomegranate	May - July	October - January
Custard apple	May - June	September - November
Ber	June - July	October - November

<b>Crop</b>	<b>Season of flowering</b>	<b>Season of fruiting</b>
Indian Gooseberry	i. July - August ii. February - March	January - February August - September
Jamun	March - April	August - September
Wood apple	May - June	January - March
Bael	May - June	April - May
Tamarind	September - October	March - April
Karonda	February - March	May - June
West Indian Cherry	August - September	December - January
Mangosteen	January - March	June - August
Passion fruit	i. February - March ii. June - July	June - July September - October
Carambola	i. April - May ii. July - August iii. September - October	July - September November - December January - February
Rambutan	February - March	June - August
Durian	December - January	May - September
Avocado	January - March	May - September
Fig	i. October - November ii. February - March	February - June July - September
Apple	February - March	May - July
Pear	February - March	June - September
Plum	February - March	May - June
Peach	January - February	May - June

# Part XV - CHEMICAL AND COMMERCIAL NAMES OF INSECTICIDES AND NEMATOCIDES

CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
1.CHLORINATE-DHYDROCARB-ONS* Aldrin I	Agroaldrin, Alcrop, Aldrex, Aldrin, Kilter, Mildrin, Termalit	5 D, 30 EC,20 EC	C, S, F	67 (38)	200 for rats 15.25 for rabbits
* Chlordane I	Agrosan,Chlordane, Chloroddra, Mitox, Starchlor, Termex, Termikil, Vegfrichlorbu	5 D, 10 D, 20 EC	S, C, F	250-500	217 rats, 780-840 rabbits
* DDT I	950,Agdit,Carox, Corodet, DDT, DEE,Deetol,Entomit,Hildit-Dinex,IntoxD-DT,Kilpest, Ramdit, Starrdit, SulBit-5 D, Tafarol, Tafeidex, TOL, Topdit,	18.5 EC	S, C	250-300 (113)	2510
Dicofol I/A	Banmite, Delcofol, Dicofol, Hilfol,Kelthane,Micothane, Tagfol, Vikofol,	18 EC	C,	809(575)	1000-1230
* Dieldrin	Dieldrin	18.5 EC	C,S	40-87 (46)	90
*Banned. See the Gazette Notification.					

Endosulfan I/A	Agrosulfan, Agirosulfan, Bangsulf, Cacosulfan, Citosulfan, Endocel, Endocid, Endohit, Endomil, Endosol, Endostar, Endosulfan, Endotaf, Ensocrop, Ensosulfan, Entacid, Fisulfan, Hexasulfan, Hildan, Hysulphan, Kemsulfan, Kilexantisulpass, Luslfan, Marvel, Parasulfan, Parry sulfan, Ramfan, Sicosulfan, Solasulfan, Sujadane, Tagsulfan, Thiokill, Thiodan, Thiotox, Vegfro, Vikasulfan	35 EC 4 D	C, S	40-50 (18)	360 for rabbits
----------------	--	-----------	------	------------	-----------------



CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
*HCH (BHC)	Agrobenz, Benzichlor, Corohex, Entemix, Gammaxene, Hexido, Hilbech, IntoxBHC, KeroBHC, KilpestBHC, Premodole, Ramacholare, Solchlor, Submar, Sulbez-50	10 D, 50 WP	C, F	200(100)	1000
Heptachlor 1	Agrochlor, Heptachlor, Heptaf, Heptar, Heptox, Heptox, Vegfov	2D, 20 EC	C, S	130 (40)	195-250 2000 rabbits
Lindane 1	Agrodane, Canon, GammaBHC, Knodane, Lindon, Lindone, Lindane, Lin sulpn, Micodane, Rasayan	6 G 20 EC 0.65 D 1.3 D	S, F, C	88-125 (76)	900-1000
Tetradifon I/A	Agrodifon, Hexamiton, Tedion, Treat	8 EC	C	500-15000(566)	10,000
*. Banned. See Government Notification.					
2. ORGANOPHOSPHATES					
Acephate I	Acemil, Agrophate, Asataf, Orthene, Start thenet Lancer, Torpedo, Tremor.	25 EC 75 SP	Sy, S, C	605-1100 (700)	2000
Carbophenothion I/A	Trithion	25 WP, 3 D, 10 G	C	32-90 (10) 166 mouse	1270 rabbits
Chlorfenvinphos I/N/A	Birlane	24 EC 10 G	C,F	24-39 (20)	1250-2500 rats 400-4700 rabbits
Chlorpyrifos I	Agrofos, Bangspan, Chlorofos, Coroban, Danusban, Durmet, Dursban, Gilphos, Hyban, Lethal, Radar, Ruban, Strike, Suban, Sulban-20	20 EC	C,S,F	135-163 (163)	2000 rabbits
Diazinon I/N/A	Agroziron, Basudin, Bazanon, Delzinon, Suzinnon, Zionovl	5 G 20 EC	C,S,F	300-850(75)	2150,3600 rabbits

Dichlorvos I/A	Agrovan-76, Bangvos, Bargros, Dichlorvos, Divipan, Divipan, Divisol, Nukem 776, Nuvan, Nuvasul, Paradeep, Vapona	76 WSC	C,F	50-8(56-80)	500
----------------	--	--------	-----	-------------	-----





CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
Dimethoate I/A	Agrodimet-30, Agromat, Champ, Cifor, Corothiate, Cropgor, Cygon, Hygro, Devigon, Dimor, Dimer, Dimethoate I/A, Dimethote, Dimex, Entogor, Hexagor, Kemithoate, Kilxdimethoate, Kilterx, Micor, Milgor, Paragor, Parrydimate, Rogor, Sicothate, Sulgor, Tagor, Tara 909, Vikagor	30 EC	Sy,C,F	250 (152)	600-1200
Disulfoton I/A	Solvirex, Disyston	5 G	Sy, C, S	26-125(2)	41 (for 4 hrs)
Ethion I/A;	Demite, Dhanumit, Ethiosul, Fosmite, Fieathion, Force, Fosmite, Miti cil, MIT 505, Novathion, Tafethion, Vegfru fosmite.	50,EC	C	208 pure (13)	915 guinea pigs
Fenitrothion I/A	Accothion, Agrothion, Fenitox, Fenitrogil-50,Fenitrothion, Fethiol,Folithion,Hexafen, Sumithion	5 D 50 EC	C, S, F	570-740 (250)	1300,300 mice
Fenthion I/A	Lebaycid, Fenthion	100 EC	C, S	241-316 (215)	345-410
Formothion I/A	Anthio	25 EC	Sy, C, S	375-535 (250)	400-1680
Malathion I	Agrolmal,Agromala, Bangmal,Bugtax,Corothion, Cythion,Entomol,Hilthion, Kathion, Kpmalathion, Malahi-90,Malamar,Malathion, Malatox,Malzone, Svlmalathion, Taimal	5D, 25WDP 50,EC	C, S	1375-2800 (885)	4100 rabbits
Menazon I	Sayfos	70 WP	Sy, C, S	1950	500-800 rabbits
Mephosfolan, I	Cytrolane	5 G	C, Sy	9-11	28 rabbits

Methamidophos I/A	Monitor, Metataf, Tamaron	50 EC, 40 WSC,	CSy	30-50	50-10
Methyldemeton I/A	Hexasystox, Himax, Knockout, Metasystox, Parasystox.	25 EC	Sy, C, S	40-60	250



CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
Methyl paration	Agropara, Agrotex, Corocid, Devithion, Dhanumar, Entocid, FolidolM, Dagrodal, Kempar, Kildet, Kilex, Klofos, Luthion, Milon, Metacid, Metapar, Methyl parathion, Metpar-760, M.Devithio, Paracrop, Parahit, Paramar, Paramet, Parasul, Parataf, Parathol, Paratox, Ramcidd, Ramthion, Tagpar, Vegfro, Vika cid	2 D, 50 EC 46.7 EC	C, S, F	12-42 (6)	67-420 rabbits
Phenthoate I/A	Agrophen,Aimsan, Cilphenthoate, Delsan, Dusab, Elsan, Fenthoate, Phendal, Phenthasul, Phentox, Tagsan	2 D, 50 EC	C,F	200-300 mice	-

Phorate I/N/A	Aelmet, Agrophorate, Cifphorate, Dragnet, Forate-10G, Foratox, Fortan, Fortox, Glorate, Granutex, Grenade, Kamet, Lophate, Milate, Phorate, Starphor-10G, Starphos, Thimet, Vegfro, Volphor	10 G	Sy, C	16-37(1.1)	20-30 (24hrs) Guinea pigs
Phosalone I/A	Agrosalone, Micozons, Phosal, Phosalone, Sugalone, Zolone	4 D, 36 EC	S, C	135 (120)	390 female rats



CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
Profenofos I	Curocron, Carina	50 EC	S, C	-	-
Propetamphos I	Safrotrin (Pesticides)	20 EC	S, C	380-490	4000
Phosphamidon I/A	Agromidon, Agrophos, Bangdon, Cildon, Daron, Dimecron, Entocron, Kilro don, Phamidon, Phoskil, Sicomidon, Sudon, Sumidon, Vimidon	85 WSC	Sy, C, F	17.9-30 (17)	374-530 267 rabbits
Quinalphos I	Agriphos, Agroquin, Agroquinal, Award, Desalux, Ekalux, Entolux, Gilquin, Hyquin, Keterphos, Kilex, Krush, Quinalphos, Kinalux, Milux, Pharulux, Quinal, Quinalphos, Quinaltaf, Quinotox, Ramlux, Sicophos, Sicophosa, Smash, Solux, Starbrand, Tagquin	1.5 D, 25 EC, 5 G	C, S	62-137(26)	1250-1400
Thiometon I/A	Ekatin, Hexatin, Thiotox	25 EC	Sy, C, S	86-225 (25)	-
Triazophos I/A	Hostathion	25 EC	S, C	(64)	-
Trichlorfon I	Dipterex, Trichlorfon, Tugon	5 D, 5 EC, 50 WDP	S, C	450-630(450)	2000
Vamidothion	Kilval, Vamidothion, Valoson	40 EC	S	64-105	1160 rabbits
3. CARBAMATES					
Aldicarb I/N/A	Temik (Production stopped)	10 G	Sy, C	0.9	400-3200
Carbaryl I	Agrovin, Agroyl, Bangwin, Carbamate, Carbaryl, Carvint, Corovit, Devicarb, Hexavin, Kervin, Kildiryl, Kilexcarbaryl, Sevidol, Sevimo, Sevin	5D, 10D, 50, 80, 85 WDP 85 S, 40 LV, 4G	C	400-850 (250)	4000-2000 rabbits

Carbofuran, I/N/A	Furadan, Hexafuran, Vegfrodiufuran	3 G	Sy (?), C, S	8-14(5.3)	2550, 10200 rabbits (24hrs)
Methomyl I/N	Dunet, Lannate	12.5 L	C, Sy, S	17-24 (60)	1500 rabbits





CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
Oxamyl I/N	Vydate	24 WSC, 10G	Sy, C	5.4	2960 rabbits
Propoxur I	Baygon	20 EC, (PH)	C	100(83)	600-1000
4. PYRETHROIDS					
Cypermethrin	Agrocyper, Bilcyp, Bullet, Challenger, Cilcord, Cymbush, Cymet, Cymetd, Cyper 10, Cyperhit, Cyperkil, Cypermil, Cypersul, Cyporin, Hilcyperin, Hipower, Hycyper, Lacer, Mortal, Parathrin, Ralothrin, Ramagper, Ripcord, Shakti Ustod, Sicorin, Sirex, Starcyprin, Superkiller, Tackle, Trofy, Ustadd, Vegfrocolt	10 EC, 25 EC	C, S	200-800 (251)	>1600
Deltamethrin I	Decis, Decametherin, Decathrin	28 EC	S, C	128-139 (4)	>2000 rabbits
Lambda Cyhalothrin I	Karate	5 EC	C	56-79	632-696
Fenvalerate I/A	Agrofen, Bangrenn, Capvalerate, Fenkil, Fenval, Fencid, Fenicidin, Fenhit, Fenis, Fenoron, Fenrio, Gilten, Hitten, Hyfen, Kagrofen, Lufen, Milfen, Parafen, pavshafen, Pensil, Ramfen, Sicofer, Starfen, Sujafen, Sumicidin, Tagfen, Trifen, Triumheard, Valour, Vegfro, Vikafen	20 EC	C, S	3200(451)	5000, 2500 rabbits
Fluvalinate I	Marverick, Starfen	-	-	-	-
Pyrethrin I	Pyrocone E	-	C	570-1500 (584-900)	Not determinable
Alphacypermethrin I	Alphaguard Fastac, Stop	10 EC	C	-	-
5. MISCELLANEOUS COMPOUNDS					

Aluminium Phosphide I/R/A	Al-phos, Celphos, Phostoxin, Quickphos,	3 g tablet	F	32-90	-
Bromadiolone R	Bromadiolone, Bromadiolone R	0.25 SP, SL 0.005 CAKE, 0.005 bait	Anticoagulant	1.25 (rats)	21 mg/l g (rabbits)



CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
Diflubenzuron IGR	Dimilin	25 WP	C, S	4630 mouse	-
2000 rabbits					
Sulphur I/A/F	Sulphotox, Wetsulf, Devisulfan, Hexsasul, Sulfex,	40,80,85, WP	C	Non-toxic mild laxative	Skin and eye irritant
Warfarin, R	Warfarin, Rotafin, Rotafin, Ragumin	0.5 SP	Anticoagulant	1.3 (1550)	-
Zinc phosphide R	Zinc phosphide, Zincox, Ratol, Agrosphos	50 WP Granules	F	45.7 (45)	-
6. NEEM PRODUCTS					
Neem Oil	GodrejAchoo, Biosol, Kemissal, Margocide OK, Margosal, Neem plus, Neemguard, Neem pure, Nimbecidine, Phytowin, TNAU Neem	EC 1 K	Antifeedant Repellent, Oviposition deferrant,	-	-
Neem kernel	Ecomak, Margocide-OK, Neemax, NeemactinNeemicide	-	-	-	-
Note: Oil based emulson contains 0.03% and neem kernel based emulsion contains 0.15% azadirachtin					
7. BIOCIDES					
<i>Bacillus thuringiensis</i> Var <i>kurstaki</i> (B.t.k)	Delfin (Serotype 3 A&B), Biolep (BTK-I), Bioasp (BTKII), Biobit, Dipel 8 L, Halt, Lupin, Spectrin.	-	-	-	-
8. NICOTINYL					
1. Acetamiprid I	Pride	20 SP	C, S, Sy	146 - 270	>5000

2. Imidacloprid	Gaucho, Confidor, Imidacloprid, Tatamida	70 WS, 600 FS, 17.8 SL, 200 SL	Sy	450	5000
3. Nitenpyram	Best guard	SP, GR	Sy	1680	>2000



CommonName	Trade/ Common Name	Formulations	Mode of action	Toxicity LD 50	
				Oral	Dermal
4. Thiamethoxam	Actra, Cruiser	25 WG, 70 WS	Sy	5000	>2000
5. Chlothianidine	Poncho	600 FS	Sy	2000	2000
6. Thiacloprid	Calypso	240 SC	Sy		
<b>9. NERISTOXIN</b>					
Cartap Hydrochloride	Padan, Caldan	4G, 50SP	C,S, Sy	345	>2000
<b>10. PYRAZOLE</b>					
Chlorfenapor I/A	Pirate, Stalker	EC, SC	S, C	441-1152	>2000
Fenpyroximate A	Danitoron, Ortus, Pamanrin	SC	C, S	245 - 480	>2000
Tebufenpyrad A	Comanche, Masai, Oscar, Pyranica	EC, WP, WG	S, C	595 - 997	>2000
Fipronil I	Prince, Regent	SC, GR, FS, EC, WG	C, S, Sy	97	345 (rabbit)
<b>11. AVERMECTINS</b>					
Enamectin I/A	Proclaim	5 SG	C, S	>5000	>2000
Spinosyn I/A	Spinosed, Success,	48 SC	C, S	>5000	>2000
Spiromesifen I/A	Regent, Oberon	240 SC	C, S, Sy	>2000	>2000

### Abbreviations

A-Acaricide, C-Contact poison, F-Fumigant, I-Insecticide; IGR-Insect Growth Regulator, D-Dust; EC-Emulsifiable Concentrate; G-Granules; LV-Low Volume; N-Nematicide; R-Rodenticide, S-Stomach poison, SL-Soluble Liquid; SP-Soluble Powder, Sy-Systemic poison; ADP-Water Dispersible Powder; WP-Wettable Powder, WSC-Water Soluble Concentrate.

Fenthion 100 w/v but 80 EC w/w.

**NOTE:** LD<sub>50</sub> values are units for rats unless specified

**Source:**

The Agrochemicals Handbook-1983 (eds) Dougals Hartely and Hamish Kidd. The Royal Society of Chemistry (Pub.), England. In parentheses, the values from EPA, 1984 Analytical Reference Standards and Supplemental Data-The Pesticides and Industrial Chemical Repository; Pesticides Annual 1989-90





## Trade Mark of TNAU



# Part XVI

# CHEMICAL NAMES OF FUNGICIDES

## Copper Fungicides

Copper Sulphate preparations

**Bordeaux mixture** It is prepared by mixing Copper Sulphate and lime in water (To get 1 % mixture, mix 1 kg of  $\text{CuSO}_4$  and 1 kg of lime in 100 litres of water.

**Bordeaux paste** It is prepared by mixing 1 kg of  $\text{CuSO}_4$  and 1 kg of lime in 10 litres of water.

**Burgundy mixture** It is prepared by mixing of 1 kg of  $\text{CuSO}_4$  and 1 kg of Sodium Carbonate in 100 litres of water. Burcop, Taytox.

**Cheshunut compound** It is prepared by mixing 2 parts of Copper sulphate and 11 parts of Ammonium Carbonate.

## Sulphur fungicides

Inorganic Sulphur

Elemental Sulphur

Sulphur dust

Wettable Sulphur

**Organic Sulphur (Dithiocarbamates)**

Ziram

Thiram (TMTD, Thiuram)

Zineb

Mancozeb

## Mercury Fungicides

**Inorganic Mercury**

Mercuric chloride

Mercurous chloride

## **Organic Mercurials**

Methoxy ethyl mercury chloride

Phenyl mercury chloride

Ethyl mercury chloride

Tolyl mercury acetate

Trade Mark of TNAU

## **Heterocyclic Nitrogen Compounds**

Captan, Captofol, Glyodin, Folpet

## **Benzene compounds**

Quintozene

Dichloron

Fenaminosulph

Dinocap

## **Quinone Fungicides**

Chloranil

Dichlone

## **Organo Phosphorus fungicide**

Edifenphos

## **Organotin compounds**

Fentin hydroxide

Fentin acetate

Fentin chloride.

