Iron Deficiency Monograph

Book Number
CPDM.PDS. 001
Iron Deficiency Monograph

200 ***Iron Deficiency Photographs & Graphics***
89 ***Pages***

Dr Prakash Kumar
Founder of CPDM - A mission for humanity and nature

Published under-
CPDM fellow program.
Professional course-
Plant Doctor Services.

Cover Photo - Leaf of Okra (Abelmoschus esculentus L. (Moench)

Consultant Plant Doctor Mission- A Global Mission
Iron Deficiency Monograph

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Consultant Plant Doctor Mission

A Global Mission

Consultant Plant Doctor Mission (CPDM) is a science-based human welfare mission, aimed to introduce and promote '**Professional Advisory Services**' in Agriculture. The CPDM is designed to facilitate a high degree of professionalism in Agriculture Advisory Services, both in the public and private sectors.

The mission is intended to connect all prime Agriculture universities around the Globe to motivate Agriculture students and working professionals through **free** tutorial programs of CPDM. Well-designed technical lectures (Academic Releases) in the form of online videos and PDFs will be delivered to Agricultural students and professionals under this mission. Valuable literature, in the form of diagnostic photographs, and academic book chapters in PDFs, will be provided free of cost to students and professionals. This way the CPDM will make students technically more sound and professionally more confident to become practicing '*Consultant Plant Doctors*'.

To harvest the maximum benefits of the mission, the students and professionals are advised to register under the ***CPDM Fellow Program*** (An academic program under the mission). The ***CPDM Fellow* program** is absolutely **free** for all.

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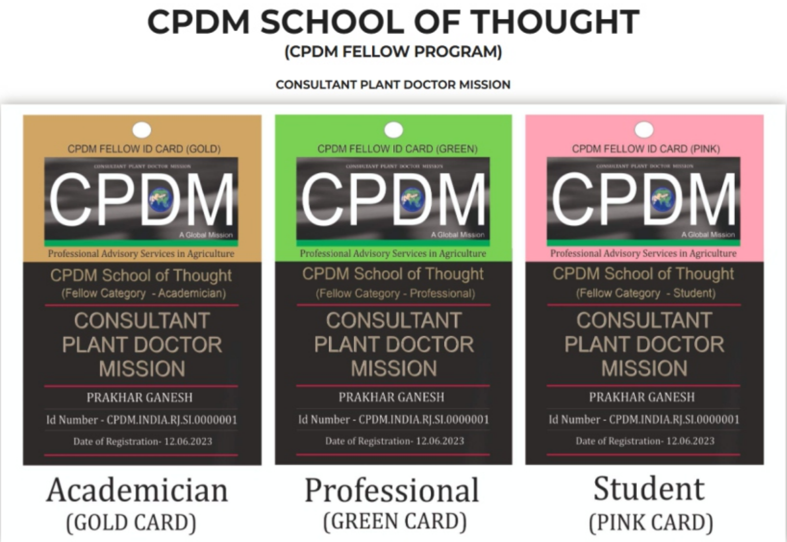
CPDM FELLOW PROGRAM

CPDM Fellow Categories

(Academicians/ Professionals/ Students)



How to register in CPDM FELLOW PROGRAM

Step 1 - Search on Google - '*Consultant Plant Doctor Mission*'.

Step 2 -Open the '*Consultant Plant Doctor Mission*' portal and go on page- **CPDM FELLOW PROGRAM**.

Step 3 - Thoroughly read the '**CPDM FELLOW PROGRAM**' page.

Step 4- If interested, register for '**CPDM FELLOW PROGRAM**' by filling the entries in *the digital registration form* (given on same page) and submit.

Step 5 - On submission, the portal will generate a **CPDM FELLOW ID CARD** with your name, unique ID number, and date of registration.

Step 6- Download the **CPDM FELLOW ID CARD** and keep it safely for future reference as **CPDM FELLOW**. This **ID card** will be important for your participation in CPDM programs and also to harvest other benefits of the Consultant Plant Doctor Mission.

An academic program under the mission

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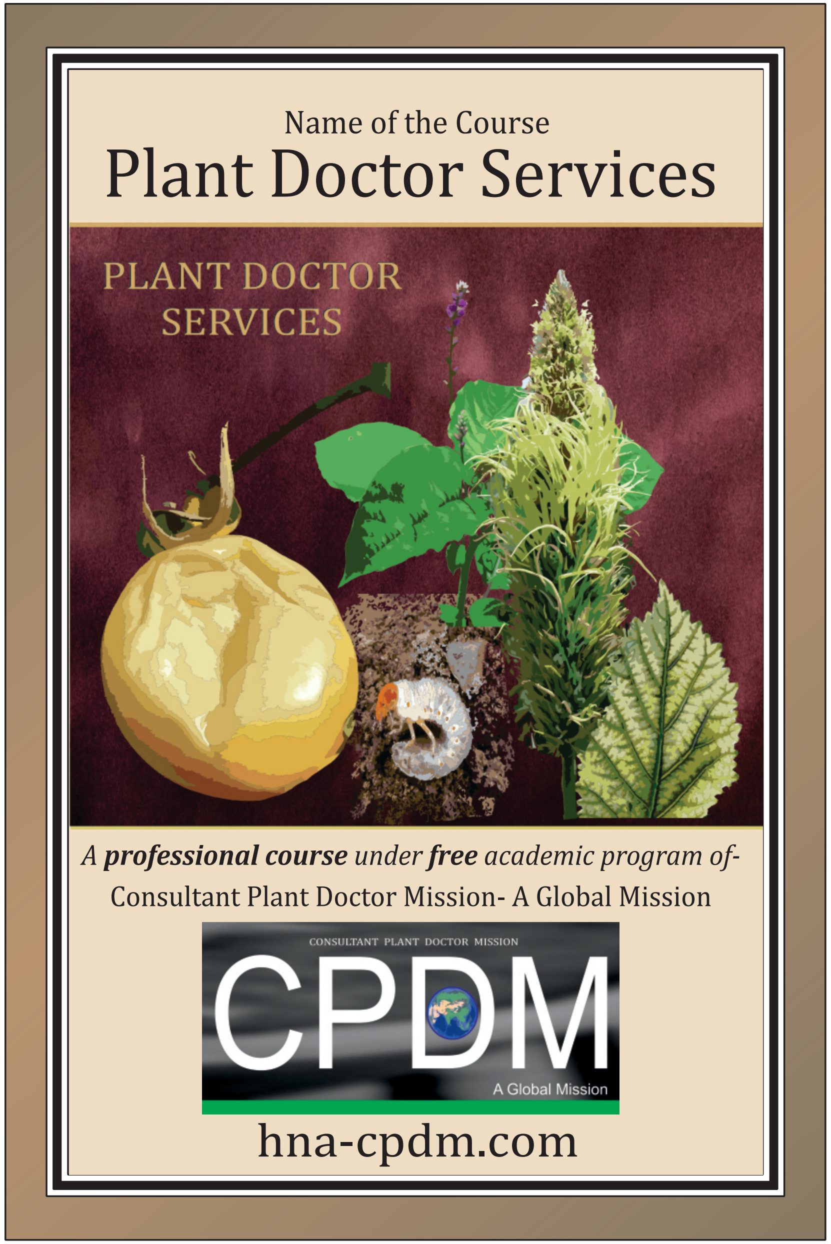

Plant Doctor Services

*(A **professional course** under **free** academic program of CPDM)*

Course Introduction - This professional course aims to improve the diagnostic and crop crisis management skills of students/ professionals, so they may become better *Plant doctors.*

Importance- After completing the course, the trainee Agriculture graduates may become *Practicing Plant doctors* and may serve farmers with their own establishments like *Plant Clinics* or *Plant Doctor Institutes*. After the course, the students may get better opportunities for jobs in Academics, Input supply services and Extension Services both in Government and private sectors.