## **Systemic fungicides**

### **1. Oxathalin and related compounds**

Carboxin



Oxycarboxin

Pyracarbolid

## 2. Benzimidazoles

Benomyl

Carbendazim

Thiabendazole

Funberidazole

## 3. Thiophanates

Thiophanate

Thiophanate methyl

## 4. Morpholines

Tridemorph

Dodemorph

## 5. Phrimidines, Piperidines and imidazole

Triadimefon

Triademenot

Ethazole

## 6. Hydroxy Pyrinidines

Ethirimol

Dimethirimol

## 7. Benzanilide Dervative

Mebanil

Benodanil

## 8. Organo phosphorous compounds

Trade Mark of TNAU



Pyrazophas

Iprobenphos

**9. Piperazine**

Triforine

**10. Phenot derivative**

Chloroneb

**11. Triazole compounds**

Triazbutyl

**12. Other systemic fungicides**

Metalaxyl

Tricyclazole

Fosetyl Al

Hexaconazole

Propiconazole

Tebuconazole

Penconazole

Difenoconazole

Pyroxychlor

**Other Fungicides**

Binapacryl

Chinomethionat

Chlorothalonil

Dodine

**Antibiotics**

Trade Mark of TNAU



Streptomycin sulphate

Oxytetracycline

Streptocycline

Aureofungxin

Griseofulvin

Cycloheximide

Thiolutin

Endomycin

# **Part XVII**

# **WEED MANAGEMENT**

# **AND HERBICIDES USAGE**

# **IN HORTICULTURAL**

# **CROPS**

Weed management has become an integral part of Agriculture. There is little doubt that with the progressive modernisation of Indian Agriculture involving intensive inputs, herbicide use will steadily gain an importance in the coming years. In the recent decades, the growth of herbicides took place principally at the expense of fungicides, which declined from a market share of 40 per cent in 1960 to 25 per cent in 1995. About 72 per cent of the herbicide consumption out of the total took place in the developed countries, viz., USA, Western Europe and Japan. As against the growth of 2.5 per cent for insecticides and 3.3 per cent for fungicides, the herbicides



grew at the rate of 5.0 per cent per annum.

In India, commercial use of herbicides came in 1980. During this period, the herbicides registered a significant growth than insecticides and fungicides. From a meagre 2 per cent share of the total pesticide consumption in the seventies in India, herbicides now account for about 11 per cent of the pesticides market. While this is a very encouraging development, the herbicide consumption in our country is still much less than that in developed countries, where herbicides constitute 40-50 per cent of the total pesticide consumption.

### **Conjunctive use approach:**

There are several advantages of using soil applied herbicides in conjunction with fertilizers. Trials on impregnated fertilizers with herbicides have been highly successful and fertilizers impregnated with several herbicides are now commercially available in USA. Herbicides like Treflan, Sutan, Sencor and Bladox are being efficiently used through this technique. Adequate research efforts need to be undertaken in this regard to develop appropriate technology for the different agroclimatic conditions including herbigation.

### **System approach:**

Integrated weed management (IWM) practices for individual crops have been developed by several workers. There is a need to study the various components of IWM into a system approach.

## **Integrated weed management system**

This approach includes the use of high yielding varieties that resist weed competition and reduce the weed-seed reserve in the soil. Practices like preplanting seed bed tillage, effective seed-bed preparation and seeding methods enhance crop growth and minimise weed growth. The use of crops that form early canopy with optimum plant population are integrated to optimize the crop growth and thus to minimise the weed growth. Precision in placement and timing of fertilizer application maximise stimulation of crops and minimise stimulation of weeds. The IWM system also includes the use of judicious irrigation practices, timely and appropriate cultivation, sound crop rotation, crop diversification, field sanitation and harvesting methods that do not spread weed seeds, use of biological agents and effective chemical methods. However, the crop-weed interactions are complex and needs application of recent advancements for the development of future weed management strategies.

## **Crop-weed competition**

Experimental results have shown that crop-weed competition at critical stages of crop life has reduced the yields in several crops. Often this period is approximately the first one fourth to one third of crop life for annual vegetables and for perennials flowering to maturity periods. Estimation of crop-weed interactions through mathematical models is being attempted.

## **Modelling of crop-weed interactions**

Competition between crop and weed for growth inputs (light, water and nutrients) is a critical process in agricultural ecosystems. The mechanisms of competition are not simple. Models on weed invasion, population growth and control will be useful for organizing biological informations on weeds and for developing weed control strategies. Conventional field trials cannot answer several of the key questions in weed control because of the constraints of cost, time or complexity. Hence models are essential as an integral part of weed management research and advice.

## **Bio-herbicide approach**

Fungi are most useful and hence the term 'mycoherbicide' is also used to refer bio-herbicides. 'De vine' containing a formulation of soil borne fungus *Phytophthora palmivora* and Colleague containing spores of *Colletotrichum gloeosporioides* an endemic anthracnose fungus are commercialised bio-herbicides. Other fungal bio-herbicides have been developed including 'Velgo' based on *Fusarium lateriteum* and 'Casst', which is based on *Alternaria cassiae*.

## Trade Mark of TNAU



## Naturally occurring herbicides

Many chemicals have been found to possess good herbicidal activity. 'Bialophos' is the first herbicide developed by this method and commercially marketed in Japan under the trade name 'Herbiace' isolated from fermentation broths of *Streptomyces agroschopius* and *S. viridochromogens* exhibits activity against wide spectrum of grasses and broad leaved weeds on foliar application.



## **I. FRUITS**

### **GRAPES**

Application of Diuron @ 3.5 kg/ha or Glyphosate @ 2 kg/ha.

Herbicide application in grapevines must be done carefully with low pressure nozzle to prevent drift.

### **BANANA**

Pre-emergence application of Atrazine or Diuron at 1.5 to 2 kg/ha soon after planting would keep the ground weed free for 3 to 5 months. At post emergence, Paraquat or Dalapon or 2,4 - D or Glyphosate can be used.

### **PINE APPLE**

Pre-emergence herbicides like Simazine or Atrazine or Diuron 3 to 4 kg/ha application 4 - 6 weeks before planting and ploughing the field 2 weeks before the leaves of the crop began to curled down to prevent weed establishment. Weed growth emerging later is treated with post emergence herbicides such as or Glyphosate 0.5 kg/ha or Dalapon 3 to 4 kg/ ha or 2,4 - D 0.5 to 1 kg/ha depending upon the predominant weed species. Dalapon spray drift can cause chlorosis on outer leaves and necrosis on leaf tips when pineapple plants are young. It should be applied carefully any time from 6 months.

## **II. VEGETABLES**

### **TOMATO**

In Tamil Nadu, tomatoes are being grown in three seasons namely June-July, December January and March.

The critical period of weed competition in tomato is the first 30 days after transplanting. For the control of annual grasses, preplanting soil incorporation of Trifluralin 3 to 5 kg/ha or Nitratin 3 to 5 kg/ha or Diphenamid 2 to 4 kg/ha is best. Similar application of EPTC 2 to 3 kg/ha controls nutgrass. Effective pre emergence herbicides of Pendimethalin 1.00 kg/ha, Alachlor 1 to 2 kg/ha, Metribuzin 0.75 kg/ha, Fluchloralin 1.0 kg/ha followed by one hand weeding on 30 DAS. Generally, a pre emergence herbicide followed by one hand weeding in the later period of crop growth gives complete weed control.

Herbicides which need preplant incorporation are particularly useful in the nursery.

In the transplanted field they are applied 3 to 4 weeks before planting seedlings.

## Trade Mark of TNAU



## **BRINJAL**

Pendimethalin @ 1.0 kg/ha as pre sowing incorporated spray + one Hand weeding at 6 weeks after transplanting or Pre emergence application of Oxyflourfen @ 0.5 kg/ha at 3 days after transplanting followed by one hand weeding at 30 days after transplanting. Post emergence application of Quizalofop-p-ethyl @ 1.00 kg/ha.

## **ONION**

Onion germinates and grows relatively slow and hence weed competition is more critical upto 40 days after sowing. Pre plant incorporation of Fluchloralin 1.0 kg/ha or Pre- emergence application of 0.20 kg/ha followed by one hand weeding at 45 days after sowing.

## **CHILLIES**

Pre-emergence application of Pendimethalin 1.00 kg/ha or Oxyfluorfen 0.15 kg/ha was supplemented with one hand weeding at 30 days after transplanting.

## **BHENDI**

- Pre emergence herbicide - Pendimethalin @ 1.00 kg/ha.
- Post emergence herbicide -Fluazifopbutyl@ 0.25 kg/ha + hand weeding on 30 DAS.
- Pre emergence application of Oxyfluorfen at 0.15 kg/ha (or) Fluchloralin at 1.00 kg/ha (or) Metolachlor at 0.75 kg/ha followed by one hand weeding on 30 DAS.

## **COLE CROPS (Cabbage and Cauliflower)**

Pre emergence application of Fluchloralin @1.00 kg/ha or Pendimethalin @ 1.0 kg/ha along with one hand weeding at 40 days after planting.

## **CARROT**

Preplant incorporation of Fluchloralin @ 1.00 kg/ha or pre-emergence Pretilachlor @ 0.5 or Metribuzin at 1.0 kg/ha to control annual weeds.

## **BEANS**

The critical period of weed competition is the first 40 days after sowing. Pre-plant incorporation of EPTC 3 to 4 kg/ha or Trifluralin 0.5 to 1 kg/ha or pre-emergence application of Fluchloralin @ 1.0 or 1.5 kg/ha.



## **RADISH**

Application of pre-emergence Metolachlor 1.0 - 2.0 kg/ha or Alachlor 1.5 - 2.0 kg/ha or Isoproturon 1.0 - 1.25 kg/ha or Pendimethalin 1.00 kg/ha or Fluchloralin 1.00kg/ha.

## **PEAS**

Pre-emergence application of Alachlor 1 to 2 kg/ha or pre-plant soil application of EPTC 2 to 3 kg/ha.

Dalapan is applied as post emergence when Peas are 5 to 15 cm tall but not within 25 days of harvest. MCPA and MCPB are applied when broad leaved weeds are at 10 to 15 cm tall.

## **GARLIC**

Pendimethalin 1.0 kg/ha + one hand weeding at 40 days after sowing.

Pre (or) Post transplanting application of Fluchloralin @ 2.00 kg/ha.

## **POTATO**

Pre plant incorporation of Fluchloralin @ 2.00 -3.00 kg/ha.

PE (or) Early post emergence of Metribuzin @ 0.75 kg/ha.

PE application of Oxyfluorfen @ 0.40 kg/ha.

**All Gourds:** Hand weeding thrice at 15 days intervals

**Cucurbits:** PE application of Oxyfluorfen @ 0.25 kg/ha

PE application of Metribuzine @ 0.50 kg/ha.

## **III. SPICES**

### **CUMIN / FENGREEK / CORIANDER**

Pre-planting incorporation of Fluchloralin 1.00 kg/ha. (or) PE application of Pendimethalin @ 1.00 kg/ha or Quizalofop @ 1.00 kg/ha as post emergence supplemented with one hand weeding.

## **IV. PLANTATION CROPS**

### **COFFEE**

Single tank mix application of Diuron 1 kg/ha with Paraquat 0.4 kg/ha or Glyphosate 0.8 kg/ha. In coffee nurseries, apply Simazine 2 to 2.5 kg/ha immediately after planting coffee in polythene sleeves.

At post emergence spray of 8 ml/ l of Paraquat or Glyphosate @15ml/ l are used to control many perennial weeds.

Sequential application of Dalapan 1 to 2 weeks later by Paraquat and subsequently by Dalapan controls perennial grasses effectively.

### **TEA**

Although herbicides are now used over 60% of the area under tea, manual methods like cheeling, sickling and mulching are extensively used wherever labour is available than by chemical method. Cheeling removes the above ground weed growth and prepares the ground for pre-emergence herbicide application. Sickling is done to remove the tall growth of perennial weeds and cut it back to the ground level for a follow up application of foliage applied herbicides on the regrowth.

Pre-emergence application of Oxyfluorfen @ 0.40 kg/ha. Foliage application of Paraquat (8ml/l) + 2,4 – D(6g/l) or Glyphosate(15ml/l) depending on the weed spectrum and this would keep tea weed-free for the rest PE application of Oxyfluorfen at 0.40 kg/ha of the year.

### **Nursery:**

Weed control in clonal nursery is done by (2 to 3 weeks before planting cuttings) application of Simazine at 2 kg/ha. After 6 months Simazine is applied once again at the same dose.

In the case of seed nurseries hand removal is done for 6 months after planting and then Simazine applied at 2 kg/ha.

### **Young tea (Until 3 years)**

Application of Simazine 1.5 to 2 kg/ha or Paraquat 0.3 - 0.4 kg/ha at pre-emergence and 2,4 - D 0.5 to 1 kg/ha at post emergence.

### **Matured tea (Above 3 years)**

Simazine 1.5 to 2 kg/ha or Diuron 2 kg/ha as pre-emergence herbicides. Paraquat or 2,4 - D or Paraquat + MSMA or Glyphosate are applied as post emergence.

Common Name	Trade Name	Time of application
Trifluralin	Hexatox; Toxa-phone, Treflan	Preplant; pre-em
Nitralin	Planavin	Preplant; pre-em
Diphenamide	Dymid, Enide	Preplant; pre-em
Alachlor	Lasso	Pre-em
Metribuzin	Sencor	Pre-em; Post-em
Fluchloralin	Basalin	Pre-em
Nitrofen	Tok-E 25	Early post; Pre-em

Chloramben	Amiben, Vegiben	Pre-em
Metolachlor	Dual	Pre-em; Early post
Pendimethalin	Procol, Herbadox stomp	Pre-plant; Pre-em
Oxyfluorfen	Goal	Pre-em; Post-em
Butachlor	Machete	Pre-em
EPTC	Agrothion, Eptam	Pre-plant; Pre-em
Isoproturon	Arelon, Toplkan	Post-em
Dalapan	Dowpan	Post-em
Diuron	Karmex	Post-em
MSMA	Daconate, Ansar	Post-em
Atrazine	Atrataf	Post-em; Early-post
Simazine	Tafazine / Gesatop	Post-em; Post-em
Paraquat	Gramaxone	Post-em
Glyphosate	Roundup	Post-em



# Part XVIII Cultural tips for F-1 hybrid vegetables

S. No.	Crops	Varieties	Season	Seed rate gram s/ha	Spacing in cm.	Numb- er of plants/ ha	Farmy- ard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
1	Brinjal	Arka Navneet, Suphal, Ajay, Vijay, Kirti, Mhb1, Mhb2, Mhb3, Mhb9, COBH1 COBH2, Kalpa Tharu, Ravayya	Planted during May - June Oct - Nov Jan - Feb	200	90 x 60	18,520	25	200:150:100	200 - 500	150	25	-
2	Tomato (Deter- minate)	Mangala, Rajani, Rashmi, Rupali, Sheetal, Vaishali, Hybrid No.10, Varla- kshmi, Ruchi, Avinash - 2 COTH 1, COTH 2 TNAU Tomato, Hybrid CO3	Planted during March - April Nov - Dec Sep - Dec	175	75 x 45	29,630	40	200:250:250	80	120	35	Suitable for mechanic- al harvest, tolerant to Fusarium and Verti cillium wilt

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Number of plants/ha	Farmyard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
3	Tomato (Indeterminate)	Karnataka, Naveen, Suruchi, Sangam, Amrut, Cross-B, Sonali, Sadabhakar Preethi, Gulmohar, S-28, S-29, Morning Sun, SH -771	Planted during May - June Oct - Nov Jan - Feb	120 - 150	75 x 60	22,220	40	200:250:250	80 - 200	150 - 165	100 - 110	Tolerant to Fusarium Verticillium and Nematode

4	Bhendi	Shobha 110, Shoba 111, Badsha, Hybrid-6, Hybrid-7, Varsha, Vijaya, Vishal, HYb.135, Mahyco. Hy.10, CoBHH1	Sown in Feb - March June - July, Oct - Nov	15000	60 x 15	1,11,1- 10	40	200:100:100	-	90	12 - 15	Tolerant to yellow vein mosaic and powdery mildew.
---	--------	---	---	-------	---------	---------------	----	-------------	---	----	---------	---

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Number of plants/ha	Farmyard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
5	Cabbage	Hybrid No.10, Hybrid No.20, Indu, Pooja, Namratha, Sumathi, Lakshmi, lahs-I, lahs-II, lahs-III, Kranthi, Kalyani, Sriganesh Khol, Kaveri, Ganga, Hariranigol, NSC .10	Planted during May - Feb	300 - 550	60 x 30	55,550	25	200:125:150	2000 - 3500 (Head)	105	50 - 75	Heat tolerant (upto 38°C)



6	Cauliflower	lahs-12, lahs-18, Snowball, Improved, Swati, Himani, Subarna, Serena , Subasini, Pawas	Planted during Jan - Feb June - July	300 - 350	60 x 30	55,550	25	200:125:125	500 - 700 (Curd)	105	25 - 30	
---	-------------	---	---	-----------	---------	--------	----	-------------	---------------------	-----	---------	--



S. No.	Crops	Varieties	Season	Seed rate gram s/ha	Spacing in cm.	Number of plants/ha	Farmyard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
7	Capsicum	Bharath, Heera California Wonder, Yolo Wonder, Hybrid No.10, Hybrid No.11, Midway, Indira,	Planted during June – July, Sep - Oct Jan - Feb	375	60 x 30	55,550	30	250:150:150	100 - 150	165	35 - 40	Tolerant to T.M.V.

8	Chillies	Sujatha, Surya, MHB-55, MHB-58, MHB-59, Cayennelar- ge Red Thick,Cayenn e Long Slim, Divya,Rathna, Samrat, Prithivi Thejeswini TANU Chilli Hybrid Co1	Planted during June - July Sep - Oct Jan - Feb	200 - 250	75 x 60	22,220	30	120:80:80	-	150	13 - 16	Wide adaptabili- ty for fresh market high degree uniformity, Lateblight & bacterial leaf spot resistant
---	----------	---	--	--------------	---------	--------	----	-----------	---	-----	---------	--

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Number of plants/ha	Farmyard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
9	Water-melon	Madhu, Milan, Mohini, Arka Jyoti, Amruth, MHW-11, Sunthrupthi, MHW-15, MHW-6, Apoorva, Madhuri	Sown in Nov - Jan	1500 - 2750	150 x 30	22,220	30 - 40	200:100:100	5000 - 8000	90 - 105	100 - 110	Tolerant to Fusarium wilt
10	Musk Melon	Swarna, MHC-2, MHC-5, MHC-6, Honeydew, Sona, Earli-Dew, Magnum-45	Sown in Nov - Jan	525 - 800	150 x 30	22,220	30 - 40	200:100:100	800 - 1000	120	25 - 30	Tolerant to Fusarium wilt

11	Cucum-ber	Priya, Bliiz, Lucky Strike, Poinstt-76, Harsha, Calypso,	Sown in Nov - Jan	373	150 x 60	25	150:75-:75	300	90	20 - 25		Tolerant to downy mildew, powdery mildew and mosaic
----	-----------	--	-------------------	-----	----------	----	------------	-----	----	---------	--	---



## Trade Mark of TNAU

S. No.	Crops	Varieties	Season	Seed rate grams/ha	Spacing in cm.	Number of plants/ha	Farmyard Manure Tons/ha	Fertilizers N:P:K kg/ha	Average fruit weight in grams	Total crop duration in days	Average yield Tons/ha	Special features Tolerance resistance to diseases etc.
1	2	3	4	5	6	7	8	9	10	11	12	13
12	Bitter Gourd	Hybrid-49, While Long, COBgoH1 Greenlong, MPDH-101, MPDH-102	Sown in June - July	1800	180 x 60	9,259	25 - 30	200:100:100	100 - 120	90 - 105	60 - 65	Thick flesh with less seeds, attractive colour
13	Bottle Gourd	Pusa Megdooth, MGH-1, Varath, Hybrid-204 TNAU Bottle gourd Hybrid Co1	Sown throughout the year. Yield will be more if it is sown during June - July	1800	180 x 60	9,259	25 - 30	200:100:100	3000 - 5000	90 - 105	45 - 60	Suitable for long distance transport
14	Ribber Gourd	Sureka, MSGH-1, Haritha	Sown in June - July	1800	180 x 60	9,259	25 - 30	250:100:100	125 - 150	105 - 120	40 - 45	Attractive green colour.

## Trade Mark of TNAU





# Part XIX

## FARM IMPLEMENTS FOR HORTICULTURAL CROPS

### TRACTOR DRAWN LOW DRAFT CHISEL PLOUGH

1. Function : Suitable for deep tillage up to a depth of 40 cm for opening hard soil pan.

2. Specification

- i. Type : Mounted implement
- ii. Power requirement : 35 to 45 hp tractor
- iii. Overall dimensions : 450 x 940 x 1250 mm
- iv. Weight : 42 kg
- v. Capacity : 1.4 ha / day at a spacing of 1.5m between rows

3. General Information :

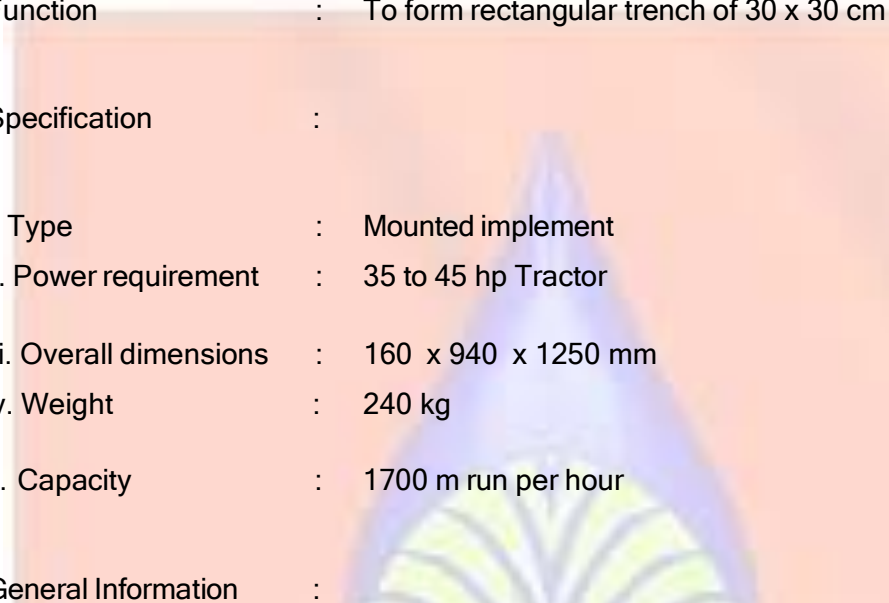
The chisel plough has a sturdy but light structure made of 3mm thick hollow rectangular tubular mild steel sections. The implement has only three components namely frame, standard and share. The implement is protected by shear pin, which prevents damage from overloading.

4. Cost of the unit : Rs. 8000/-

5. Salient features :

The implement could be used for deep tillage up to 40 cm depth. Easily operated by any 35-45 hp tractor.

### TRACTOR DRAWN TRENCHER

- 
1. Function : To form rectangular trench of 30 x 30 cm
2. Specification :
- i. Type : Mounted implement
  - ii. Power requirement : 35 to 45 hp Tractor
  - iii. Overall dimensions : 160 x 940 x 1250 mm
  - iv. Weight : 240 kg
  - v. Capacity : 1700 m run per hour
3. General Information :

The unit consists of two mould board bottoms placed in line one behind the other. The front and rear bottoms operate at a depth of 0-15 cm and 15-30 cm respectively. The two bottoms throw

the removed soil in opposite directions and form vertical walls one on each side of the trench. A safety pin is provided to protect the unit from over loading.

4. Cost of the unit : Rs. 35,000/-

5. Salient features :

Can also be used for laying drip irrigation pipes by opening trenches Application of manure in coconut fields Cost of operation is Rs. 0.10 per m run of trench as against Rs. 2.00 per m run using manual labour

### **TRACTOR DRAWN CHANNEL FORMER**

1. Function : To form channels and beds at regular intervals for irrigation.

2. Specification :

- i. Type : Mounted implement
- ii. Power requirement : 35-45 HP
- iii. Overall dimensions : 2200 x 1126 x 900 mm
- iv. Weight : 90 kg
- v. Capacity : 1.2 to 1.5 ha/hr

3. General Information :

The unit consists of two inner blades of size 100 cm x 25 cm and two outer blades of size 130 cm x 25 cm. The front portions of the two inner blades are joined together such that they form an angle of 30° in between them. At the junction of these two inner blades a cultivator shovel is fixed to penetrate into the soil. The two outer blades are placed one on each side of the inner blades and at an angle of 60° to the direction of the travel. The soil collected in 105 cm width is formed as bund of size 35 cm on both the sides of the irrigation furrow formed by the inner blades.

4. Cost of the unit : Rs. 20,000/-

5. Salient features :

Saving in Cost of forming irrigation channel at 5 m interval is 57%

### **POWERTILLER OPERATED HEAVY DUTY AUGER DIGGER**

1. Function : To dig holes for planting tree saplings

2. Specification :

- i. Type : Screw auger type
- ii. Power requirement : 8 to 10 hp power tiller
- iii. Overall dimensions : 400 x 635 x 1635 mm
- iv. Weight : 50 kg
- v. Capacity : 25 -30 holes per hour

3. General Information :

It consists of a spiral auger of 300 mm dia and 150 mm pitch actuated by a rack and pinion arrangement. A shaft mounting worm gear box has been designed and fabricated to accommodate the sliding auger shaft. This gear box provides a speed reduction of 10:1 to reduce the engine

speed. The auger bit was fabricated as a double start auger having two cutting edges. The hand wheel provided at the side of the unit can be effectively used for the depth control.

4. Cost of the unit : Rs. 45,000/-

5. Salient features :

Results in 16.0 and 91.0 per cent saving in cost and time when compared to manual digging of holes

Application of manure in coconut fields. Cost of operation is Rs. 0.10 per m run of trench as against Rs. 2.00 per m run using manual labour

### **POWERTILLER OPERATED AXIAL FLOW PUMP**

1. Function : To lift water from open water sources

2. Specification :

- i. Type : Axial flow type
- ii. Power requirement : 8 to 10 hp power tiller
- iii. Overall dimensions : 300 x 750 x 620 mm
- iv. Weight : 26 kg
- v. Capacity : 2500 litres per minute at 3.0 m head

3. General Information :

The unit consists of a axial flow impeller, pump shaft casing pipe, pump stand and swiveling mount for hitching to the power tiller. A telescopic swivel assembly facilitates the pump to be mounted to the power tiller front. The pump as a whole is supported by a pump stand at the

discharge end. The main pump shaft of two sections is supported by the spider armed bracket and a simple bushed bearing with a stuffing box to prevent leakage of water.

4. Cost of the unit : Rs. 20,000/-

5. Salient features :

Highly suitable for lifting water from open water sources

### **POWERTILLER OPERATED BOOM SPRAYER**

1. Function : For row crop spraying

2. Specification :

- i. Type : Power tiller mounted
- ii. Power requirement : 8 to 10 hp power tiller
- iii. Overall dimensions : 1550 x 5000 x 1550 mm
- iv. Weight : 100 kg
- v. Capacity : 1 ha per hr

3. General Information :

The boom sprayer attachment consists of spray boom mast, spray pump, pressure regulator, chemical tank, and double tail wheel and foliage deflectors. The tail wheels are carried on a

separate frame and length 75 cm and hitched to the power tillers' hitch bracket. The spray boom of length 6 m was chosen with 3 m either side of the power tiller. The boom had 16 hollow cone nozzle with a total discharge rate of 7.3 lit/min. the nozzle spacing was made continuously adjustable. A cut off valve is also provided on the discharge line to the boom to avoid dripping from the nozzle while closing the spray. Two number of foliage deflectors were provided on both the front of the power tiller drive wheels and the tail wheels to deflect the crop canopy to spread in the rows.

Trade Mark of TNAU

4. Cost of the unit : Rs.30,000/-

5. Salient features :

Light in weight and suited for row crops

### SPRAYER FOR TALL TREES

1. Function : To spray chemicals in orchard trees

2. Specification :

i. Type : Mounted implement

ii. Power requirement : 35 hp tractor

iii. Overall dimensions : 65 x 65 x 1950 mm

iv. Weight : 200 kg

v. Capacity : 35 trees per hour

3. General Information :

The unit has a telescopic (62 and 37 mm ) G.I. pipes which can extend from 9 m to 14 m height by winding a cable. At the base of the frame, a 200 lit capacity chemical tank is mounted. A reciprocating pump is mounted on a base plate near the PTO shaft of the tractor. At the top of the 37 mm G.I. pipe, two spray guns with nozzles for cone or jet spray are hinged so that they



can be moved up and down by ropes from the ground level. In addition the spray guns can be rotated about the vertical axis of the telescopic pipe arrangement. These features ensure that the entire canopy area of the tree is easily sprayed.

4. Cost of the unit : Rs. 40,000/-

5. Salient features :

The total height of spray is 55 feet. The sprayer can be used in orchard trees and for spraying in field crops, by bifurcating the delivery section into spray lines with spray lances and spray guns.

### **POWERTILLER OPERATED LAWN MOWER**

1. Function : For mowing lawn grass

2. Specification :

- i. Type : Mounted type
- ii. Power requirement : 8 -10 hp power tiller
- iii. Overall dimensions : 400 x 636 x 1665 mm
- iv. Weight : 79 kg
- v. Capacity : 0.8 ha per day

### 3. General Information :

The cylindrical lawn mower attachment to power tiller consists of 750 mm width and 235 mm diameter cylinder fitted with 12 numbers of helical steel blades on its periphery. A horizontal ledger plate with a concave groove is provided beneath the cylinder. The power is transmitted from the power tiller rotary drive shaft to the cylinder shaft through chain and sprocket. A tail wheel is provided for controlling the height of cut. The unit is attached to the power tiller rotary hitch bracket assembly of the transmission case and the rear portion of the unit derives support from the power tiller handle through two support arms.

4. Cost of the unit : Rs.25,000/-

### 5. Salient features :

The unit is simple to operate and easy to handle. Results in 50 per cent and 64 per cent saving in cost and time respectively

## **POWERTILLER OPERATED TURMERIC HARVESTER**

1. Function : For harvesting turmeric rhizomes

2. Specification :

- i. Type : Mounted type
- ii. Power requirement : 8 -10 hp power tiller
- iii. Overall dimensions : 400 x 636 x 1665 mm
- iv. Weight : 67 kg
- v. Capacity : 0.6 ha per day

### 3. General Information :

The unit consists of a blade with three bar points for easy penetration into the soil. To the rear end of the blade six slats spaced at mm apart are hinged at both ends. The oscillating motion for the slats is obtained through eccentric provided on either side of the unit. The power is transmitted from the clutch pulley of the power tiller to a reduction gearbox mounted near the hitch bracket

assembly of the power tiller. From the gear box the power is transmitted to the shaft of the turmeric digger unit through V belt transmission. The pneumatic wheels are replaced with a pair of special type cage wheels to accommodate the height of ridges.

4. Cost of the unit : Rs. 28,000/-

5. Salient features :

65 % saving in cost and 90 % saving in time. Damage caused to the rhizomes is 0.5 % as compared to 4.2 % in manual harvesting.

### **TRACTOR DRAWN TURMERIC HARVESTER**

1. Function : For harvesting Turmeric rhizomes

2. Specification :

- i. Type : Mounted type
- ii. Power requirement : 35 - 45 hp Tractor
- iii. Width of the digger : 120 cm
- iv. Capacity : 1.6 ha per day

3. General Information :

The unit consists of a blade with five bar points for easy penetration into the soil. The blade is fixed at an inclination of  $20^{\circ}$  to a cultivator frame with straight tynes at both ends. It can be hitched to the tractor through three – point linkage connection provided in the front portion of the unit. The rake angle of the blade can be adjusted by moving the blade through a clevis provided at the bottom of the two tynes. At the rear end of the clevis two converging slats are fixed to convey the harvested turmeric with the soil on to the lift rods without spilling to the side ways. To the rear end of the blade seven lift rods of 250 mm length are provided. For digging, the bar points with the blade penetrate into the soil, lift the turmeric rhizomes from the soil. The

soil slip back to the ground and the dug out rhizomes deposited at the centre of the unit.

4. Cost of the unit : Rs. 22,000/-

5. Salient features :

Results in 70 per cent saving in cost and 90 per cent in time. Extent of damage caused to the rhizomes is very much less (2.83 per cent).

### **POWER ROTARY WEEDER**

1. Function : For mechanical control of weeds in crops such as sugarcane, tapioca, cotton and orchards.

2 , Specification :

i. Type : Self propelled

ii. Power requirement : 8.38 hp Diesel engine

iii. Overall dimensions : 2400 x 1750 x 1100 mm

iv. Weight : 200 Kg

v. Capacity : 1 - 1.2 ha per day

3. General Information :

A 8.38 hp diesel engine operates the weeder. The engine power is transmitted to ground wheels through V belt-pulley. A tail wheel is provided at the rear to maintain the operating depth. Weeding is done by the rotary weeding attachment. The rotary weeder consists of three rows of discs mounted with 6 numbers of curved blades in opposite directions alternatively in each disc. The width of coverage of the rotary tiller is 500 mm.

4, Cost of the unit :Rs. 1,00,000

5. Salient features :

Useful for weeding between rows of crops like tapioca, tomato and crops whose rows spacing is more than 45 cm.

### **POWERTILLER DRAWN BUND FORMER**

1. Function : For forming bunds
2. Specification :
  - i. Type : Trailed type
  - ii. Power requirement : 8 -10 hp power tiller
  - iii. Overall dimensions : 1080 x 770 x 520 mm
  - iv. Weight : 15kg
  - v. Capacity : 2.5 ha per day at 3 m interval
3. General Information :

The unit consists of two converging steel blades fixed to a frame which can be attached to a power tiller. The size of the bund is regulated by the size of the wings and adjustable holes provided on the wings. Three sizes of the bunds can be formed with the unit.

4. Cost of the unit :Rs. 5000/-
5. Salient features :

It forms bunds in irrigated lands and across the slope of dry land to conserve soil moisture.

### **Mechanical thresher for pepper (*Piper nigrum* L.)**

Pepper (*Piper nigrum* L.), the king of spices is the most important spice of India. It is the dried fruit of perennial climbing vine, mostly found in hot and moist parts of Southern India. Kerala alone contributes 96% of the total production in India.

The spikes of well-matured, unripe berries are manually picked when they are blackish green

and most pungent by climbing on the ladders. Normally two women jointly do the harvesting. Threshing of pepper berries is done by manual trampling, which involves either a man / woman labour. A labourer will be able to trample about 200 kg of spikes and separate the berries. The empty spikes are disposed to the compost pit and used as manure. To overcome the drudgery to the labourer, a mechanical thresher has been developed at the Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore.

This pepper thresher consisted of a metallic drum provided with rasp bars, concave, oscillating sieve, power source and power drive. On the periphery of the drum, 8 numbers of rasp bars made of wood are mounted. The drum is placed inside a concave provided with an opening and a suitable cover. A feed hopper is provided for easy feeding of spikes into the concave. An oscillating sieve is provided with an eccentric to separate the berries and spikes after threshing. The power to the drum is transmitted through V pulley arrangement from a 2 hp motor.

The pepper spikes fed through the hopper reach the threshing drum and undergoes threshing. The separated berries and empty spikes fall on the sieve and separated. The performance of the thresher was evaluated in the plantations for the capacity, breakage and threshing efficiency at various speeds of operation. The capacity of the thresher is 320 kg/hour. The percentage of broken berries was negligible and the threshing efficiency was above 95% at 300 rpm of drum speed.