Basic Qualification- Those agricultural students who are studying in their graduation in any agriculture university/college any where around the globe or those professionals who have completed graduation in Agriculture may participate in this course.

How to participate in professional courses of CPDM- To harvest the maximum benefits of the mission, the students and professionals are advised to register under the ***CPDM Fellow Program*** (An academic program under the mission)**.** The program is absolutely free for all.

Professional Educational Programs of Consultant Plant Doctor Mission

The Consultant Plant Doctor Mission requests all Vice-chancellors, Deans, principals, professors and heads of the agriculture institutions that CPDM is a professional educational program for students and running 7 professional courses. This program is global and ***free*** for all students. So kindly inform your students about the Consultant Plant Doctor Mission. The students may directly join the courses through ***CPDM Fellow Program.***

If any agriculture university or college anywhere on the globe is interested in running a certificate professional course for students in their institutions, the CPDM will ***voluntarily*** coordinate with your institution through MOU. Please write to us for coordination on mail gb@hna-cpdm.com.

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Plant Doctor Services

(A professional Course of Consultant Plant doctor mission)

Practising Consultant Plant Doctor (Introduction) - Need , responsibilities and importance.
Diagnosis of Crop Problems - Specific Identification mark or SIM (A reliable tool for Clinical Diagnosis).
Diagnosis of Nutrient Deficiencies - N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu, B.
Identification and Importance - Natural Enemies in Biological Control.
A. Field Crops : Clinical Diagnosis Insects, Diseases, Weeds & N. Deficiencies-
1. Cereals - Pearl millet (Pennisetum typhoides Burm.f), Sorghum (Sorghum vulgare Pers.), Wheat (Triticum aestivum Linn.), Barley (Hordeum vulgare Linn.).
2. Pulses - Green gram (Vigna radiata Linn.), Moth bean (Vigna aconitifolia Jacq.), Chickpea (Cicer arietinum Linn.),
3. Oil Seeds - Mustard (Brassica campestris Linn.), Groundnut (Arachis hypogaea L.), Sesame (Sesamum indicum Linn.), Groundnut (Arachis hypogaea L.), Castor (Ricinus communis Linn.).
4. Cash Crops- Cotton (Gossypium hirsutum Linn.), Cluster bean (Cyamopsis tetragonoloba (L.) Taub).
B. Horticulture Crops : Clinical Diagnosis Insects, Diseases, Weeds & N. Deficiencies-
1. Vegetables - Tomato (Lycopersicon esculentum), Brinjal (Solanum melongena Linn.), Cauliflower (Brassica oleracea var. botrytis), Okra (Abelmoschus esculentus L. (Moench), Botle Guard (Lagenaria siceraria Molina. Standl), Carrot (Daucus carota L.).
2. Species & Medicinal Crops- Capsicum(Capsicum annuum L.), Cumin (Cuminum cyminum Linn.), Fennugreek (Trigonella foenum-graecum L.), Onion/ Garlic (Allium sp.), Isabgol (Plantago ovata).
3. Fruit Crops - Citrus (Citrus aurantiifolia (Christ.) Swingle), Pomegranate (Punica granatum), Ber (Ziziphus mauriticzna), Amla (Emblica officinalis Gaertn.).
Biological Inputs in Crop management- Natural Enemies and Biological pesticides.
Chemical Inputs in crop management- Insecticides, Nematicides, Fungicides, Antibiotic, Fertilizers & Crop supplements.
Mechanical & cultural measures in crop management- Mechanical devices of pest control and cultural measures to manage pests.
Practising Consultant Plant Doctor (Basic Skills)- General behaviour, conversation language and mode, digging out facts (like - stage of problem, already applied treatments or efforts, present damage level and economic viability of treatment etc.). Availability of prescribe inputs in market. Searching root cause of the problem through soil test, water test, weather assessment and field history etc. Utilising soil/ water/ plant tests for diagnosis.
How to write Prescription & maintain client record- The correct way to diagnose and prescribe on doctors prescription . Maintaining client records in your computer for future reference.

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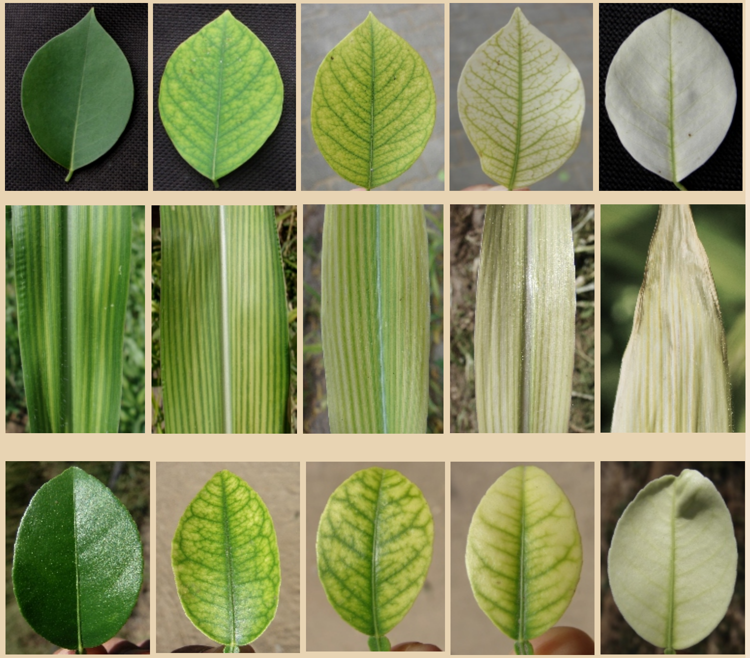
Iron Deficiency Monograph

Dr Praksh Kumar

Founder of CPDM - A mission for humanity and nature

Dedicated to-

All human, animals & plants -
suffering from Iron Deficiency



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Index

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Part-1

Iron:

An essential nutrient for life

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Iron:

Nutritional Importance for Plants, Human and Animals-

IN PLANTS

Iron(Fe) is essential for the synthesis of green pigment chlorophyll in plants.

Sun energy is absorbed by Chlorophyll during the process of "Photosynthesis" in plants to produce carbohydrates(organic food).These carbohydrates are the basic raw materials,which directly or indirectly give rise to all the organic compounds.

The **Iron** is essential for the synthesis of pigment **chlorophyll** in Plants.

The **Iron** is a constituent part of **hemoglobin**, the portion of Blood.

IN HUMAN

In human and other animals iron is a constituent part of hemoglobin,the inportant portion of blood.

Sufficient Hemoglobin levels in blood are must for good health, disease resistance and long healthy life . Regular consumption of iron rich food is one of the factor that maintains required levels of hemoglobin in blood .