Salient features:

- ! Suitable for threshing black pepper from the pepper vine
- ! Operated by a 2 hp electric motor/ suitable power drive
- ! Efficiency - 95%
- ! Capacity - 320 kg/hour
- ! Cost of the thresher - Rs.30,000/-
- ! Cost of operation - Rs.125/- per tonne of pepper

### **Fluidised Bed Dryer for Mushroom**

Mushroom, contains about 90% moisture and is highly perishable. To reduce the spoilage

and increase the shelf life of the mushroom, drying is one of the techniques. By the traditional sun drying method it takes about 10 to 14 hours to dry the mushroom to a final moisture content of about 8 per cent. By mechanical drying, mushroom is dried at higher temperature and faster which preserves the colour and the quality of the final product. Hence, a mechanical dryer suitable for drying of oyster and milky mushroom by the medium and large growers has been developed in the Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore.

The developed dryer is of fluidised bed type, as this type of drying is faster and uniform compared to that cabinet drying and tray drying. The fluidised bed dryer consists of a centrifugal blower, holding bin, heating coils, motor and thermostat control. The blower is run by a 3 hp, three phase motor. The delivery of the blower is connected to the heater drum, provided four numbers of fin type electrical heaters of each 500 Watts and controlled through a stem type thermostat. At the other end of the heater drum, the drying chamber is placed. Hot air of 50 to 90°C temperature at a flow rate of 9 to 32 m<sup>3</sup>/ minute can be obtained in this dryer. The whole assembly is placed on a suitable frame made of mild steel.

The atmospheric air discharged by the blower reach the heater drum and come in contact with the heaters and heated. The hot air entering into the drying chamber dries the mushroom. The velocity of air is controlled by adjusting the position of the shutter in the suction of the blower, so that the mushroom pieces float over the bin surface during drying. It takes about 2 and 6 hours to dry the oyster and milky mushroom to a final moisture of 8-10 %(w.b) from an initial moisture content of 70-80%(w.b).

Salient features:

- ! Suitable for drying oyster and milky mushroom
- ! Dries oyster mushroom in 2 hours and milky mushroom in 6 hours
- ! 5 hp power is required for the blower and heaters
- ! Capacity is 6 kg of mushroom per batch



! Cost of the dryer is Rs.50,000/-

! Cost of drying is Rs.50/- per kg of dry mushroom

### **Pulper cum Washer for Coffee**

Coffee is an important commercial and high altitude crop grown in southern and north- eastern parts of our country. Its annual production is 2.1 lakh tonnes. Pulping and washing are the important unit operations in the coffee processing. The coffee pulper and washers available at present are of higher capacities and the cost is beyond the reach of small farmers. To meet the requirement of small and marginal farmers an integrated unit with pulping and washing mechanism has been developed by Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore - 3.

The unit essentially consists of a trapezoidal hopper, drum type pulper and a screw auger model washer. The hopper holds and feeds the coffee fruits to the pulper uniformly through a fluted roller mechanism. The pulper has a drum with projections and two breastplates. Provisions are made to adjust the clearance between the breastplate and drum so as to pulp different sizes of fruits. The pulper removes the skin from the matured ripened fruits. The skin is discharged over the perforated inclined tray fitted below the pulper and collected separately.

The washer has an inner roller and a perforated outer cylinder. The inner roller is made of mild steel pipe with screw auger and helical bars with cross stoppers for conveying the parchment. The inner roller is mounted on bearings inside the perforated outer cylinder. During operation, the parchment is moved in between the perforated outer cylinder and inner roller. Friction and abrasion developed due to movement of beans remove the mucilage present over the parchment. By adjusting the counter weight provided at the discharge end, the pressure inside the washer is regulated and thorough washing of the bean is achieved.

Water for washing is provided on the top of the perforated outer cylinder through five nipples placed at equal intervals and is regulated by a valve. Both pulper and washer are operated by a 3-hp electric motor through suitable pulleys and belt.

Salient features:

- ! Capacity of the unit is 500 kg of fruits per hour
- ! Water requirement is only 4 litres of water per kg of fruits.
- ! The approximate cost of the unit is Rs.50,000/-.

### **Mechanical Chipper for Tapioca**

Tapioca (*Manihot esculenta*) is a root crop cultivated for use of food, animal feed and production of starch. In India tapioca is grown in 0.35 million ha. area and produces about 6 million tonnes annually. The physiological deterioration of tapioca root is related to accumulation after the harvest within a shorter period of one week. This spoilage can be prevented by chipping and drying of tapioca tubers. At present the tuber is sliced manually which is highly time consuming and in-efficient, besides causing drudgery to the person working. Therefore a vertical feed type motorised tapioca chipping machine has been developed in the Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore.

The developed tapioca chipper consists mainly of a feed hopper with guides, chipping disc with knives, chips outlet and a 0.5 HP single phase electric motor. The feed hopper is provided with vertical guides made of pipes of diameter 25 to 80 mm for 100 mm length to facilitate feedings of tubers of varying diameters. Through these guides the tubers reach the chipping disc having three blades, rotating at 300 rpm. The radially mounted blades on the chipping disc slice the tuber and the chip is collected through the outlet.

Salient features:

- ! Suitable for varying diameters of tubers
- ! Thickness of chips can be varied
- ! Also suitable for slicing other tuber crops like radish, carrot, potato etc.
- ! The capacity of the unit is 270 kg per hour.
- ! The cost of the unit is Rs.10,000/-.

### **Tomato Seed Extractor**

Tomato is one of the important commercial crop ranking second in importance to potato in India. At present, seed extraction from tomato is carried out manually by squeezing the fruits and by scooping the seeds, with hands. Manual method is unhygienic, tedious, highly labour intensive and time-consuming process. In certain places, mechanical seed extraction is practiced using a juicer or pulper. The juice is filtered out while the pulp and seeds are separated by acid, alkali, or fermentation methods. The pulp is discarded since the whole fruit is pulped and the seed is separated by filtration with repeated washing. In order to make use of the flesh in the tomato for further processing, the extraction of the seed has to be done by crushing the fruits in a hygienic way. Considering all these facts, a tomato seed extractor has been developed by Department of Agricultural Processing, Tamil Nadu Agricultural University, Coimbatore- 3. The newly fabricated tomato seed extractor consists of a feed hopper, fruit crushing chamber, seed separation unit, water recycling system and seed collecting trough. The fruit crushing chamber consists of a rotating shaft with a screw auger of 90 mm diameter and 45 mm pitch. In the crushing chamber the tomato fruits are crushed and squeezed by the rotating screw auger. As the squeezed fruit crosses the squeezing zone seed separation starts. The seed separation unit consists of a rotating shaft with studs (arranged in a helical fashion throughout its length), a perforated outer cover, water distribution nozzles, rectangular trough, seed outlet and squeezed fruit outlet.

As the squeezed fruit enters the seed separation unit, the studs open the squeezed fruit, exposing the seeds to the stream of water. The water separates the seed from the flesh and comes down along with the seed through the perforated outer cover and is collected in a rectangular trough, placed at the bottom of seed separation unit. The water collected in the trough is recycled by means of a centrifugal pump. The flesh coming out of the seed separation unit is collected separately. The power for the crushing the fruits and water recycling is taken from the 0.5-hp electric motor fitted at the bottom of the unit.

#### **Salient features:**

- ! Capacity of the unit is 180 kg of fruit ( 1.8 kg of seed) per hour.
- ! The cost of unit is Rs.25,000/-.

! Cost of seed extraction per kg is Rs.10/-.

! The saving in cost is 90 per cent

! Saving in time is 97 per cent.

### **Brinjal Seed Extractor**

Trade Mark of TNAU

Brinjal, a non-seasonal important vegetable crop is grown all over India throughout the year, in an area of 0.45 million ha had recorded about 5.8 million tonnes of production. Seed is one of the important inputs and plays a key role in the productivity and production of any crop and brinjal too. At present, seeds are extracted from brinjal fruits, manually by beating the fruits with mallet, trampling under feet, squeezing with hands, splitting the fruits and scooping seeds, etc. The manual methods of extraction of seed are tedious, highly time and labour consuming process. Sometimes delayed seed extraction resulted in decreased seed quality and increased cost. Keeping this in view, a new gadget for the extraction of seeds from brinjal has been developed.

The brinjal seed extractor consists of a fruit crushing chamber and seed separation unit. In the fruit crushing chamber, 70 mm length crushing rods are fixed in the shaft which crushes the fruit into pulp with the help of feed water and discharges the same into the bottom portion of the seed separation unit. The seed separation unit houses a horizontal sieve bottom, sloping solid bottom below the sieve bottom, seed outlet, agitator, pulp outlet and drain cock. The inclined bottom of the seed separation unit helps for easy collection of seeds towards the seed outlet. Seeds are collected along with water by opening the value and keeping a sieve tray with 3 mm holes. The brushes fixed in the agitator move over the sieve surface, remove the lodged seeds if any and keep the sieve always clean for easy passage of seeds through the sieve.

The brinjal fruit pulp with seeds is introduced into the seed separation unit at the bottom in a standing column of water. The rotating agitator with radial arms, agitates and separates the denser healthy seeds from pulp and ill filled light seeds. Due to the difference in specific weight, the good seeds are moving towards the bottom, pass through the sieve and get collected through seed outlet. The lighter pulp and other ill filled seeds rise to the surface and discharged through the pulp outlet.



### **Salient features:**

- ! Capacity of the unit is 120 kg of fruits or 2 kg of seeds per hour.
- ! The cost of the unit is Rs.25,000/-.
- ! The cost of seed extraction is Rs.10/- per kg of seed.
- ! Savings in cost is 88.9%.
- ! Savings in time is 97.5%.

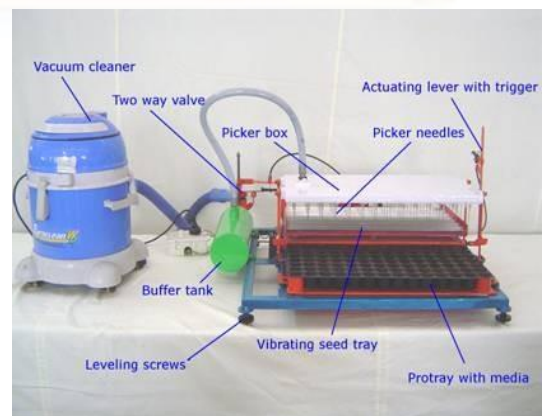
### **Coconut tree climber (TNAU Model)**

The coconut tree climber has two components, the upper frame is operated by hands and the lower frame is operated by foot. The two components are connected by adjustable belts. The upper frame is provided with a seating arrangement and a provision for gripping by foot. The frames are mounted on a vertical member. By standing on the lower frame, the upper frame can be moved up the tree. Similarly, by sitting in the upper component, the lower frame can be moved down the tree. The operator can climb up or down the tree using the frames alternately. Since the operator is safely held against the tree, there is practically no possibility of the operator falling down. The operator can climb, harvest the nuts and descend a tree. The cost of the unit is Rs.3000/-. An improved model with added safety features is available for Rs.4000/-



### **Semi automatic Needle type tray seeder for vegetable nursery production**

Nowadays, vegetable growers prefer pro-tray grown seedlings over conventional ones for manual transplantation. Moreover, the tray seedlings are grown under controlled environments and have appreciable vitality and plant stand after transplantation. One of the major tasks in the production of tray grown seedlings is to sow the seeds into the tray cells, which is presently a tedious manual process. Manually picking and placing of

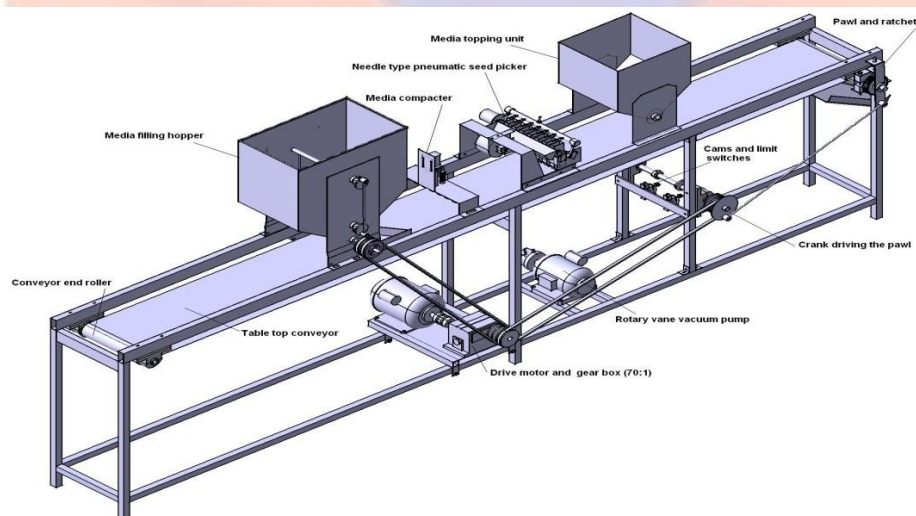


single flat seeds such as chilli and tomato into the pro tray cells is all the more tedious and slow.

A pneumatic pick and place seeder has been developed, which has an air sealed box that is moved in an semi circular locus as mounted on a set of four bar linkages on either side of the box. The box holds 98 receptacles for needle pickers as arranged in the same configuration of the pro-tray. Picker needles of various sizes ranging from 21 to 16 G can be directly fitted to these receptacles. The seed feed tray has longitudinal compartments with a sloping bottom, meant for each of 7 rows of 14 picker needles. It is imparted a low amplitude vibration by an eccentric coupled small electrical motor, to loosen the seed mass and to sift down the dust. A vacuum source (house hold vacuum cleaner) is connected pneumatically to the picker box through a custom made spring return valve, through a vacuum buffer to even out pressure. When the picker needles are positioned over the seed tray, the valve is manually actuated to create suction on the needles to pick and hold seeds. Then the picker box is moved by a lever to the partially media filled pro-tray and vacuum released to drop the picked seeds into the cells.

The device was evaluated for its pick/place performance on different type of seeds such as tomato, brinjal and chilli. The operating cost analysis based on experiments found that the device can save the cost by 50% and labour by about 60%. The cost of the seeder is Rs. 10,000 and its capacity is 860 trays per day.

### **Automatic needle type tray seeder for vegetable nursery production**



To mechanize the placement of seeds in the pro-tray cells, an automated protray sowing machine has been developed. The device has an automated needle picker, which can handle a queue of protrays. A flat conveyor belt is moved in steps on a table top to cater the inter cellular distance of a standard 98 celled protray. A media filling mechanism with a media hopper and a feed roller are provided along with regulating shutters, so that the volumes of media metered correspond to fill each row of the protray cells. Similarly another feed hopper for dispensing media to top up the tray after the sowing operation is also provided. The device has a solenoid actuated tray compacting device, that press the media down a single row of the media filled protray at a time. The seed picking arm having a row of 7 needle pickers which alternately dip into a vibrating seed tray and shuttles back to drop the seed into each row of the protray below. An electrical drive and appropriately mounted limit switches control the above action. This is integrated to the main control circuit operating the compacter and the vacuum release solenoid. Since the seed pick/drop mechanism needs to be stopped when the seed tray is not present below it, an optical sensor is incorporated in the circuit to sense the tray's presence. A rotary vane vacuum pump is provided from which the vacuum is sourced to the picking array. A solenoid valve is coupled on the line between the pump and the picker manifold to make and break the vacuum supply to the picker. This intermitted air flood is used to pick and drop the seeds at the appropriate locations. Cams are mounted to actuate limit switches to control the seeding/ compacting actions appropriately.

The protrays once fed on the conveyor are automatically filled with growth media, compacted, sown, topped up with media and passed out to the other side of the conveyer, thus achieving fully automating the process. About 80 sown trays can be prepared in an hour. Cost of operation works out to Rs 350/ day for sowing 600 trays /day. The savings in cost and labour is about 117 per cent and 60 per cent respectively. The cost of the unit is Rs. 30,000 only.



## Aerial access hoist for coconut and tall tree crop management

All existing tools and devices involve the operator to climb up the tree for harvesting and carrying out other management practices at the crown. Farmers who own large areas are interested in having a system which can elevate a person up to the tree crown by a portable aerial access platform. The existing aerial access platforms are having the following limitations.



1. The access is vertically upward and not side wards
2. The machines are designed to operate by resting on firm surface
3. Most machines have very wide stabilizing legs which cannot be operated under field conditions.
4. Require long time for setting up and operating

Keeping the above constraints in view and after a through study of the planting pattern and space requirements the following technical requirements of a tractor mounted aerial access hoist were formulated.

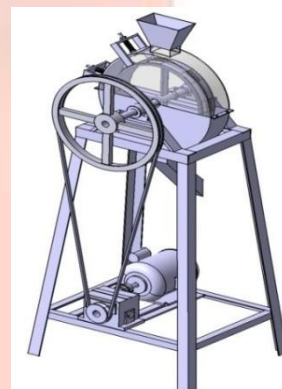
Lifting capacity	120 kg
Platform size	1000 x 700 x 1000 mm
Working height	16 m
Platform access height from the ground	15 m
Platform outreach	6 m
Rotation/slewing angle	360 degrees
Stabilizer	Hydraulically operated 4 nos. to provide absolute stability
Power	PTO of tractor, with exclusive hydraulic system and controls

The time required for locating unit and operating stabilizers was 1 min. The time required for positioning against a tree of 10 m height was 2 min. Suitable safety devices were incorporated to ensure stability of the hoist. The positioning of the operator platform can be done by the operator himself using electro hydraulic controls.

- |    |  |   |                      |
|----|--|---|----------------------|
| a) | Cost of the operation, Rs./hr          | : | Rs. 296 /- per hr    |
| b) | Comparative savings in time and labour | : | At par               |
| c) | Coverage                               | : | 8 -10 trees per hour |
| d) | Cost of implement / equipment          | : | Rs. 7.6 lakhs        |



### **Dehusker for fresh arecanut**




Arecanut is being cultivated in 3.86 lakhs ha in India with a production of 4.76 lakhs tones of kernels. Most of the areca produced in Tamil Nadu is dehusked in green state. Labour requirement for dehusking is estimated as 7-8 kg of nuts per hour per labour. This involves huge labour requirement and high cost. Existing models are expensive and also cause damage to the kernels. The machine has longitudinal profiled blades. The concave had two spring loaded rubber pads that press the fruit gently against the rotor. The fruits are fed at the top manually. The fruits travel half the circumference and are dehusked in the process. The dehusked kernals fall to the bottom along with the husk. Tests were conducted with both the models. The speed was varied from 40 to 80 rpm. The results showed that the dehusking efficiency was 53 to 67%. The best dehusking performance was observed in 60 rpm. The breakage was observed in the range of 8 to 10 %.






# Part XX




## FOOD PROCESSING TECHNOLOGIES

TECHNOLOGY	SALIENT FEATURES	PICTURES
<b>Bio-Colours</b>	<ul style="list-style-type: none"> <li>❖ Increased preference for natural colours.</li> <li>❖ Extraction of colour from beetroot.</li> <li>❖ Standardization of colour extraction with acetone and maltodextrin for maximum colour retention and yield recovery.</li> <li>❖ Rich in antioxidants with enhanced sensory appeal.</li> <li>❖ Good storage stability and maintenance of colour intensity for 12 months at room temperature.</li> <li>❖ No health hazards.</li> </ul>	 <p>Beetroot powder</p>
<b>Greens based Paruppu and Idli podi</b>	<ul style="list-style-type: none"> <li>❖ Greens add colour, flavor, nutritional and therapeutic value to foods.</li> <li>❖ Incorporation of greens enhances the quality of the paruppu and idli podi.</li> <li>❖ Good source of <math>\beta</math>-carotene (7473 <math>\mu\text{g}</math>), B-vitamins and iron (37 mg).</li> <li>❖ Shelf life upto 10 months.</li> </ul>	

<p><b>Aonla mouth freshner</b></p>	<ul style="list-style-type: none"> <li>❖ Aonla granules can be used as mouth fresheners and as substitutes for areca nut and tobacco.</li> <li>❖ Developed from shredded and dehydrated pieces of aonla and source of lime juice and spices.</li> <li>❖ Vitamin C (960 mg/100g) and <math>\beta</math> carotene (98 <math>\mu</math>g) with improved flavor and sensory appeal.</li> <li>❖ Contains 226 mg calcium, 273 mg phosphorous, 20 mg iron and 16 mg fibre / 100g.</li> </ul>	
<p><b>Protein Enriched Spicy Mango Bar</b></p>	<ul style="list-style-type: none"> <li>❖ Protein rich mango bar is a combination of pulse (soya and green gram) with mango pulp</li> <li>❖ Enhanced protein and <math>\beta</math> carotene content.</li> <li>❖ Shelf life upto nine months</li> <li>❖ Provides 10 g protein, 5 g fibre, 15 mg vitamin C and 305<math>\mu</math>g <math>\beta</math> carotene.</li> <li>❖ Can be used in nutrition intervention programmes to prevent protein malnutrition and vitamin A deficiency.</li> </ul>	
<p><b>Papaya Fruit Bar</b></p>	<ul style="list-style-type: none"> <li>❖ Fruit bars are manufactured by the dehydration of papaya fruit pulp.</li> <li>❖ Papaya based bars are rich sources of <math>\beta</math> carotene (1688<math>\mu</math>g/100g) with 16 % moisture content.</li> <li>❖ Shelf stable up to six months at room temperature.</li> </ul>	



<b>Tomato Powder</b>	<ul style="list-style-type: none"> <li>❖ Ready to use convenience food.</li> <li>❖ Can be readily rehydrated and used to substitute tomato pulp or puree and also used to thicken soups, sauces, stews, and gravies.</li> <li>❖ Rich source of lycopene, a natural antioxidant.</li> <li>❖ Low moisture food and has good storage stability.</li> </ul>	
<b>Coconut Powder</b>	<ul style="list-style-type: none"> <li>❖ Contain high fibre content of 32.67-35g%</li> <li>❖ Also provides 40 to 45% fat, 350 to 370 mg% of calcium, 6.5 to 8% protein, 2-3% moisture and 2-3 % ash.</li> <li>❖ Has a shelf life of six months.</li> <li>❖ Ready to use in, extruded products, snacks foods and confectionery.</li> </ul>	
<b>Ginger Garlic Powder</b>	<ul style="list-style-type: none"> <li>❖ Ready to use and an easy substitute for fresh ginger garlic powder.</li> <li>❖ Low moisture food and has shelf life for more than 12 months.</li> <li>❖ Easy to use and blends well with food preparations.</li> <li>❖ Less bulk and hence saves cost on transport and storage.</li> </ul>	
<b>Bael Fruits Noodles</b>	<ul style="list-style-type: none"> <li>❖ Bael fruit pulp its incorporated for the preparation of noodles.</li> <li>❖ The phyto-chemical analysis showed the presence of alkaloids in bael fruit pulp.</li> <li>❖ The noodles contain 13.12 % protein, 964 µg/β carotene, 110 mg calcium, 15.30 mg potassium, 2.60 mg iron, 2.51 mg zinc and 2.69mg magnesium</li> </ul>	

	<p>per 100g.</p> <ul style="list-style-type: none"> <li>❖ Shelf-life upto six months in MPP packaging materials.</li> <li>❖ Low glycemic index and suitable for diabetes.\</li> </ul>	
<b>Mushroom products</b>	<ul style="list-style-type: none"> <li>❖ Mushroom protein comparable to meat protein.</li> <li>❖ Dehydrated mushroom powder finds application in formulation of a variety of value added products.</li> <li>❖ Mushroom powder (100 g) contains 12 g protein, 47 g fibre, 57 mg calcium and 29 mg iron.</li> <li>❖ Instant mushroom soup mix and mushroom biscuits which are rich in protein and fibre.</li> <li>❖ The products have a shelf life of three months at room temperature.</li> </ul>	
<b>Probiotic enriched food products from fermented cassava flour</b>	<ul style="list-style-type: none"> <li>❖ Fermentation has been reported to be responsible for product stability, flavor development and cyanide elimination.</li> <li>❖ Using mixed culture inoculums the cassava chips has been fermented dried and milled.</li> <li>❖ New and alternative nutritious bread, noodles and biscuits can be produced from different combinations of fermented cassava flour ( FCF) and Refined Wheat Flour (RWF) in the ratio of 75;25 and 50;50 as base and fortified with 15,20,25 and 30 per cent Defatted soy Flour ( DSF).</li> <li>❖ The calcium, phosphorus and iron content of the fermented cassava and defatted soy flour</li> </ul>	

- substituted products were increased when compared to control products. Protein content increased upto 12%
- ❖ Important essential amino acids like lysine and methionine were comparatively higher in fermented cassava flour and defatted soy flour incorporated bread, noodles and biscuits.

## Part XXI

# Soil Test Crop based Integrated Plant Nutrition System for Horticultural Crops (STCR-IPNS)

Soil test crop response based fertilizer prescriptions under integrated plant nutrition system (STCR-IPNS) for horticultural crops provide a scientific basis wherein the fertiliser doses for NPK are tailored to the requirement of NPK for specific yield levels of crops taking into account the contribution of NPK from soil, fertilizer and organic and or biofertilisers. Being a site and situation specific technology, STCR-IPNS along with entire improved package of practices for various crops ensures balanced nutrition, increased productivity and efficiency of applied NPK with sustained soil health over long run. The STCR-IPNS recommendations for various horticultural crops are furnished in Tables 1-13 and can be adopted to similar and allied soil types.

## I. VEGETABLES

### Onion (1)

Soil : Red sandy loam (Irugur series)       $FN = 0.99 T - 0.37 SN - 0.58 ON$   
Season : Kharif/Rabi       $FP_2O_5 = 0.58 T - 1.43 SP - 0.69 OP$   
Target : 170 q ha<sup>-1</sup> fresh bulb       $FK_2O = 0.67 T - 0.25 SK - 0.44 OK$

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM @25 t ha <sup>-1</sup> + <i>Azospirillum</i> @ 2 kg ha <sup>-1</sup> + PSB @ 2 kg ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O



180	10	200	53	60	37
200	12	220	46	58	32
220	14	240	39	55	27
240	16	260	31	52	22
260	18	280	24	49	17

Trade Mark of TNAD

Note: FN,  $FP_2O_5$  and  $K_2O$  are fertilizer N,  $P_2O_5$  and  $K_2O$  in  $kg\ ha^{-1}$ , respectively; T is the yield target in  $q\ ha^{-1}$ ; SN, SP and SK respectively are available N,P and K in  $kg\ ha^{-1}$  and ON, OP and OK are the quantities of N, P and K supplied through organic manure in  $kg\ ha^{-1}$ .

### Bhendi (2)

Soil : Mixed black calcareous

(Perianaickenpalayam series)

Season

OK

Target : 150  $q\ ha^{-1}$  green fruit

$$FN = 1.15 T - 0.46 SN - 0.81 ON$$

$$FP_2O_5 = 0.52 T - 1.31 SP - 0.87 OP$$

$$FK_2O = 1.77 T - 0.64 SK - 0.91 OK$$

Initial soil tests ( $kg\ ha^{-1}$ )			NPK ( $kg\ ha^{-1}$ ) + FYM@25 $t\ ha^{-1}$ + <i>Azospirillum</i> @ 2 $kg\ ha^{-1}$ + PSB @ 2 $kg\ ha^{-1}$		
SN	SP	SK	FN	$FP_2O_5$	$FK_2O$
180	10	250	51	40	60**
200	12	300	42	37	47
220	14	350	33	35	15*
240	16	400	23	32	15*
260	18	450	14	30	15*

\*maintenance dose ; \*\*maximum dose

### Cabbage (3)

Soil : Red Sandy loam

$$FN = 0.55 T - 0.89 SN - 0.76 ON$$

(Irugur series)

$FP_2O_5 = 0.29 T - 2.75 SP - 0.86 OP$

Season : Rabi

$FK_2O = 0.36 T - 0.31 SK - 0.56 OK$

Target : 700 q ha<sup>-1</sup> fresh head

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM@15 t ha <sup>-1</sup> + <i>Azospirillum</i> @ 2 kg ha <sup>-1</sup> + PSB @ 2 kg ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
180	10	200	181	144	160
200	12	250	163	138	145
220	14	300	145	133	129
240	16	350	127	127	114
260	18	400	110	122	98

#### Cauliflower (4)

Soil : Red Sandy loam

$FN = 0.93 T - 0.79 SN - 0.63 ON$

(Irugur series)

$FP_2O_5 = 0.44 T - 1.74 SP - 0.85 OP$

Season : Rabi

$FK_2O = 0.44 T - 0.18 SK - 0.46 OK$

Target : 400 q ha<sup>-1</sup> fresh curd

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM@15 t ha <sup>-1</sup> + <i>Azospirillum</i> @ 2 kg ha <sup>-1</sup> + PSB @ 2 kg ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
180	10	200	185	124	112
200	12	250	169	120	103
220	14	300	153	117	94
240	16	350	137	113	85
260	18	400	122	110	76

#### Potato (5)

Soil : Laterite- Sandy clay loam (Ooty series)  $FN = 0.70 T - 0.24 SN - 0.41 ON$

Season : Kharif / Rabi  
 Target : 400 q ha<sup>-1</sup> fresh tuber

FP<sub>2</sub>O<sub>5</sub> = 1.40 T - 0.55 SP - 0.95 OP  
 FK<sub>2</sub>O = 0.72 T - 0.25 SK - 0.39 OK

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM @ 15 t ha <sup>-1</sup> + <i>Azospirillum</i> @ 2 kg ha <sup>-1</sup> + PSB @ 2 kg ha <sup>-1</sup>		
SN	SP (Bray)	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
200	300	300	185	361	178
225	350	350	179	334	166
250	400	400	173	306	153
275	450	450	167	279	141
300	500	500	161	251	128

#### Carrot (6)

Soil : Laterite -Sandy clay loam (Ooty series) FN = 0.48 T - 0.17 SN - 0.33 ON  
 Season : Kharif / Rabi FP<sub>2</sub>O<sub>5</sub> = 1.11 T - 1.17 SP - 0.31 OP  
 Target : 400 q ha<sup>-1</sup> fresh root FK<sub>2</sub>O = 0.83 T - 0.40 SK - 0.43 OK

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM@ 15 t ha <sup>-1</sup> + <i>Azospirillum</i> @ 2 kg ha <sup>-1</sup> + PSB @ 2 kg ha <sup>-1</sup>		
SN	SP (Bray)	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
200	200	300	110	175	183
225	250	350	106	117	163
250	300	400	102	68*	143
275	350	450	97	68*	123
300	400	500	93	68*	103

\*maintenance dose

#### Beetroot (7)

Soil : Red Sandy clay loam (Palathurai series) FN = 0.64 T - 0.65 SN - 0.96 ON  
 Season : Kharif / Rabi FP<sub>2</sub>O<sub>5</sub> = 0.52 T - 1.58 SP - 0.92 OP

Target : 500 q ha<sup>-1</sup> fresh root

$$FK_2O = 0.61 T - 0.27 SK - 0.92 OK$$

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + Vermicompost @ 5 t ha <sup>-1</sup> + <i>Azospirillum</i> @ 2 kg ha <sup>-1</sup> + PSB @ 2 kg ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
180	10	300	152	206	194
200	12	350	139	203	180
220	14	400	126	200	166
240	16	450	113	197	153
260	18	500	101	193	139



### Radish (8)

Soil : Red Sandy clay loam (Palathurai series) FN = 0.69 T - 0.74 SN - 1.03 ON

Season : Kharif / Rabi  $FP_2O_5 = 0.28 T - 1.35 SP - 1.15 OP$

Target : 500 q ha<sup>-1</sup> fresh root  $FK_2O = 0.43 T - 0.21 SK - 0.64 OK$

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + Vermicompost 5 t ha <sup>-1</sup> + <i>Azospirillum</i> @ 2 kg ha <sup>-1</sup> + PSB @ 2 kg ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
180	10	300	100**	91	100**
200	12	350	100**	88	100**
220	14	400	100**	85	100**
240	16	450	100**	82	94
260	18	500	98	80	83

\*\*maximum dose

### Tapioca (9)

Soil : Red Sandy loam (Thulukkanur series) FN = 0.56 T- 0.61 SN- 0.81 ON

Season : Annual  $FP_2O_5 = 0.35 T - 1.80 SP - 0.53 OP$

Target : 500 q ha<sup>-1</sup> fresh tuber  $FK_2O = 0.94 T - 0.67 SK - 0.70 OK$

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM / Coirpith compost/ Poultry Manure @ 12.5 t ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
180	10	200	105	124	272
200	12	220	93	120	259
220	14	240	81	116	245
240	16	260	69	113	232
260	18	280	56	109	218

## Tomato (10)

Soil : Red Sandy loam (Palaviduthi series)

FN = 0.45 T- 0.63 SN- 0.72 ON

Season : Kharif /Rabi

FP<sub>2</sub>O<sub>5</sub> = 0.42 T- 4.18 SP- 0.73 OP

Target : 90 t ha<sup>-1</sup>

FK<sub>2</sub>O = 0.40 T- 0.48 SK- 0.66 OK

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM @ 12.5 t ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
200	14	200	239	297	229
220	16	220	226	289	219
240	18	240	214	281	210
260	20	260	201	272	200
280	22	280	189	264	191

## II. SPICES

### Chilli (11)

Soil : Red Sandy loam (Irugur series)

FN = 8.29 T - 0.32 SN

Season : Kharif /Rabi

FP<sub>2</sub>O<sub>5</sub> = 7.13 T - 5.24 SP

Target : 20 q ha<sup>-1</sup> dry pod

FK<sub>2</sub>O = 5.86 T - 0.15 SK

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM / Coirpith compost/ Poultry Manure @ 12.5 t ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
180	10	200	68	70	47
200	12	220	62	60	44
220	14	240	55	49	41
240	16	260	49	39	38
260	18	280	43	28	35

### Turmeric (12)

Soil : Red Sandy loam (Irugur series)

FN = 1.11 T - 0.83 SN - 0.98 ON

Season : Annual

$FP_2O_5 = 0.57 T - 5.21 SP - 1.02 OP$

Target : 350 q ha<sup>-1</sup> fresh rhizome

$FK_2O = 0.83 T - 0.50 SK - 0.61 OK$

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM / Coirpith compost / Poultry Manure @ 12.5 t ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
175	10	175	168	102	138
200	12	200	148	92	126
225	14	225	127	82	113
250	16	250	106	71	101
275	18	275	85	61	88

### III. MEDICINAL CROP

#### Ashwagandha (13)

Soil : Mixed black calcareous

$FN = 24.77 T - 0.61 SN - 0.74 ON$

(Perianaickenpalayam series)

$FP_2O_5 = 18.33 T - 2.68 SP - 0.84 OP$

Season : Kharif / Rabi

$FK_2O = 18.12 T - 0.21 SK - 0.59 OK$

Target : 9 q ha<sup>-1</sup> dry root

Initial soil tests (kg ha <sup>-1</sup> )			NPK (kg ha <sup>-1</sup> ) + FYM @ 12.5 t ha <sup>-1</sup>		
SN	SP	SK	FN	FP <sub>2</sub> O <sub>5</sub>	FK <sub>2</sub> O
180	10	300	74	114	69
200	12	350	61	109	58
220	14	400	49	103	48
240	16	450	37	98	37
260	18	500	25	93	26

Note: (i) FN, FP<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O are fertilizer N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in kg ha<sup>-1</sup>, respectively; T is the yield target in q ha<sup>-1</sup>; SN, SP and SK respectively are available N,P and K in kg ha<sup>-1</sup> and ON, OP and OK are the quantities of N, P and K supplied through organic manure in kg ha<sup>-1</sup>.

(ii) 50% of blanket dose is fixed as maintenance dose to avoid nutrient mining.

(iii) 200% of blanket dose is fixed as maximum dose.