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Iron:

The deficient supply of **Iron** may cause-

Leaves devoid of **chlorophyll** in Plants

Fe deficiency **Anaemia** in Humans & Animals

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Damage to environment



Iron deficiency severely damages foliage and badly affects reproduction. The wild grass and other species produce no ears or very few grain ears. Fruits and Grains of these wild plant species are the feed of birds and other wild animals. So, the entire food chain of wild animals is affected, if availability of iron is deficient in soils.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Part-2

Iron Deficiency:

Present status in soils

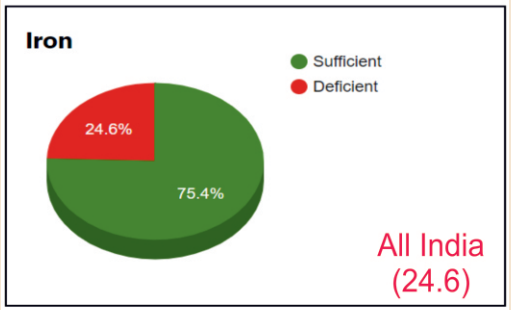
Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

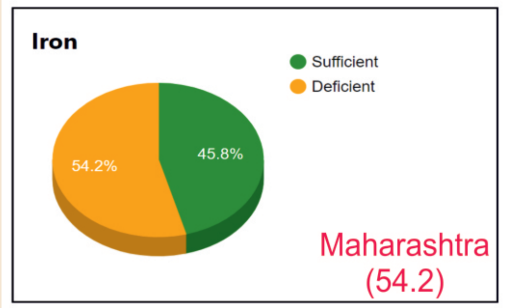
Iron:

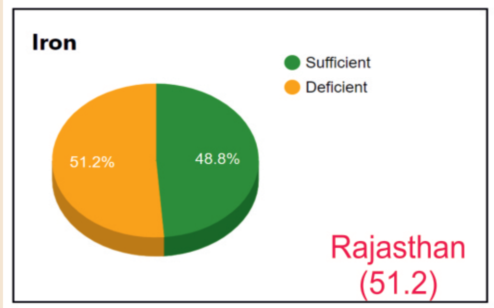
Deficiencies in Indian Soils

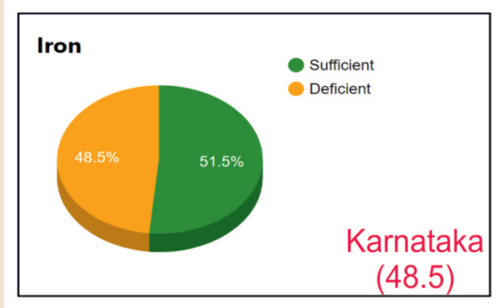
(**Source** - Soil health card website, Government of India- https://soilhealth.dac.gov.in/home - *27.02.2024*)

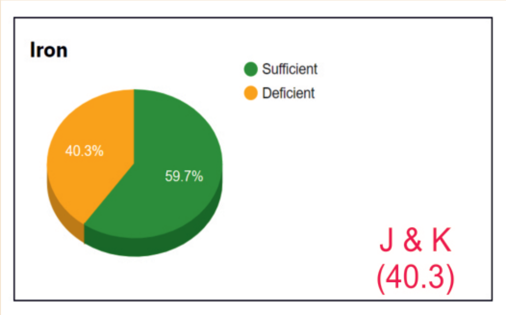
Top 11 **Iron** Deficient States of India

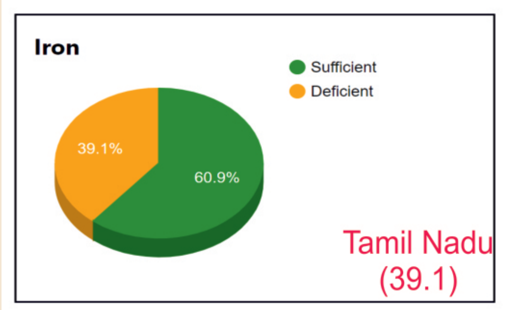


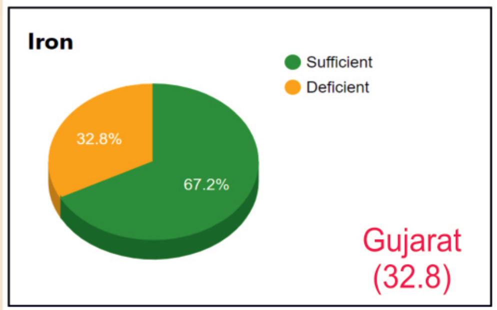


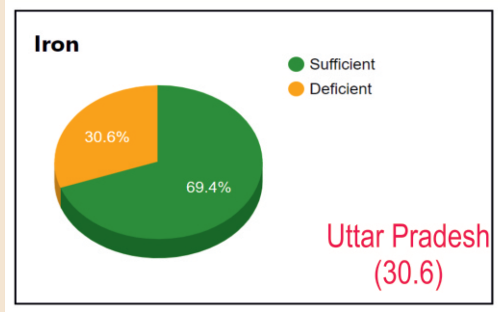


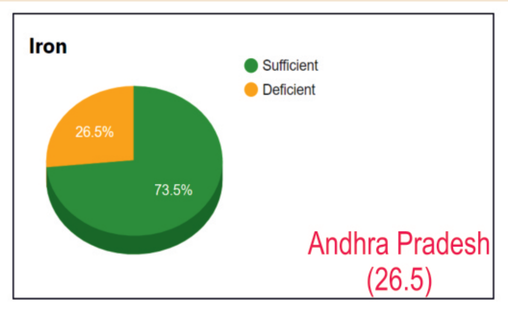


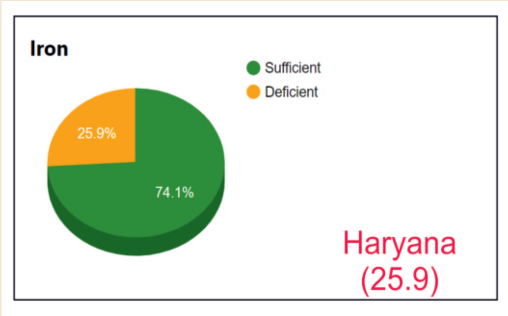


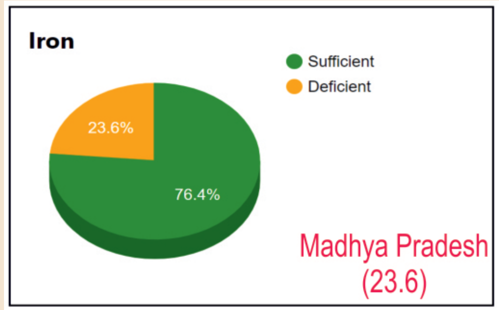


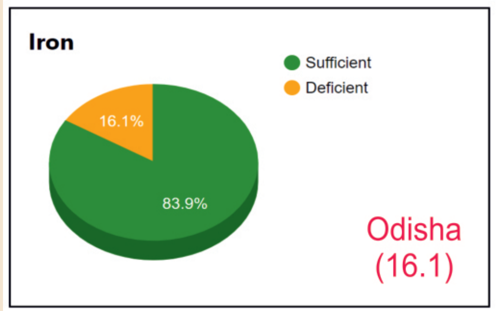












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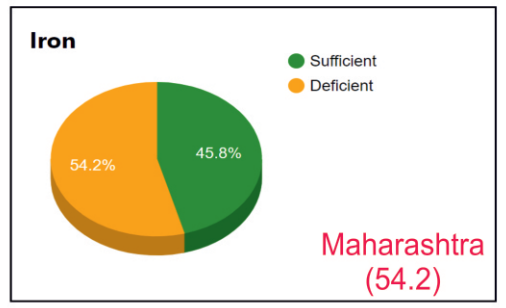
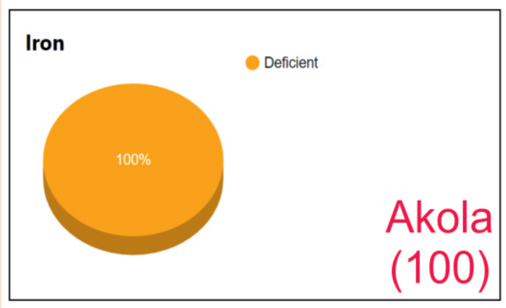
Iron:

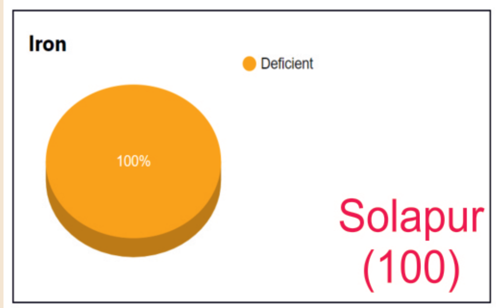
Deficiencies in Maharashtra Soils

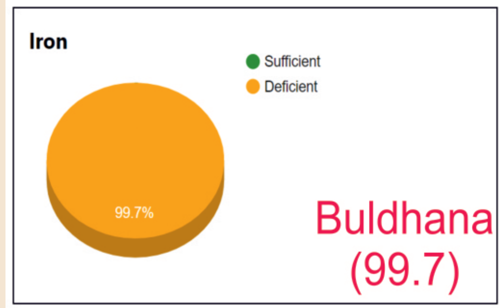
(Source - Soil health card website, Government of India, Nutrient Dashboard- https://soilhealth.dac.gov.in/home - *27.02.2024*)

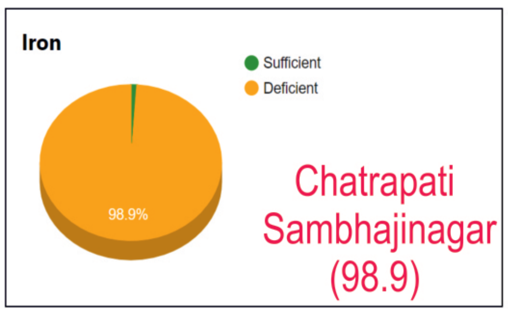
Top 11 **Iron** Deficient districts of Maharashtra

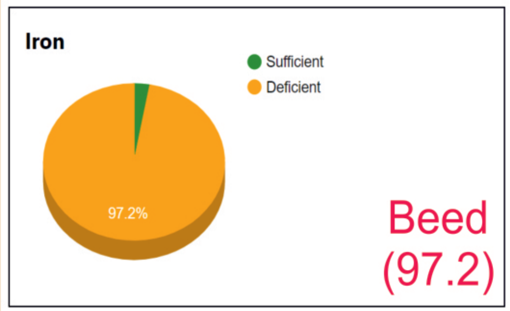


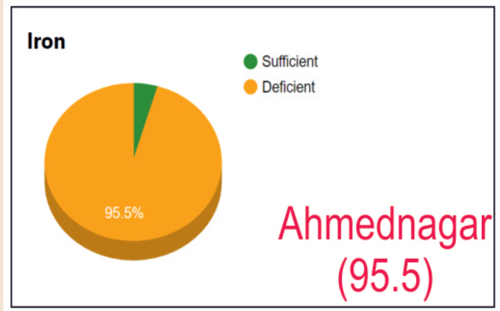


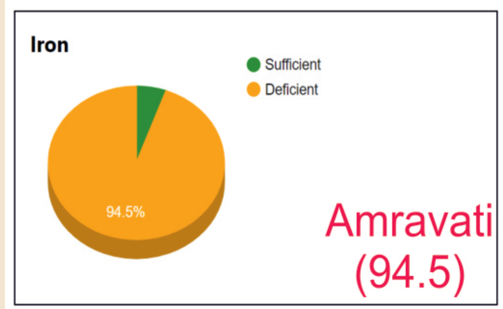


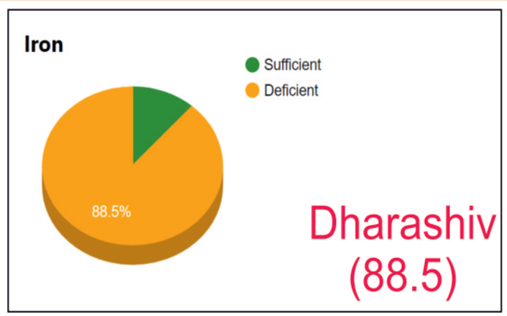


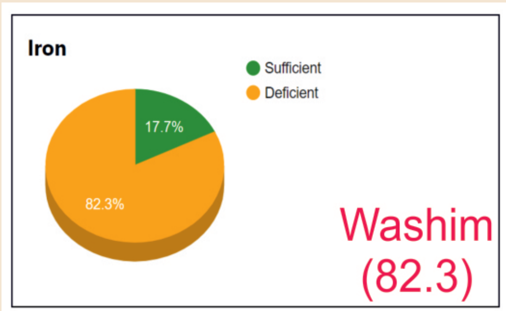


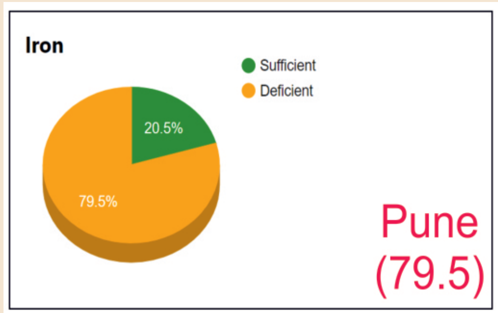


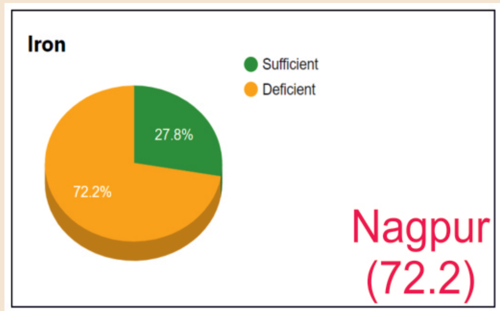












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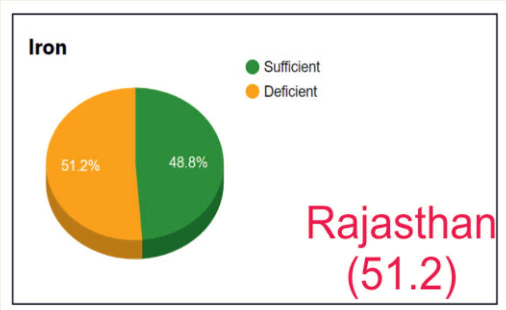
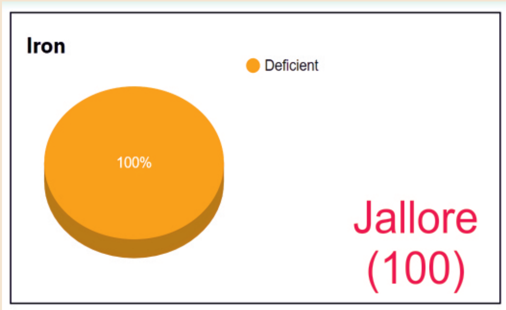
Iron:

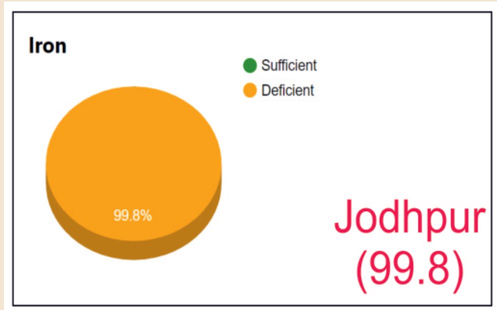
Deficiencies in Rajasthan Soils

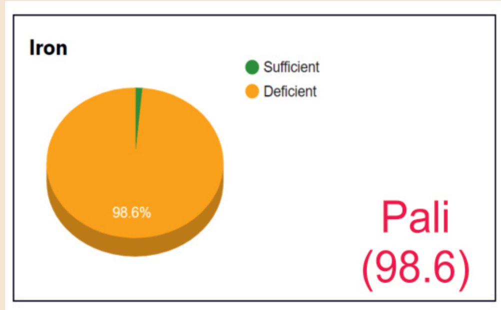
(**Source -** Soil health card website, Government of India, Nutrient Dashboard- https://soilhealth.dac.gov.in/home - *27.02.2024*)

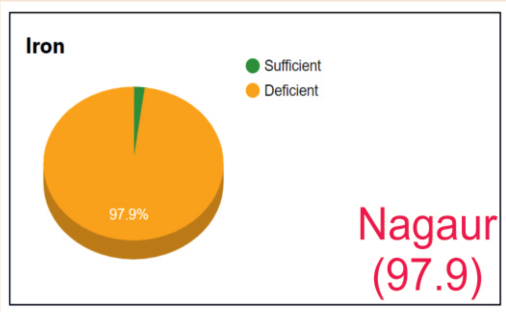
Top 11 **Iron** Deficient districts of Rajasthan

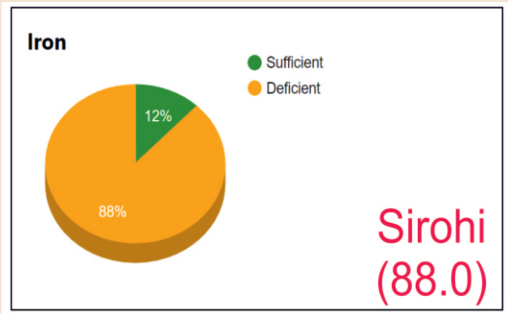


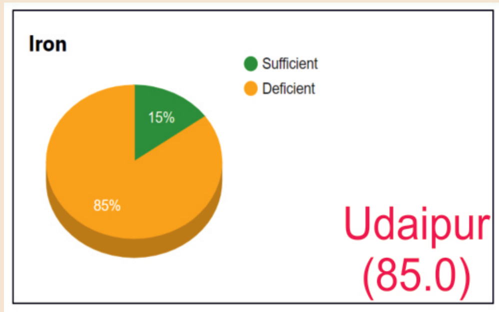


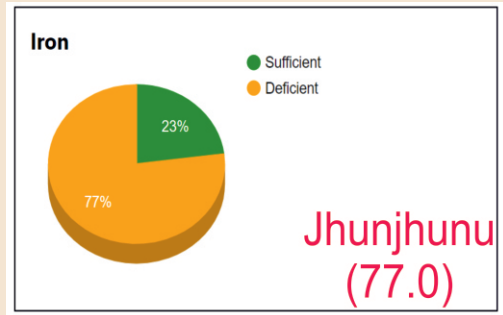


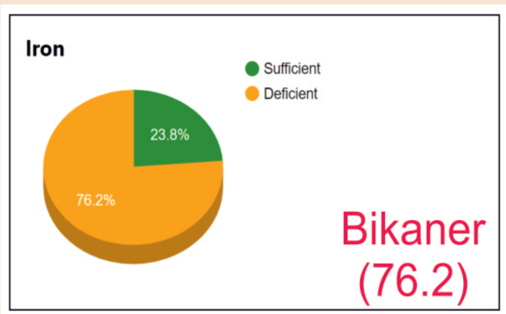


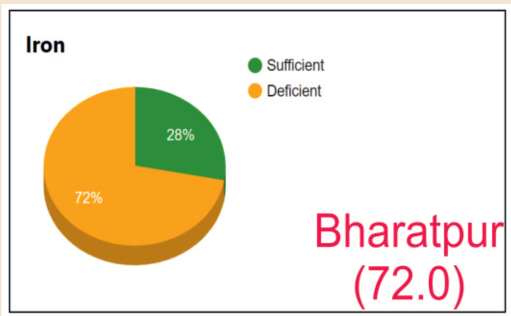


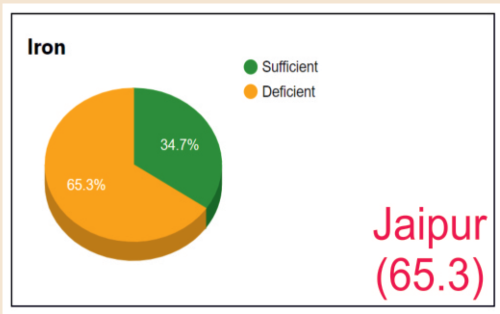


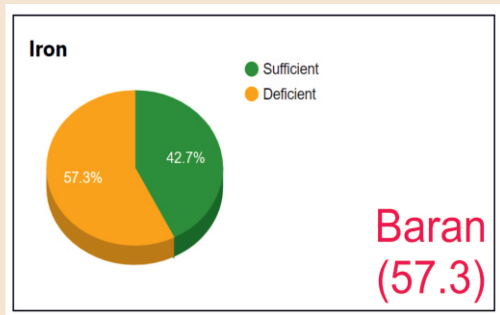












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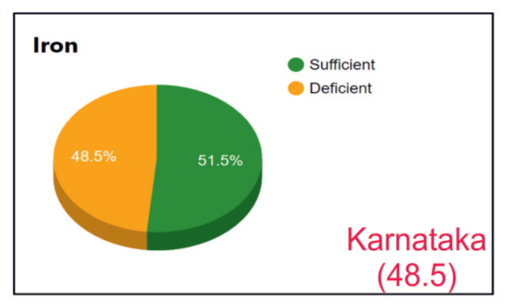
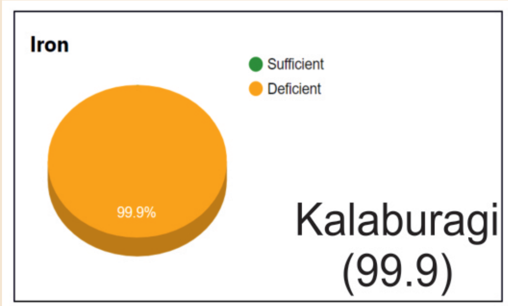
Iron:

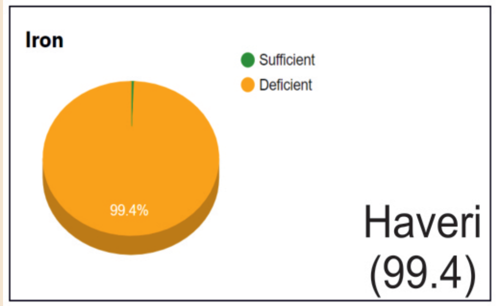
Deficiencies in Karnataka Soils

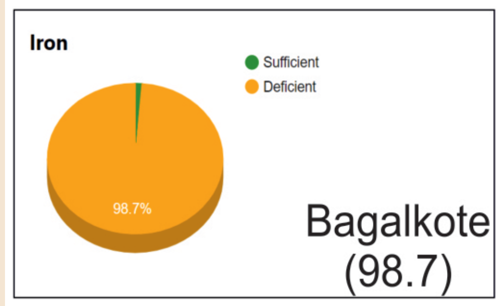
(Source - Soil health card website, Government of India, Nutrient Dashboard- https://soilhealth.dac.gov.in/home - *27.02.2024*)

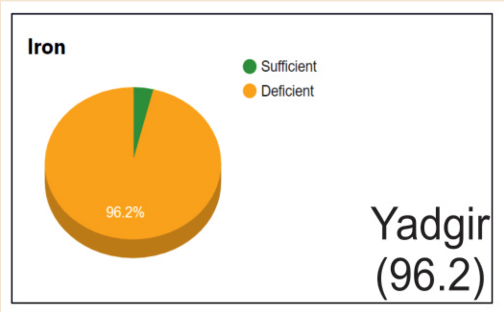
Top 11 **Iron** Deficient districts of Karnataka

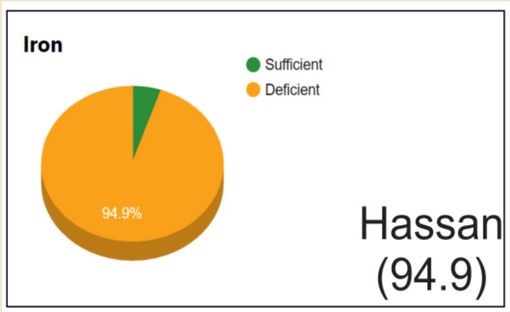


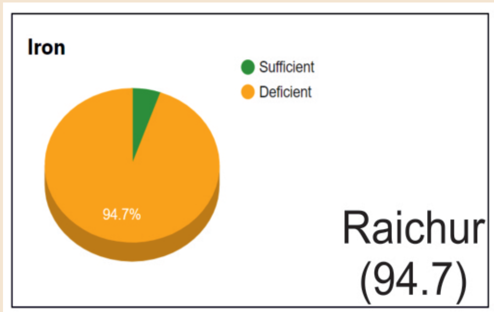


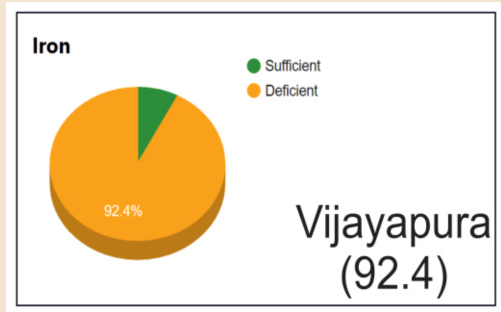


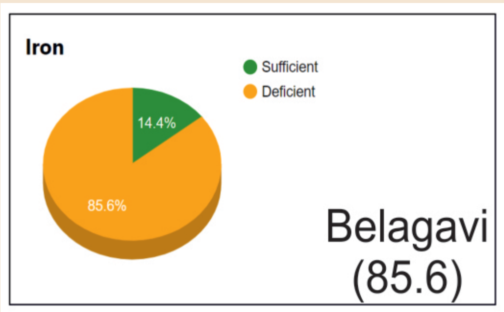


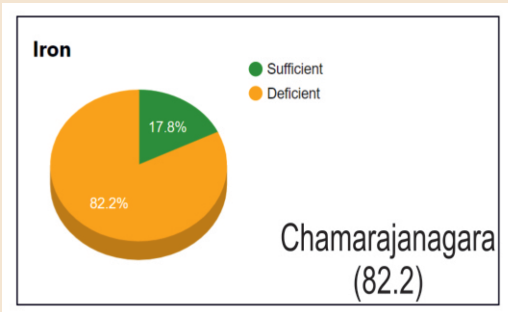


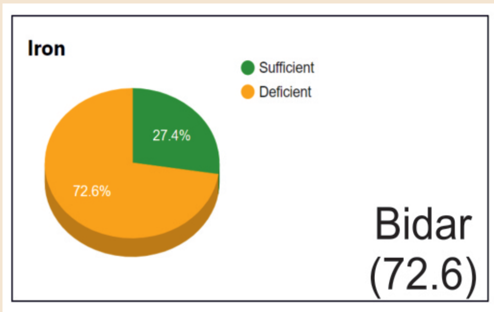


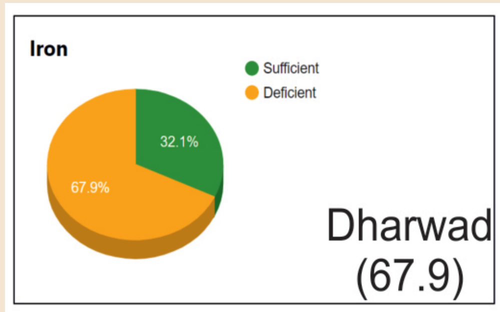












Part-3

Iron Deficiency:

Clinical Diagnosis

Iron Deficiency: Specific Identification Mark (SIM)

Interveinal chlorosis of top leaves

Interveinal = Tissues between the veins **Chlorosis** = An abnormally yellow color of tissues **Top Leaves** = younger leaves on top of the branch

Pale yellow chlorosis develops in interveinal tissues (tissues between the veins), leaving the veins green and prominent. Interveinal chlorosis of top leaves is the specific identification Mark (SIM) of iron deficiency.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Basis of Clinical Diagnosis

1. Pattern of Appearance- Iron is immobile in plants. So, deficiency symptoms always appear first and more severe on younger leaves. The older leaves remain normal and apparently healthy.

2. Stages of Development - Based on the severity of the deficiency, the iron deficiency symptoms go through the well established developmental stages.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Example - Maize (Zea mays Linn.)

Pattern of appearance

Iron is immobile in plants. So, deficiency symptoms always appear first and more severe on younger leaves. The older leaves remain normal and apparently healthy.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Stages of development

Based on the severity of the deficiency, the iron deficiency symptoms go through the well established developmental stages. **Example - Maize (Zea mays L.)**

Stage I - In mild deficiencies the top most leaves of the plants develop temporary fading of interveinal tissues with prominent green veins. Plants recover and regain normal condition after some time.

Stage II - When deficiency persists and become more severe Interveinal tissues of affected leaf turn bright pale yellow with prominent green veins - described as- "Interveinal chlorosis".

Stage III - In later stages of deficiency the prominent green veins also fade and become light green to pale yellow.

Stage IV - In acute deficiency conditions entire leaf bleach to papery white. The leaf is completely devoid of chlorophyll.

Stage V- In acute deficiency conditions & in complete absence of chlorophyll, the leaf becomes unable to form food resulting dying of tissues that causes necrosis and burning of leaves.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Pattern of appearance

Example-Tree Plant - ***Dalbergia sissoo Roxb.***

Deficiency symptoms always appear first and more severe on younger leaves. The older leaves remain normal and apparently healthy.