# Part XXII

## APPENDICES

### Appendix - I

Number of plants per acre

Distance in feet	No.of plants per acre	Distance in feet	No. of plants per acre
1 x 1	43560	12 x 12	302
1½ x 1½	19460	13 x 13	257
2 x 2	10890	14 x 14	222
2½ x 2½	6960	15 x 15	193
3 x 3	4840	16 x 16	170
3½ x 3½	3556	17 x 17	150
4 x 4	2722	18 x 18	134
4½ x 4½	2151	19 x 19	120
5 x 5	1742	20 x 20	108
6 x 6	1210	22 x 22	108
7 x 7	889	24 x 24	55
9 x 9	537	28 x 28	55
10 x 10	435	30 x 30	48
11 x 11	360	40 x 40	27

1 Acre = 4840 sq. yard

1 Acre = 43.560 sq.ft.

1 Acre = 40 Guntas

1 Acre = 4046.80 sq.mt.

1 Hec = 10000 sq.mt.

1 Hec = 250 cents

1 Hec = 2.47 acres

Trade Mark of TNAU



**Appendix - II**  
**Number of trees per acre**

Spacing(ft)	Square	Quincunx	Hexagonal
10	435	870	500
16	170	340	195
20	109	218	125
24	75	150	86
28	56	112	64
36	34	68	39
40	27	54	31

**Appendix - III**  
**Number of plants per acre**

Distance in metre	No. of plants per acre
1 x 1	4000
2 x 2	1000
3 x 3	444
4 x 4	250
5 x 5	160
6 x 6	111
7 x 7	81
8 x 8	62
9 x 9	43
10 x 10	40

## Appendix - IV

### Germination and purity standards

Sl. No.	Variety	MinimumGermination percentage	Purity minimum percentage
1	Cowpea	75	98
2	Cluster beans	70	98
3	Field beans	75	98
4	Beans	75	98
5	Bhendi	65	99
6	Bitter gourd	60	99
7	Sponge gourd	60	99
8	Bottle gourd	60	99
9	Cucumber	60	99
10	Snake gourd	60	99
11	Watermelon	60	99
12	Pumpkin	60	99
13	Cauliflower	65	98
14	Cabbage	70	98
15	Knol-khol	70	98
16	Carrot	60	95
17	Radish	70	98
18	Brinjal	70	98
19	Tomato	70	98
20	Chillies	60	98
21	Capsicum	60	98
22	Greens	70	95
23	Fenugreek	70	98
24	Basella	60	96
25	Onion	70	98

**Appendix - V**  
**Viability of Horticultural seeds**

S.No	Name of seed	Max. viability period
<b>A. Vegetables</b>		
1	Onion	6 Months
2	Beans, Pea, Cowpea	1 Year
3	Brinjal, Tomato, Chillies, Capsicum, Cucumber, Squashes, Pumpkin, Carrot, Radish, Turnip, Cole crops.	1.5 Years
4	Bhendi, Lettuce, Amaranthus, Methi, Beet root, Palak.	2 Years
<b>B. Fruits and root stock plants</b>		
1	Lime, Mandarin, Citrus rootstock species	1 Week
2	Mango stones, Litchi, Passion fruit, Butter fruit, Rose apple, Jambulana.	1 Month
3	Papaya, Kirni seeds	3-4 Months
4	Guava	4 Months
5	Watermelon, Musk melon	1 Year
6	Custard apple, Ramphal and other Annona sp.	1.5 Years
<b>C. Plantation and Spices</b>		
1	Clove, Nutmeg, Cinnamon, Curry leaf	1 Month
2	Arecanut, Cashewnut	3 Months
3	Coconut	4 Months
4	Coriander and other annual spices	1 Year
<b>D. Flowers</b>		
1	Aster seeds, Gladioli corns	1 Year
2	Marigold	1.5 Years
3	Other annual flower seeds	1 to 2 Years

## Appendix VI

### Average composition of manures and fertilisers

Materials	Percentage of Nutrients		
	N	P	K
Ammonium sulphate	20.5	-	-
Ammonium sulphate nitrate	26.0	-	-
Ammonium nitrate	33.5	-	-
Ammonium phosphate	16.0	20.0	-
Calcium ammonium nitrate	20.5	-	-
Nitrate of soda	16.5	-	-
Urea	46.0	-	-
Superphosphate-single	-	18.0	-
Superphosphate-double	-	35.0	-
Superphosphate-triple	-	45.0	-
Ultraphos	-	28.3	-
Mussoriephos	-	20-24	-
Rock phosphate	-	28.4	-
Bone meal	3.5	21.0	-
Muriate of Potash	-	-	50 or 60
Poultry manure	1.2 - 1.5	-	-
Sheep manure	0.8 - 1.6	-	-
Farm yard manure	0.4	0.3	0.2
Compost	0.5	0.25	0.5

## Appendix VII

### Conversion of pure nutrients to various N, P and K fertilisers

Rate of application (kg/ha)	Ammonium sulphate (20% N)	Urea (46% N)	Super phosphate (18% P)	Muriate of potash	
				(50 % K)	(60 % K)
10	50	22	56	20	17
20	100	44	112	40	34
30	150	66	168	60	51
40	200	88	224	80	68
50	250	110	280	100	85
60	300	132	336	120	102
70	350	154	392	140	119
80	400	176	448	160	136
90	450	198	504	180	153
100	500	200	560	200	170
110	550	242	616	220	187
120	600	264	672	240	204
130	650	286	728	260	221
140	700	308	784	280	238
150	750	330	840	300	255

## Appendix VIII Neutralising value of liming materials

Calcium carbonate or lime stone	$\text{CaCO}_3$	100
Burnt lime	$\text{CaO}$	179
Slaked lime	$[\text{Ca}(\text{OH})_2]$	136
Dolomite	$[\text{CaMg}(\text{CO}_3)_2]$	109



rops' 1993, KAU.

Trade Mark of TNAU



## Appendix IX

a.i.	0.05	0.1	0.2	0.3	0.4	0.5	1.0	2.0	3.0	4.0	5.0
Quantity of plant protection chemical required to be added to 10 litres of water (in ml or gm)											
20	10	20	25	30	40	50	100	150	200	250	
25	8	16	20	24	32	40	80	120	160	200	
30	7	13	17	20	27	33	67	100	133	167	
35	6	11	14	17	23	29	57	86	114	143	
40	5	10	13	15	20	25	50	75	100	125	
45	4	9	11	13	18	22	44	67	89	111	
50	4	8	10	12	16	20	40	60	80	100	
55	4	7	9	10	15	18	36	55	73	90	
60	3	7	8	10	13	17	33	50	67	83	
65	3	6	8	9	12	15	30	46	62	77	
70	3	6	7	9	11	14	29	43	58	71	
75	3	6	7	8	11	13	27	40	53	67	
80	3	5	6	8	10	13	25	36	50	63	
85	2	5	6	7	9	12	24	35	47	59	
90	2	4	6	7	9	11	22	35	44	56	
95	2	4	5	6	8	11	21	32	42	53	
100	2	4	5	6	8	10	20	30	40	50	

Source: Horticultural Technical Guide, GOK

**Appendix X**  
**Vernacular names of Horticultural Crops**

Crop	Scientific name of the crop	Tamil	Telugu	Malayalam	Kannada
Mango	<i>Mangifera indica</i> L.	Ma	Mamidi	Manga	Marinna
Guava	<i>Psidium gujava</i> L.	Koyya	Jama	Pera	Seba
Pomegranate	<i>Punica granatum</i> L.	Madulam	Danimma	Madulam	Dalimbari
Jack	<i>Artocarpus heterophyllus</i>	Pala	Panasa	Pilavu	Alasu
Jamun	<i>Eugenia jambolana</i>	Naval	Neerudu	Navil	Neredu
Tomato	<i>Lycopersicon esculentum</i> Mill.	Thakkali	Seemavanga	Thakkali	Vanga
Bhendi	<i>Abelmoschus esculentus</i> L.Moench.	Vendakkai	Bhendakaya	Bhendakayi	Vendakai
Onion	<i>Allium cepa</i> var. <i>aggregatum</i> L.	Vengayam	Neerulli	Bawanj	Nirulli
Cluster beans	<i>Cyamopsis tetragonolobus</i> L.	Kothavarai	Goruchikkudukaya	Kothavarakka	Govardanakayi
Pumpkin	<i>Cucurbita moschata</i> Poir.	Poosani	Gummidikaya	Mattanga	Kumblakayi
Ribbed gourd	<i>Luffa acutangula</i> Roxb.	Peerankai	Nunnabheera	Peechinga	Heerekkai
Bitter gourd	<i>Momordica charantia</i> L.	Pavakkai	Kakarakaya	Kaipakka	Hagalakkai
Snake gourd	<i>Trichosanthes anguina</i> L.	Pudalankai	Potlakaya	Padavalanga	Padivalakkai
Ash gourd	<i>Benincasa hispida</i> Cogn.	Kalyanapoosani	Budeethagummidi	Kumbalam	Budikumbla
Bottle gourd	<i>Lagenaria siceraria</i> Standl.	Sorakkai	Anapakaya	Churakkai	Soarekkai
Cucumber	<i>Cucumis sativus</i> L.	Velliri	Dosakaya	Vellirikkai	Southikadi
Cowpea	<i>Vigna sinensis</i> L.Walp.	Karamani	Alasandalu	Kottapairu	Avadai
Lablab	<i>Lablab purpureus</i> var. <i>typicus</i> L.	Avarai	Chikkudukayalu	Avarakka	Avaraikkai
Potato	<i>Solanum tuberosum</i> L.	Urulaikizhangu	Urulaigadda	Urulakizhangu	Urulagadda

Sweet potato	<i>Ipomoea batatas</i> L.Lam.	Sakkaraivalli	Genusagaddalu	Chakkaraikizhangu	Genusa
Tapioca	<i>Manihot esculenta</i> Crantz.	Maravalli	Karrapandalam	Kappakka	Maragenusa
Elephant yam	<i>Amorphophallus companulatus</i> Blume.	Shenaikizhangu	Thiyyakanda	Chenai	Suvarnagadda



Crop	Scientific name of the crop	Tamil	Telugu	Malayalam	Kannada
Colocasia	<i>Colocasia esculenta</i> L.Scott.	Seppankizhangu	Chamagadda	CHEMBU	KERUGADDA
Amaranthus	<i>Amaranthus</i> sp.	Keerai	Thotakoora	Cheera	Arivesoppu
Coccinia	<i>Coccinia indica</i>	Kovaikkai	Donda	Kovaikkai	Thondikkai
Curryleaf	<i>Murraya Koengii</i>	Karuveppilai	Karepaku	Kariveppillai	Kariberu
Mint	<i>Mentha</i> sp.	Pudina	Pudina	Muthina	Pudina
Pepper	<i>Piper nigrum</i> L.	Milagu	Mirialu	Kurumulagu	Karimenasu
Nutmeg	<i>Myristica fragrans</i> Hoult.	Jathikkai	Jajikaya	Jatikka	Jajikayi
Cinnamon	<i>Cinnamomum zeylanicum</i> Blume.	Lavangapattai	Sannalavanga	Erikkolam	Dalacinnicakke
Coriander	<i>Coriandrum sativum</i> L.	Kothamalli	Dhaniyalu	Kothumpalari	Kothumpari
Garlic	<i>Allium sativum</i> L.	Vellaipoondu	Tellagadda	Vellulli	Bellulli
Tamarind	<i>Tamarindus indicus</i> L.	Puli	Chintha	Puli	Hunase
Ginger	<i>Zingiber officinale</i> Rosc.	Inji	Allam	Inji	Shunti
Fennel	<i>Foeniculum vulgare</i> Mill.	Perunjeeragam	Saompu	Peerunjeeragam	Sompu
Fenugreek	<i>Trigonella foenumgraecum</i> L.	Venthayam	Menthulu	Uluva	Menthya
Cardamom	<i>Elettaria cardamomum</i> Maton.	Yelakkai	Yelakayalu	Elathari	Yelakki
Cumin	<i>Cuminum cyminum</i>	Seeragam	Jeelakkara	Jiragam	Jeerigae
Turmeric	<i>Curcuma domestica</i> Val.	Manjal	Pasupu	Manjal	Arashina
Mustard	<i>Brassica juncia</i> L. Czern. Coss	Kadugu	Avalu	Katuka	Sasive
Clove	<i>Eugenia caryophyllus</i> Sprengel.	Kirambu	Lavangam	Grambu	Lavanga
Cashew	<i>Anacardium occidentale</i> L.	Munthiri	Jeedimamidi	Parangimavu	Geru

Betelvine	<i>Piper betle</i>	Vethalai	Tamalapakulu	Vettala	Veeluvadele
Senna	<i>Cassia augustifolia</i> Vahl.	Surathnilavakai	Nilathangadu	Sunnamukki	Sunnamukki
Ajowan	<i>Trachyspermum ammi</i> L.	Omum	Vamu	Omum	Oma



## Appendix XI

### WAITING PERIODS FOR THE SAFE HARVEST OF HORTICULTURAL PRODUCE

	Crops	Pesticide	Concentration (%)	Waiting period (Days)
1.	Mango	Dimethoate	0.06%	14
		Fenthion	0.05	14
		Cypermethrin	0.01	6
		Quinalphos	0.05	12
		Methyl demeton	0.05	14
		Mancozeb	0.20	7
		Lindane	350 g a.i./ha	---
2.	Acid lime	Chlorpyrifos	0.05	9
		Methyl demeton	0.05	12
		Methyl parathion	0.05	7
3.	Grapes	Carbaryl	0.10	5
		Dimethoate	0.06	5
		Fenthion	0.05	4
4.	Guava	Malathion	0.10	7
		Methyl parathion	0.05	9
		Phosalone	0.07	4
		Quinalphos	0.05	12
5.	Ber	Endosulfan	0.07	5
			0.04	15
		Quinalphos	0.05	7
6.	Tomato	Phosalone	0.05	3
		Fenitrothion	0.07	2
		Methyl parathion	0.05	5
		Quinalphos	0.05	5
		Mancozeb	0.20	5



	Crops	Pesticide	Concentration (%)	Waiting period (Days)
7.	Brinjal	Phosalone	0.07	2
		Fenitrothion	0.10	5
		Endosulfan	0.07	3
		Carbaryl	0.10	3
		Methyl parathion	0.05	5
		Mancozeb	0.20	2
		Disulfoton	1 kg a.i./ha	60
		Aldicarb	1 kg a.i./ha	60
8.	Bhendi	Phosalone	0.07	5
		Fenitrothion	0.05	6
		Endosulfan	0.07	3
		Carbaryl	0.10	3
		Methyl parathion	0.05	7
		Triazophos	350 g a.i./ha	5
		Lindane	350 g a.i./ha	5
		Disulfoton	1 kg a.i./ha	55
		Aldicarb	1 kg a.i./ha	55
9.	Chillies	Dicofol	0.05	1
		Quinalphos	0.05	8
		Mancozeb	0.20	6
		Lindane	350 g a.i./ha	2
		Aldicarb	1.25 g a.i./ha	60
		Carbofuran	1.25 g a.i./ha	60
		Dimethoate	0.03	5
		Acephate	0.06	7
			0.075	5
			0.151	8
10.	Lablab	Endosulfan	0.07	6.8
			0.14	9.9
			0.1	16.5

11.	Cardamom	Methyl parathion	0.05	Fresh capsules : 18-20
		Endosulphan	0.07	Cured capsules : 24-31 16
12.	Betelvine	Carbofuran	0.75 kg a.i/ha	33

Trade Mark of TNAU



## About . . .

### **Government Botanical Gardens, Udhagamandalam**

The Government Botanical Gardens, nestled in a beautiful ravine with its entire splendor lying adjacent to the Raj Bhavan within the town. It covers an area of 22 ha ascending the slope on the hill at an elevation of 2400 - 2500 metres above MSL.

The gardens enjoys a cool temperate climate with an average rainfall of 140 cm per annum, most of which is received during South-West monsoon with frosty nights from November to February. The maximum and minimum temperatures are 29° C to 0° C respectively.

Before the garden was laid out, the area was then a patch of vegetable Garden. The upper portion with a wildness of Shola and shrubs, the lower part a swamp traversed by deep ravines. Early in 1847 at the aspiration of Marquis of Tweeddale who was then the Governor of Madras, a fund was raised by donations and subscriptions to start a public garden.

In 1848, Mr. C. Mc Iver who had the training at the Royal Botanic Gardens Kew, London was appointed as Superintendent of the Government Botanic Gardens, Udhagamandalam.

The main garden is divided into six different sections, viz.,

- ! The front gardens
- ! The band stand
- ! The conservatory and its surroundings
- ! The fountain terrace and picnic gardens
- ! The new band stand and its surroundings
- ! And the nurseries

The Government Botanic Gardens, Udhagamandalam had played an important role in the earlier years by introducing many crops in the Nilgiris. Systematic introduction and maintenance of plants has resulted in the collection of about 2000 spices of plants representing 119 natural orders.

The Government Botanic Gardens, Udhagamandalam is from the inception, the primary

centre of Horticulture development in the Nilgiris.

In the recent past, studies on various aspects of ornamental plants such as propagation techniques, cultivation methods, etc., are undertaken apart from introduction of new species of plants enriching the existing collection.

Trade Mark of TNAU

The special feature of the Government Botanic Gardens, Udhagamandalam is the conduct of flower show in the middle of May, every year. Exhibitions and competitive shows on various collections of flowers are held during the show. The show draws an immense crowd of enthusiasts and tourists every year.



### (For information only)

#### **Growth and development of moringa under organic and inorganic systems of culture**

An experiment was conducted to find out the efficacy of organic manures viz., FYM, poultry manure, neem cake, biofertilizer viz., *azospirillum*, VAM and natural organic product panchakavya on the growth and yield of moringa. The treatment combinations of poultry manure + neem cake + panchakavya (2% spray) out yielded other treatments for the growth and yield characters. Days to 50% flowering was advanced to 14.93 days in the above treatment. The yield attributes viz., number of pods / tree (225.57), pod weight (95.37g), pod yield 35.67 kg / tree were highest in the above treatment combination of poultry manure + neem cake + panchakavya. The nutrient contents viz., carotene (144.97 mg / 100g ascorbic acid (131.53mg / 100g) and soluble protein (5.74 g/100g) were found to be highest in the same treatment combination of poultry manure + neem cake + panchakavya. It was also found that the treatment combination of poultry manure

+ neem cake + panchakavya was very effective in controlling the fruit fly incidence (26.4%), when compared to control (38.22%).

#### **Studies on the manipulation of source – sink relationship for increasing the fruit size of tomato hybrid H24 x CLN 2123 A**

In tomato, the hybrid H2s x CLN 2123 A showed greater response for the application of panchakavya. It was found that the treatment combinations of panchakavya 5% at nursery state and 40 days after transplanting + tender coconut spraying (10% once in a week for 3 times) (T8) recorded highest number of fruits per plant of 71.40, followed by 71.0 in the panchakavya 5% spray at nursery stage alone (T4) whereas the control registered the lowest number of fruits of 43.25. Similarly, the fruit weight and yield per plant were also highest in the treatment T8 (59.4g and 3.65 kg respectively). Fruit quality parameters viz., TSS ,Total acidity and ascorbic acid contents were also highest in the treatment T8 (7.5, 0.73% and 16.8 mg/100g respectively).

#### **Organic production package of *Coleus forskohlii***

In a study conducted with *Coleus forskohlii* revealed that application of panchakavya 4% spray was found to be superior in respect of root yield 12.40 kg / plot. when compared to control 5.23 kg / plot. Similarly, number of roots same (14.99), root length (13.73 cm), root

diameter (2.49 cm) and root weight (459.35 g/ plant) was maximum in the above treatment when compared to control.

Trade Mark of TNAU



### **Standardization of organic production package of *Withania somnifera***

An experiment was conducted for the standardization of organic production package of *Withania somnifera* at Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Panchakavya 2%, 3% and 4% sprays and moringa leaf extracts 10 ml /plant, 20 ml / plant and 30 ml/ plant and chemicals cytozyme 1%, A tonic -1% and Miraculan – 1% sprays were given. Panchakavya 4% was found to be the best among all the treatments for growth and yield characters viz., plant height (145.63 cm), shoot fresh weight (976.24g), number of fruits (498.46) fruit yield (64.74 g / plant) and root length (54.21cm) . Compared to control, with only 98.48 cm, 720.61 g, 348.67, 36.23g /plant, 38.62 cm respectively.





### **Effect of organics on growth and yield of Bhendi var. Varsha Uphar**

An experiment was conducted to study the effect of panchakavya and moringa leaf extract on growth and yield of bhendi var. Varsha Uphar at Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Four sprays panchakavya (3%) and moringa leaf extract (25 ml/plant) were used started from 2 weeks after sowing and then the subsequent sprays given at 15 days interval. Both the treatments viz., panchakavya and moringa leaf extract were revealed the higher plant height, number of branches per plant, number of fruits per plant and fruit yield than the control (water spray). Moringa leaf extract increased the higher plant height and numbers of branches, while the number of fruits and fruit yield were the highest in panchakavya treated plants.

### **Physiology of petal shedding in Rose**

A study was conducted on the physiology of petal shedding in two cultivars of rose, viz., Edward rose and Red rose. It was found that the treatment calcium acetate 0.5% + panchakavya 5% significantly influenced the morphological characters, such as the height of the bush, length of the flowering shoot and the floral characters, such as the flower diameter, pedicel length, receptacle diameter, number of petals and petal : receptacle ratio. The treatment panchakavya 5% resulted in earlier flowering of 45.6 days and 53.31 days in cv. Edward rose and cv. Red rose respectively.

### **Studies on the effect of pinching, spacing and growth regulators on growth, yield and quality of Ashwagandha (*Withania somnifera*)**

In Ashwagandha, the yield attributes viz., root length (50.67 cm), root girth (4.93cm), root primaries (6.50 cm), root fresh (96.33g), dry weight (38.27 g) and root bark weight (22.33g) per plant were the highest under the treatment pinching + wider spacing + panchakavya (3% spray).

However the treatment pinching + closer spacing (60 x 30cm) + panchakavya (3%) registered the highest root yield of 1350 kg / hectare.

### **Biodynamic Agriculture**

(Pfeffer, 1984) "Biodynamic Farming" refers to working with energies, which create and maintain life. The term derives from Greek Word "Bios (life) and 'dynamics' (energy). The use of word "method" indicates that one is not dealing merely with the production of another

fertilizer, organic though it is, but rather that certain principles are involved which in the practical application secure a healthy soil and plants which in turn produce healthfuy food for man and healthy feed for animals . Biodynamic agriculture works on the following principles:

- ! To restore to the soil, the organic matter in the form of humus, which holds it's fertility.
- ! To establish, maintain and improve soil living system.
- ! Organic matter as the basic factor for the soil life.
- ! Biodynamic method is not only fertilizing the soil but skillfull application of the factors contributing to soil life and health.

---

Courtesy : R.K. Pathak and R.A.Ram (2003). Approaches for green food production in horticulture. Precision Farming in Horticulture



- ! Establish a system that brings into balance all factors which maintain life.
- ! In biodynamic way of treating manure and composts, the knowledge of enzymatic, hormone and other factors are also included.
- ! The biodynamic method puts special emphasis on the importance of crop rotation, green manuring and cover crops.
- ! The soil is not only a chemical, mineral or organic system, but it also has a physical structure. Maintenance of a crumbly, friable, deep, well-aerated structure is essential feature of fertile soil.

Efforts are being made to elaborate the concept and brief account of preparations used in biodynamic agriculture with a few explanations and experiences with the cultivation practices.

## **Cosmic integration**

### **Zodiac Principles**

The ultimate fine tuning of biodynamic principles lies in harnessing cosmic influences for cultivation. Only at particular times of month or year, the cosmic influences are most supportive to growth of a particular part of a plant. (Schilthuis 2000).

The cosmic factor that determines a month is the Moon. The movement of the Moon in relation to the Zodiac is more interesting. These Zodiac symbols are Greek in origin. The system has 12 constellations though represented by different archetype figures and animals. Within these 12 signs, there are four groups of these constellations, each of which have same qualities. They are related to basic four elements, i.e. earth, water, fire and air. These four elements can be placed in relation to influencing the four parts of the plant, the root, leaf, flower, and fruit as summarized below.

- ! Root is associated with the earth. There is no root growth without earth,
- ! Leaf is associated with water because it contains more than 80 per cent water,
- ! Flower corresponds to air and light. There is no light without air (no light on the Moon) because there is no atmosphere,
- ! Fruit and seed associated with fire, there is no fruit seed maturity without warmth.

Performing farm operations on specific days means harnessing these cosmic influences for development of a particular plant part.

The earth is emerged in the planetary spheres of solar system and these forces stamp themselves

for example, morphology of the plants. The earthly forces of Moon, Mercury and Venus soak into the earth from the air above and the cosmic forces of Mars, Jupiter and Saturn moves upward from the rocks below. They interact in the region of clay so that the plants grow out of it. The light of the Sun, Moon, Planets and stars reaches to the plants in regular rhythms.

Trade Mark of TNAU

Each contributes to the life, growth and form of the plant. Planets impress effect on metals, rocks, plants, animals and man, so called “astral influences” coined from Greek where astar means, “star”. Just as sunshine contributes to the growth of plants and moon affect water content of all organisms, the planet also influences the earth and all who dwell on her. Since olden time, they have been divided as inner planet (Moon, Mercury and Venus between earth and Sun) and outer planets (Mars, Jupiter and Saturn). The inner planets work directly through atmosphere are indirectly via water, humus or calcium (limestone, potassium and sodium) on growth of plants.

The influences of Mars, Jupiter and Saturn are channeled through warmth and silica (quartz, feldspar and mica), they stream in through silica contents of soil and on plants being expressed in colours of flower and in fruit and seed production.

By understanding the gesture and effect of each rhythm, agricultural activities like soil preparation, sowing, intercultural operations and harvesting need to be programmed accordingly.

### **Biodynamic Calendar**

Biodynamic farmers use the knowledge practically by choosing time to sow on plant, to use various plant husbandry techniques. Agricultural practices, i.e. field preparation, sowing, manuring, harvesting etc. performed as per constellation are more effective and beneficial. Every constellation has dominant elemental influence and affects four specific parts of the plants as enumerated below in Table 1.

Table 1. Showing interaction of element and constellation on plant parts

Element	Plant part	Constellation
Earth	Root	Virgo, Capricorn, Taurus

Air	Flower	Germini, Libra, Aquarius
Water	Leaf	Cancer, Scorpio, Pisces
Fire	Fruit	Aries, Leo, sagittarius

Trade Mark of TNAU

Agricultural practices for better root activity (manuring and rooting), flowering, growth and fruiting/ seed is to be done as per constellation.

*Ascending period of moon:* During this period, cosmic forces are active above the *earth* /ground. Any agricultural practice (spray, propagation etc.) performed during the period show beneficial effect.

Descending period of moon : During this period, cosmic forces are active below the earth. Therefore, agricultural practices (field preparation, sowing, manuring and harvesting of root crops) performed during the period shows better success.

Agricultural Operation as per Movement of Moon : The moon moves regularly around earth and it travels monthly through each of the 12 signs of the Zodiac, staying approximately two-and-a half days in each sign. As it does so, it forms an angular relationship with the sun that is known as a Phase of the Moon, which means the angle between moon, earth and sun. Moon orbits the earth and the earth orbits the sun. It is the earth's orbit that defines the 'ecliptic', which is divided symbolically into the zodiac. (Table 2)

Table 2. Showing position of earth and moon for harnessing cosmic forces.

Ascending moon	Descending moon
The earth is breathing out- the development occurs in upper parts of	The earth is breathing in - the development of the plant occurs parts below the ground, eg.
Cosmic energy works above the rhizosphere	Cosmic energy works below the rhizosphere
Spring and summer season	Autumn and winter season
Foliar applications, propagation activities, harvesting and sowing	Root development, transplanting, manure application and harvesting

Phases occur in two stages - waxing and waning

The moon is "waxing" (ascending period) - growing during these phases stages are :

New moon, crescent moon, first quarter moon, gibbous moon.

The moon is waning (descending period) - shrinking - during these phases

Full moon disseminating second quarter balsamic.

As a general thumb rule, when moon is waxing plants develop leaves above the ground systems and when moon is waning, plants develop their root system.

Planting leafy crops that grow above ground are best sown at waxing moon and those that will require strong root system or grow below ground should be snow after full moon, in the waning phase.

Perigee (Poornima : full moon) when the moon is nearest to the earth, this occurs after every 29 and half day. In 48 hours, proceeding to full moon, there appears to be distinct increase in the moisture content of the earth and in the atmosphere. Growth promoting activities of the plants seems to be enhanced and plants are more susceptible to fungal attack because of relatively higher moisture content in the rhizosphere and atmosphere.

Apogee (new moon) - when the moon is farthest from the earth. This occurs every 27<sup>th</sup> and ½ days. Owing to moisture deficiency, harvesting and seed storage practices show better response.

Moo opposite to Saturn - this is favourable period, agricultural operation performed during this period show better response.

Lunar Node



Imaginary point when moon crosses path of sun. It occurs twice in 27.2 days of a month and known as Rahu and Ketu

Rahu - Lunar node in ascending period of moon not suitable for agricultural activities.

Ketu - Lunar node in descending period, not suitable for agricultural activities.

Trade Mark of TNAU





## **Biodynamic preparations**

Basically there are two types of biodynamic preparations.

- ! Biodynamic field sprays (BD-500-501).
- ! Biodynamic compost preparations (BD-502-507).

### **Biodynamic Field Sprays (BD 500-501)**

Cow horn manure (BD-500) : This is fundamental biodynamic field spray preparation. The cow is an earthy creature with a very strong digestive system. The cow horn has the ability to absorb life energies during decomposition of the dung being incubated in winter months.

### **Steps in preparation**

- ! Cow horns are cleaned properly with water. While collecting the horn it should be ascertained that only cow horn to be picked which is solid from proximal end their rings are at distal end.
- ! Cleaned cow horns are filled with fresh cowdung (especially from lactating and indigenous one) and buried at 30 cm depth in the soil in root free zone in descending period of moon during October – November.
- ! After 6 months of incubation, horns are taken out in descending period from moon during March- April.
- ! If decomposition of dung is not proper, cow horns should not be taken out and should be left for some more period and again is to be taken out during descending period of moon.
- ! Properly decomposed compost is to be stored at cool and dry place in earthen pot.

Specially prepared manure is made into a spray to vitalize the soil, enhance seed germination, root formation and primary root development. For spraying, 25g of BD-500 is dissolved in 13.5 litres of water in wooden / plastic bucket by making vortex in clock and anti-clockwise for one hour in the evening and the solution is spread either with the help of natural brush or with a tree twig. Spraying of BD-500 is done at the time of field preparation in descending period of the moon. Stirring small quantities of material in large amount of water is called Dynamization. This process transfers the forces and energy from the preparation to the water.

Thimmaiah (2001) observed the microbial activity of BD-500 during stirring and very interesting response has been obtained. (Table. 3)

Table.3. Microbial analysis of BD 500

Stirring interval (minutes)	Bacteria (cfu/g)	Actionmycetes (cfu/g)	Fungi (cfu/g)
15	26 x 10 <sup>3</sup>	22 x 10 <sup>3</sup>	10 x 10 <sup>3</sup>
30	35 x 10 <sup>3</sup>	35 x 10 <sup>3</sup>	14 x 10 <sup>3</sup>
45	58 x 10 <sup>3</sup>	60 x 10 <sup>3</sup>	12 x 10 <sup>3</sup>
60	66 x 10 <sup>3</sup>	88 x 10 <sup>3</sup>	35 x 10 <sup>3</sup>

It is interesting to observe that during stirring period, there was a corresponding increase in number of cfu's of bacteria, actinomycetes and fungi during one hour of stirring. The CISH, Lucknow, has also identified the following microorganisms (fungi) from BD-500 preparation.

- \* *Fusarium semitatum*
- \* *F. sporotrichiodes*
- \* *Syncephalastrum racemosum*

Cow horn silica (BD-501) : In this, ground mountain quartz (silica) after proper incubation is made in to spray on plants. It helps them to achieve optimum development and maturity and particularly affects taste, colour and aroma.

### Steps in preparation

- ! After taking out of cow horn manure (BD-500), cow horns are thoroughly cleaned with water.
- ! Cow horns are filled with silica with powder paste, and buried in same pit where cow horns were buried for the preparation of BD-500 during ascending period of moon in March-April.
- ! After 6 months of incubation, horns are taken out in October-November during the ascending period of moon.
- ! Light yellowish silica powder is taken out from the horn and stored in light near the house window in glass jars.

BD 501 works on photosynthetic process in the leaf. Its action is to strengthen the effect of light and warmth on the plant and promotes healthy growth. It strengthens the quality of plant and the plant product and encourages the development of fruit and seeds. For maximum effect, the BD 501 should be applied once at the beginning of a plant's life, at the four-leaf stage and again at the flowering or fruit maturation stage. BD 501 should be applied on the leaves in the form of 'mist' in the morning at the sunrise and the best constellation is moon in opposite to Saturn.

Following fungi are isolated from BD -501 at this Insitute.

- \* *Fusarium moniliformae*
- \* *Penicillium chrysogenum*
- \* *Syncephalastrum racemosum*

### **Biodynamic Field Sprays**

Biodynamic sets (BD-502-507) are prepared from six herbal plants, which have healing properties and influence the fermentation processes in the compost, liquid manure and Cow Pat Pit. These are also associated with particular constellations as summarized in Table.4. All these preparations are made in descending period of the moon, except BD-507, which is best prepared in air / light day. The BD sets are used in the Cow Pat Pit (CPP), BD – compost, Biodynamic liquid manure and Biodynamic liquid pesticides.

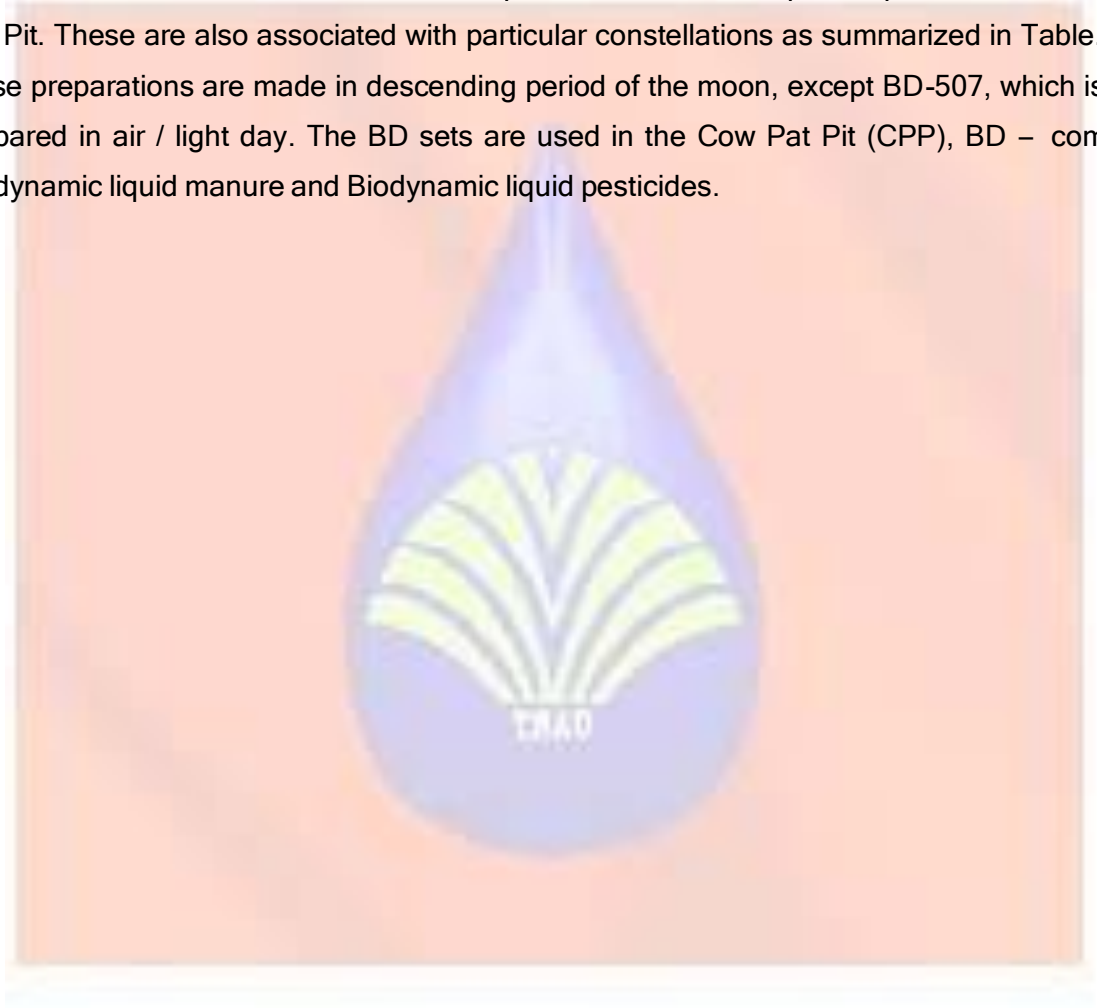


Table 4. Basic BD sets used CPP, BD compost, liquid manures and pesticides

Preparation	Constellation	Substances from which preparation is prepared	Role
BD-502	Venus	Fermented flower heads of Yarrow ( <i>Achillea millefolium</i> )	Rich in S, K and N
BD-503	Mars	Fermented Chamomile ( <i>Matricaria recutita</i> ) blossom	Rich in S, K and N
BD-504	Mercury	Whole shoot of Stinging Nettle ( <i>Urtica dioica</i> ) with flower, fermented in the soil	Rich in Fe
BD-505	Moon	Fermented oak ( <i>Quercus robur</i> ) bark	Rich in Ca
BD-506	Jupiter	Fermented flower heads of Dandelion ( <i>Taraxacum officinale</i> )	Rich in K and Si
BD-507	Saturn	Valerian ( <i>Valeriana officinalis</i> ) flower extract	Rich in P

These work to regulate the composting process and enable the different elements (calcium, nitrogen and phosphorus) needed for healthy plant growth to be present in a living way. The specifications of BD sets used in these preparations are described in the Table.5.

Table.5 Showing number of sets used for specific preparation.

Specific preparation	No. of sets used
Cow Pat Pit (CPP)	2 sets per 60 kg of cow dung
Liquid manure	2 sets per 200 litres
Biodynamic compost	1 set per 5 m <sup>3</sup>

Cowdung and urine are important components of Cow Pat Pit (CPP), BD liquid manure and BD pesticides. Their brief account are summarized below.

### **Cow Pat Pit (CPP) or Barrel Manure**

It is a biodynamic field preparation also called as soil shampoo. Cow Pat Pit (CPP) is a strong soil conditioner. It enhances seed germination, promotes rooting in cutting and grafting, improvement in soil texture, provides resistance powers to the plants against pests and diseases, replenishes and rectifies the trace element deficiency. CPP is increasingly used for improving soil biological activities in the seed treatment and foliar applications. The CPP may be prepared throughout the year.

### **Steps in preparation**

1. Preparation of a pit of 60cm x 90cm size in shade and root-free zone. Precaution is to be

taken that pit should be 15cm higher than plane surface.

- ! Pasting of inner wall of the pit with fresh cowdung paste.
- ! Dung of lactating cow (60kg) mixed thoroughly with 250g each of bentonite and egg shell powder and filled in the pit.
- ! Compost gets ready in 75-90 days depending upon the temperature.

Trade Mark of TNAU



One kg CPP dissolved in 40-45 litres of water overnight and sprinkled in the next morning as field sprays on the plants. This should be applied at the time of field preparation and on plants. CPP can also be applied in BD compost and with FYM for improving their nutritive value. The preparation is ready for use when it is dark brown, friable and has lost the smell of cowdung.

### **Biodynamic Compost Heap**

Biodynamic compost is an effective soil conditioner and is an immediate source of nutrient for a crop. Biodynamic Compost Heap can be prepared by using green leaves (nitrogenous material) and dry leaves (carbonaceous material) in 8-12 weeks. Integrating with cowdung slurry is always good in the decomposition process. The composition of air, moisture and warmth is very important in the breakdown and decomposition of material. The enriched compost is ready in 75-100 days depending upon the prevailing temperature.

#### **Steps in preparation**

- ! Five-meter long thick wood is placed on higher elevation where waterlogging does not occur during rainy season.
- ! Thick layer (20 cm) of dry grasses is spread on the area of 5 m x 2.5 m on the ground.
- ! Water (100-150 litres) mixed with dung sprinkled on the grasses.
- ! Again 20 cm thick layer of green grasses are sprayed equally on the heap and 100 to 150 litres of water mixed with dung sprinkled on the heaps.
- ! Above process (putting 20 cm thick layers of dry and green grasses alternatively) is repeated to the height of 1.5m.
- ! For enriching the compost with different nutrients as per the need, rock phosphate (P), slacked lime (Ca) wood ash (K) etc. can also be used in between the layers of dry / green grasses.
- ! Two B.D sets (502-507) are incorporated and the heap is plastered with mixtures of dung and clay.

The BD compost is said to be more fertile with a stronger ability to improve soil than the conventional compost. When the specially prepared CPP and BD compost have been applied to the soil, the plants become more sensitive to their environment and responsive to the rhythms of the day, seasons and planets.

### **Vermicompost**

Vermiculture technology is an aspect involving the use of earthworms as versatile natural



bioreactors for effective recycling of non-toxic organic wastes to the soil. They effectively harness the beneficial soil microflora, destroy soil pathogens, and convert organic wastes into valuable products such as biofertilizers, biopesticides, vitamins, enzymes, antibiotics, growth hormones and proteinous biomass (5).

Earthworms participate in soil farming system in following ways :

- ! Through their influence on soil pH
- ! As agents of physical decomposition of organic wastes
- ! Promoting humus formation
- ! Improving soil structure
- ! Enriching soil and water-holding capacity.

### **Steps in composting**

#### **Vermicomposting on plane surface**

- ! Partially decomposed organic wastes are piled up on 2 m x 1 x 0.5 m areas at cool and elevated place.
- ! Two to five thousand red worms (*Eisenia foetida*) are released in the middle of bed by putting 2-4 kg one week-old dung.
- ! Water (2-5 litres) is sprayed everyday to keep the earthworms active. To protect earthworms from the excessive heat and rain, shade should be provided.
- ! Depending upon the weather conditions complete heap of the organic waste get converted into fine compost within 75-120 days.
- ! Ready compost is sieved to separate the earthworms.
- ! Separated worms are released in another heap of partially decomposed organic waste.
- ! As the time passes population of worms and vermicompost production increases very fast.

#### **Vermicomposting in pit**

- ! Brick structure (3 cm x 1.5 cm x 5 cm) is prepared in shade.
- ! One brick wall made of cement is preferred.
- ! After putting 5 cm thick layer of concrete and sand, each 40 cm thick layer of partially decomposed or soft organic waste is spread equally above the sand.
- ! One -week-old cowdung (1-2 kg) is kept at 6-8 places on the organic waste and 50-100 earthworms are released in each heap of cowdung.
- ! Water (2-5 litres) is sprayed in the bed and covered with 5 cm thick layer of organic waste.
- ! The bed is covered with thatch to protect earthworms from excessive heat, rain and cold.



- ! To keep the worms active, light spray of water is essential everyday.
- ! Worms convert all the organic waste into compost. Again 30-40 cm thick layer of partially decomposed organic waste is spread equally in the bed and moistened and it takes another 30-45 days for full conversion of organic waste into compost within 45-60 days.
- ! Prepared compost is taken out and sieved to separate earthworms from the compost.
- ! Pit is again filled up with organic waste and earthworms are released as described earlier.
- ! As earthworm's population increases very fast, a few more pits are to be required to increase the vermicompost production.

## **Vermiwash**

Vermiwash is prepared from the heavy population of earthworms reared in earthen pots or plastic drums. The extract contains major, micronutrients, vitamins (such as B 12) and hormones (gibberellins) secreted by the earthworms. Earthworms produce bacteriostatic substances and it was found the vermiwash can protect the bacterial infections. Vermin wash can be sprayed on crops and trees for better growth, yield and quality.

### **Steps in preparation**

- ! Bio earthen pot / plastic drum with capacity of 200 litres (provided with tap in the bottom) is placed in shade.
- ! Five cm each of concrete and coarse red sand (Morang) is laid in the bottom of the pot for effective drainage.
- ! Layer of soften kitchen waste or one-week-old dung (30-40cm) is filled in the pot.
- ! Red worms (200-300) are released in the waste / dung.
- ! An earthen pot with minute hole in the bottom from where water comes out in the form of drops is hanged over the pot / drum after 30 days of worms inoculation.
- ! After 2-3 days, extract collected in earthen pots from the tap provided in the bottom of pot / drum which is called 'Vermiwash'.
- ! Extract diluted in the water (1:5 ratio) can be used as a foliar spray.

**Precaution :** Continuous pouring of water in the pot / drum having hole in the bottom and the organic waste in the pot / drum should be changed regularly, after its full conversion into the compost.

## **Nadep Compost**

A farmer at Indore developed this method of aerobic composting. Because of aerobic respiration, composting is very fast and nutritional status of the compost is better than the ordinary compost. In this method of composting, farm wastes (cow-dung, green / dry grasses, wheat / paddy straw and weeds and garden soil) are used and the technique has been summarized below. The compost can be enriched through incorporation of rock phosphate, wood ash, slacked lime, Azotobacter and Rhizobium. Incorporation of two BD sets (BD 502-507) further improves the nutritive status of NADEP compost, Thimmaiah (2001) named it as hybrid compost.

### **Methods of composting**

- ! Brick aerobic structure (2m x 3.30m x 1m) is constructed at elevated place in farm area. First and the last two rows are provided without any gap to strengthen the structure.
- ! Length of the structure can be altered as per the requirement
- ! Thick layers (18-20 cm) of organic wastes are piled and water 100-150 litres mixed with cowdung is drenched on the waste.
- ! Again 18-20 cm thick layer of organic waste pile, covered with thick layer (2-3cm) of garden soil is sprayed and sprinkled with water (100-150 litres).
- ! The above processes are repeated till the piling goes 30-45 cm higher than the structure. Total heap is plastered with mixture of dung and mud.
- ! After 10-15 days heap gets settled leaving 15-30 cm gaps from the top.
- ! Process of filling and plastering are again repeated.

Incorporation of any of these preparation and the following other associated activities will suffice the nutritive requirement for production of horticultural crops, which can be summarized as below.

In green food production nutritional requirement can be taken care through

- ! Regular incorporation of organic waste through NADEP, Vermi, Biodynamic Compost (BD) or Microbe Mediated Compost (MM compost).

- ! Use of cakes (neem, mahuwa, pongamia, castor, groundnut etc) as per availability need to be promoted.
- ! Promotion of green manuring and legumes as inter and cover crops whenever and wherever possible.
- ! Promotion of mulching with organic wastes which can be further promoted by spread of 5-20 kg vermin / BD compost or 100g CPP and incorporation of 50-100 earthworms.
- ! In order to encourage soil biological properties, regular use of Cow Pat Pit (CPP), Cow Horn Manure (BD -500) are also helpful.

Need-based use of liquid manure prepared from cowdung, cow urine, leguminous leaves or vermin wash are also effective in promotion of growth and fruiting.

Wide variations in nutrient status of composts and CPP have been observed as evident from Table 6. This can be further enriched through incorporation of rock phosphate, bone-meal, slacked lime, blood and fish meal. Various combination of green vs dry leguminous non-leguminous may be helpful. These need to be worked out for meeting the nutritional requirement of various horticultural commodities.

### **Biodynamic Tree Paste**

In a biodynamic process for the management of orchards and gardens, the “biodynamic tree paste” is prepared by mixing of cowdung, bentonite (clay), BD 500 and sand. The tree paste is polished on the tree trunks and cut surfaces

Table 6. Nutrient status of compost and CPP

Preparation	N (%)	P (%)	K (%)
General compost	0.3 - 0.5	0.20 - 0.35	0.50-1.50
Vermi compost	1.12-1.75	0.214-0.285	0.506-1.72
Cow Pat Pit	0.70-2.24	0.214-0.428	0.718-0.925
Nadep compost	1.33-2.03	0.202-0.389	0.775-2.35

The important properties of biodynamic tree paste are :

- ! It nourishes, strengthens and protects the bark and cambium of tree to make it healthy.
- ! Seals and heals wounds.
- ! Helpful in prevention and control of disease.
- ! On application after pruning, stimulates tree growth.

Trade Mark of TNAU



In rejuvenation of mango orchard, copper oxychloride pasting (CoC) is very expensive. Pasting with the above paste on tree trunk and cut surfaces, alone has shown better response compared with CoC pasting. Similar to tree paste, cowdung has been found to be rich in actionmycetes. Cowdung paste and actionmycetes isolated from cow dung paste has also shown positive response in control of dieback, stem end rot and anthracnose in mango and guava. Similarly, BD pesticides have shown effective control of bacterial fruit canker and tent caterpillar in mango. These need to be validated for control of pest and diseases of horticultural crops.

Biodynamic system is almost new, but the preliminary observation over 4 years by the authors and overview of world literature including personel communications have shown very encouraging response with number of horticultural and field crops and following interferences can be drawn at this juncture.

If appears to be sustainable, economic and eco-friendly

There is minimum risk of residual toxicity

There has been continuous improvement in soil fertility and produce quality including self-life. Considering these experiences, following strategies are proposed to be initiated.

Strategies for green food production

- ! Various aspects of green food production particularly for horticultural commodities need to be standardized.
- ! Promotion of establishment of demonstrations for preparation of biodynamic compost, cow horn manure (BD0-500), horn silica (BD-501), Cow Pat Pit (CPP), liquid manures and liquid biodynamic pesticides.
- ! Promotion for field demonstrations for organic biodynamic system of cultivation.
- ! Organizing intensive training to farmers, NGO representative, entrepreneurs, and extension personnel of Department of Horticulture for biodynamic preparations and their applications.

! Scientific explanation for responses of the above materials with reference to soil physical and microbiological properties and their impact.

! Helping State Agriculture Universities (SAUs) to initiate a few courses on Organic / Biodynamic Agriculture.

! Facilitation for certification / Demeter for organic /biodynamic production.

! Establish national standards for covering marketing of certain agricultural products as green produced products.

! Assure consumers that these meet a consistent standard.

! Market promotion for 'Green Food' and their processed products.

! Regular monitoring of nutrients status of the soil.

! Study on various combination of locally available waste recycling for meeting the nutrient requirement and techniques of compost enrichment.

! Impact of organic / biodynamic farming on flora and fauna of the area.

! Impact analysis of organic /biodynamic farming on agro-ecosystem of the region over the years.

## References

01. Pathak, R.K and Ram, R.A (2002). Approaches for green good production. In : Souvenir, National Seminar-cum-workshop on Hi-Tech Horticulture and Precision Farming, held at Taj Residency, Lucknow, pp.33-35.
02. Pathak, R.K and Ram, R.A (2001). Approaches for biodynamic farming. Approaches for Sustainable Development of Horticulture. Singh, H.P., Negi, J.P and Samuel, J.C. (Eds), NHB, Gurgaon, pp. 113-19.
03. Pfeffer, E. (1984). Using the bio-dynamic compost preparation and sprays in garden, orchard and farm. Biodynamic Farming and Gardening Association, Inc, Kimberton, PA, 64 pp.
04. Schilthuis W. (2000). Biodynamic Agriculture, S&H Home Ag. Library Biodynamic Agriculture.
05. Sharma, A.K.(2001). A Hand Book of Organic Farming. Agrobios, India, Jodhpur, pp.193-215.
06. Thimmaiah, A. (2001). Studies on biodynamic system and vermitechnology for sustainable Agriculture. Ph.D thesis, IIT, New Delhi.

## HIGH DENSITY PLANTING IN FRUIT CROPS

High density planting is the current concept by which productivity of the fruit crops can be enhanced per unit area . As most of the perennial fruit crops takes long years to attain a bigger canopy, it is possible to accommodate and maintain more trees per unit area till such canopy development interferes with general cultural operations or performance of the nearby plants by competing for light, water , nutrients and other inputs. High density planting of similar kind of fruit trees is also advantageous as it will not require much labour as required for intercropping with seasonal crops to make use of the alley spaces available otherwise. The following are some of the advantages of high density planting.

- ! The yield per unit area could be increased.
- ! Reduced labour cost and labour involvement towards weeding and desuckering.



- ! Efficient utilization of land, water, fertilizer and solar radiation.
- ! Cost of production per unit quantity of fruits could be reduced considerably.

The methods by which, the HDP can be practiced in different fruit crops are mentioned briefly below.

### **Mango**

Mangoes can be planted at a spacing of 5m x 5m and maintained till such time canopy overlapping is noted. The alternate rows can be removed if necessary at later stage when canopy overlapping interferes with the normal growth and performance of the plants or with cultural operations. Mangoes can be also maintained at HDP system by proper pruning and regulating the canopy. Dwarf statured varieties with narrow canopy are much suitable for HDP system. Experiments with mango varieties like Amrapali, Dashehari and Mallika in Indian Agricultural Research Institute, New Delhi have indicated that even a spacing of 2.5-3m either way can be maintained in the initial years accommodating nearly 1300 plants per ha.

### **Sapota**

Similar to mango, sapota is usually planted at 8-9m spacing conventionally. However, it is advisable to use a spacing of 5-6 m either way under HDP as it takes many years for the plants to assume the full canopy coverage. The recently released varieties like CO 3 sapota and PKM 4 sapota can be planted under HDP owing to their upright growth habit.

### **Banana**

Banana is grown normally at a spacing of 1.8 x 1.8 m (6' x 6') by planting one sucker per pit, in India. A new concept of increasing the plant density by planting more number of suckers per pit at a wider spacing has proven successful in increasing the productivity of banana. This system of high density planting in banana was devised at Horticultural College and Research Institute, Coimbatore and has proved efficient in increasing the productivity of banana. Interestingly, it has also showed that possibility of reducing the water and fertilizer to a tune of 30-40% without

affecting the yield.

Based on a series of research trials on HDP on banana taken up in the Department of Fruit crops, TNAU, Coimbatore it is recommended that HDP can be achieved by planting three suckers / hill spacing of 1.8 x 3.6 m which ( 4629 plants/ha). On per plant basis, instead of full dosage of fertilizer (i.e. 110: 35 : 330 g of NPK ) only 75 % of the fertilizer needs to be applied on per plant. By this method 25-40 % enhanced yield can be obtained from an unit area. Though a slight reduction in individual bunch weight was observed when compared to conventional planting, the bunch grade was found to be similar indicating no difference in the market appeal of the bunch/hands.

### **Pineapple**

It is possible to accomodate 43,000-50,000 plants per ha in pineapple by planting in double rows either in beds or in trenches with the plants into the second rows set in the middle of the plants in the first row. The spacing between two trenches will be 90 cm. Row to row spacing in the same bed per trench can be 45- 60 cm and plant spacing within the row is 30 cm.

HDP systems are not without disadvantages. Some disadvantages of high density planting are high initial capital investment, extended cropping cycle in herbaecious crops like banana or pineapple and occasionally quick spread of pest and diseases. But if managed properly, the HDP system will prove to be economically advantageous to the grower in the long run.