A branch of tree plant ***Dalbergia sissoo Roxb.*** showing iron deficiency pattern – Lower leaves normal, middle leaves with mild interveinal chlorosis and upper leaves with severe interveinal chlorosis.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Example-Tree Plant - ***Dalbergia sissoo Roxb.***

Stages of development

The deficient supply of Iron directly hits the formation of Chlorophyll in growing leaves. So, intensity of chlorophyll in growing top leaves indicates the severity of Iron deficiency in a branch of the plant. In clinical diagnosis of Iron deficiency, all stages of development are important to understand.

Normal Leaf - The leaf fully green and rich of chlorophyll. Based on the severity of the deficiency, the iron deficiency symptoms go through the well established developmental stages.

Stage I - In mild deficiencies the top leaves of the plants develop temporary fading of interveinal tissues with prominent green veins. Plants recover and regain normal condition after some time.

Stage II - When deficiency persists and become more severe Interveinal tissues of affected leaf turn bright pale yellow with prominent green veins - described as- Interveinal chlorosis.

Stage III - In later stages of deficiency the prominent green veins also fade and become light green to pale yellow.

Stage IV - In acute deficiency conditions entire leaf bleach to papery white. The leaf is completely devoid of chlorophyll.

Stage V - In acute deficiency conditions & in complete absence of chlorophyll, the leaf becomes unable to form food resulting dying of tissues that causes necrosis and burning of leaves.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Pattern of appearance

Example- Lemon - ***Citrus limon***

Deficiency symptoms always appear first and more severe on younger leaves. The older leaves remain normal and apparently healthy.

A branch of plant ***Citrus limon*** showing iron deficiency pattern – Lower leaves normal, and upper leaves with severe interveinal chlorosis.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Example-Lemon Plant - ***Citrus limon***

Stages of development

The deficient supply of Iron directly hits the formation of Chlorophyll in growing leaves. So, intensity of chlorophyll in growing top leaves indicates the severity of Iron deficiency in a branch of the plant. In clinical diagnosis of Iron deficiency, all stages of development are important to understand.

Normal Leaf - The leaf fully green and rich of chlorophyll. Based on the severity of the deficiency, the iron deficiency symptoms go through the well established developmental stages.

Stage I - In mild deficiencies the top leaves of the plants develop temporary fading of interveinal tissues with prominent green veins. Plants may recover and regain normal condition.

Stage II - When deficiency persists and become more severe Interveinal tissues of affected leaf turn bright pale yellow with prominent green veins - described as- Interveinal chlorosis.

Stage III - In later stages of deficiency the prominent green veins also fade and become light green to pale yellow.

Stage IV - In acute deficiency conditions entire leaf bleach to papery white. The leaf is completely devoid of chlorophyll.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Example - Bambusa vulgaris)

Pattern & Stages of development : An unique Example

Bamboo

(*Bambusa vulgaris*)

The pattern of appearance and all developmental stages of Iron deficiency are uniquely available on one branch of Bamboo.

Stage IV - In acute deficiency conditions entire leaf bleach to papery white. The leaf is completely devoid of chlorophyll.

Stage III - In later stages of deficiency the prominent green veins also fade and become light green to pale yellow.

Stage II - When deficiency persists and become more severe Interveinal tissues of affected leaf turn bright pale yellow with prominent green veins - described as- "Interveinal chlorosis".

Stage I - In mild deficiencies the top most leaves of the plants develop temporary fading of interveinal tissues with prominent green veins. Plants recover and regain normal

Stage 0 (Normal) - Lower and older leaves are normal and with full of chlorophyll.

*Published under **CPDM fellow program**, course **Plant Doctor Services**. This Iron deficiency monograph is **free** for awareness and educational purposes. Pages of this monograph (without any alternation) may be printed and displayed in **institutions, offices, exhibitions** etc. and may be used in workshops in digital displays. But all type of commercial uses without permission are restricted. (Visit **hna-cpdm.com** for further details)*
Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Part-4

Iron Deficiency:

Confusions in clinical diagnosis

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Example - Okra (Abelmoschus esculentus L. (Moench)

Iron Deficiency v/s Mosaic Diseases

The most common confusion is between **mosaic** diseases and **Iron** deficiency. Both look similar from a distance. But in close observation, the difference is quite clear.

Plate 1 -Veins are **green** and interveinal portion are **yellow.** The symptom is described as **interveinal chlorosis.**

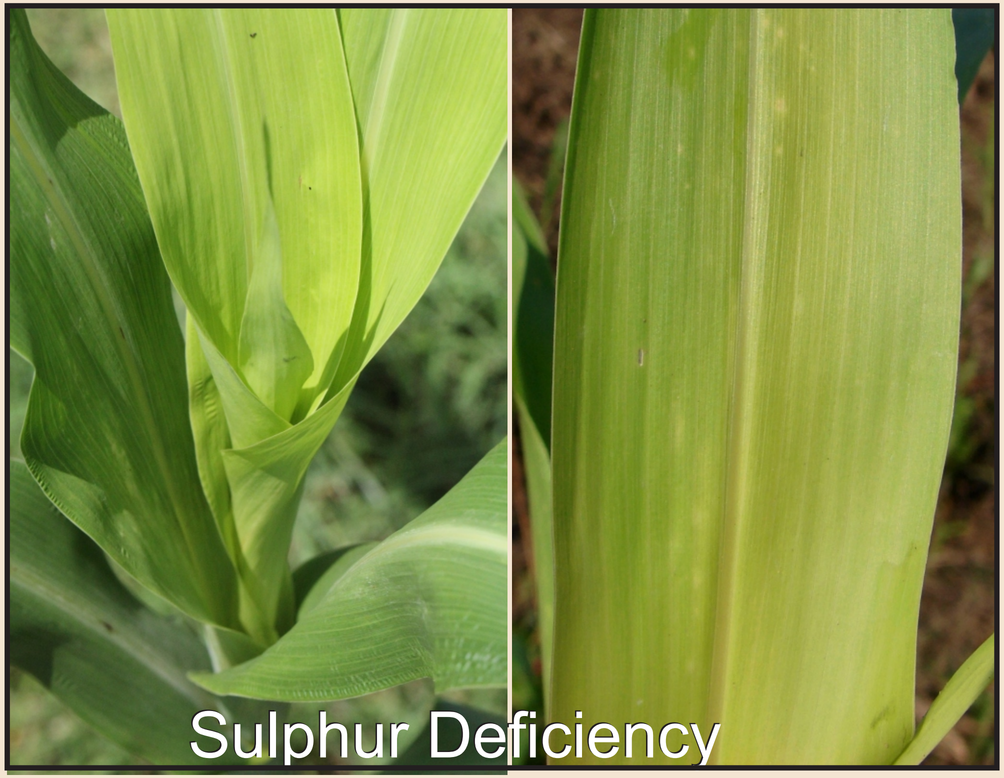
Plate 2 -Veins are **yellow** and interveinal portion are **green.** The symptom is described as **Yellow vein mosaic.**

Iron Deficiency:

Example - Sorghum (Sorghum bicolor Linn)

Iron Deficiency v/s Sulphur deficiency

The Sulphur and iron deficiencies look similar as in both deficiencies the chlorosis (Yellowing) appears on top leaves. In the case of sulphur, the veins and interveinal portions both become yellow and so, uniform chlorosis appears on top leaves. In the case of iron, veins remain green, and interveinal portions become yellow.



Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Example - Sorghum (Sorghum bicolor Linn)

Iron Deficiency v/s Manganese deficiency

The **Iron** and **Manganese** deficiencies are the most difficult to differentiate especially in the early stages of development. Both appear on top leaves, both develop interveinal chlorosis and both become deficient in similar soil conditions. So, in the field of clinical diagnosis of nutrient deficiencies, this is a challenge for plant doctors.

The only observation may be that in dicotyledon plants in case of manganese deficiency the primary, secondary, and tertiary veins remain green and create a net-like interveinal chlorosis, and in iron only prime veins remain prominently green. However, this observation does not apply to grain crops which are monocots.

But in acute deficiencies or in an advanced stage of deficiencies the differentiation is quite clear. In the case of manganese deficiency the interveinal tissues become necrotic but in the case of Iron deficiency the entire leaf first bleach to white and then burns.

Plate 1 -Manganese Deficiency in Sorghum early and advanced stages.

Iron
Deficiency
v/s
Manganese
Deficiency

Plate 2 -Iron Deficiency in Sorghum - early and advanced stages.

Photographs by- Dr Prakash Kumar and Dr Manoj Kumar Sharma

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Iron Deficiency: Confusion on Missing of ideal stage (Interveinal Chlorosis)

When we describe the specific identification mark (SIM) of iron deficiency that is 'interveinal chlorosis' of top leaves in which veins remain green and interveinal portions become yellow. In an advanced stage of iron deficiency the entire leaf bleaches to white. Generally, all developmental stages of iron deficiency are available in the field at a time. But many times in acute deficiency conditions, the directly last stage bleached white leaf completely devoid of chlorophyll comes out after normal leaves. This may create confusion in clinical diagnosis for newly trained plant doctors.

Bottle Gourd (Lagenaria siceraria (Molina))

Lemon (Citrus limon)

Tomato (Lycopersicon esculentum)

Groundnut (Arachis hypogaea Linn)

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Part-5

Iron Deficiency:

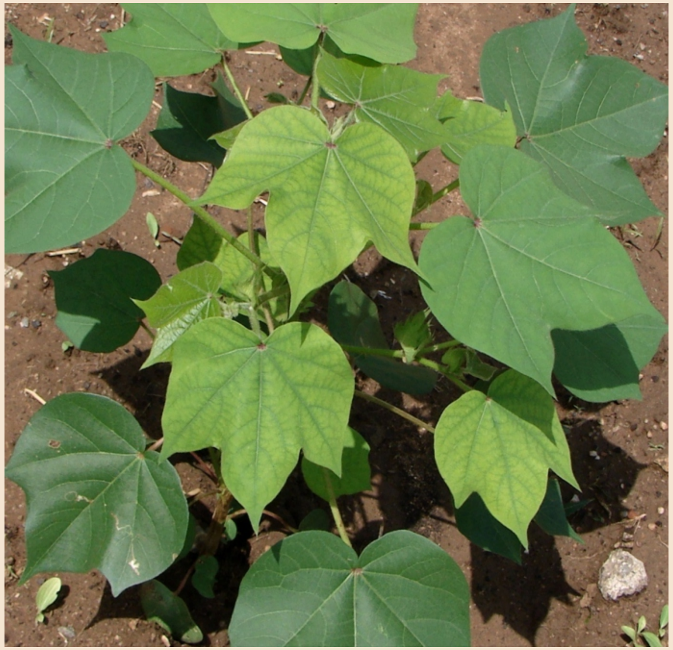
Hidden hunger and Indicator Plants

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency:

Hidden hunger and Indicator Plants

Hidden hunger is a situation in which a plant does not show deficiency symptoms even in deficiency conditions. Every plant has the capacity to hide hunger to an extent. Those plants that are unable to hide much hunger and show symptoms even in mild deficiencies are listed as **indicator plants**. Hiding hunger is not a good situation as crop decreases yield without indicating the cause of suffering. So for those crops that have strong hidden hunger capacity (for example wheat for iron deficiency), we utilize the **indicator weeds** available in field to diagnose the deficiency conditions.



COTTON (Gossypium hirsutum Linn.) - A very weak indicator crop plant for iron deficiency. Cotton has very strong hidden hunger for Iron.

WHEAT (Triticum aestivum Linn.) - A weak indicator crop plant for iron deficiency. Wheat has strong hidden hunger for Iron.

MUSTARD (Brassica campestris L.) - A weak indicator crop plant for iron deficiency. Mustard has strong hidden hunger for Iron.

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Iron Deficiency:

Indicator Crops

MAIZE (Zea mays Linn.) - A good indicator plant for Iron deficiency.

GROUNDNUT (Arachis hypogaea Linn.) - A good indicator plant for Iron deficiency.

SUGARCANE (Saccharum officinarum Linn.) - A good indicator plant for Iron deficiency.

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Iron Deficiency:

Indicator Weeds

A weed plant ***Phyllanthus niruri*** showing iron deficiency pattern – Lower leaves normal and upper leaves with interveinal chlorosis.

A weed plant ***Commelina benghalensis Linn.*** showing iron deficiency pattern – Lower leaves normal and upper leaves with interveinal chlorosis.

A weed plant **Achyranthes aspera L.** showing iron deficiency pattern – Lower leaves normal and upper leaves with interveinal chlorosis.

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Part-5

Iron:

Deficiency symptoms on various crops
(Field Crops, Vegetables, Spices & Fruits)

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Zea mays Linn.

(Maize)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Oryza sativa Linn.

(Rice)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Sorghum vulgare Pers.

(Sorghum)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Pennisetum typhoides

(Pearl Millet)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Triticum aestivum Linn.

(WHEAT)


Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)


Plate 2- As the symptom advances, prominent veins also fade.


Plate 3- In acute deficiency conditions entire leaf bleach.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Hordeum vulgare(L)emend.Bowden

(Barley)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach..

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Cajanus cajan (L.) Millsp.

(Pigeon Pea)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Vigna radiata Linn.

(Green Gram)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Phaseolus mungo var. Radiatus Linn.

(Black Gram)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Vigna sinensis Linn.

(Cowpea)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Cyamopsis tetragonoloba (L.) Taub.

(Cluster Bean)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- A closeup of interveinal chlorosis.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Cicer arietinum Linn.

(Chickpea)

Plate 1 - Iron deficiency chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- A close of Iron deficiency chlorosis of top leaves.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Phaseolus vulgaris Linn

(Kidney Bean)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions the leaves bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Iron chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Lens culinaris Medik

(Lentil)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Iron chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Pisum sativum var. arvense Linn.

(Pea)

Plate 2- A close up of top leaves.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Ricinus communis Linn.

(Castor)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- A close up of leaf showing Interveinal chlorosis.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Sesamum indicum Linn.

(Sesame)


Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)


Plate 2- A close up of top leaves showing Interveinal chlorosis.


Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Helianthus annuus Linn

(Sunflower)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Carthamus tinctorius Linn.

(Safflower)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to yellowish white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Arachis hypogaea Linn

(Groundnut)


Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)


Plate 2- As the symptom advances, prominent veins also fade.


Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Glycine max Linn.

(Soyabean)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Brassica campestris Linn.

(Mustard)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Gossypium hirsutum Linn.

(Cotton)

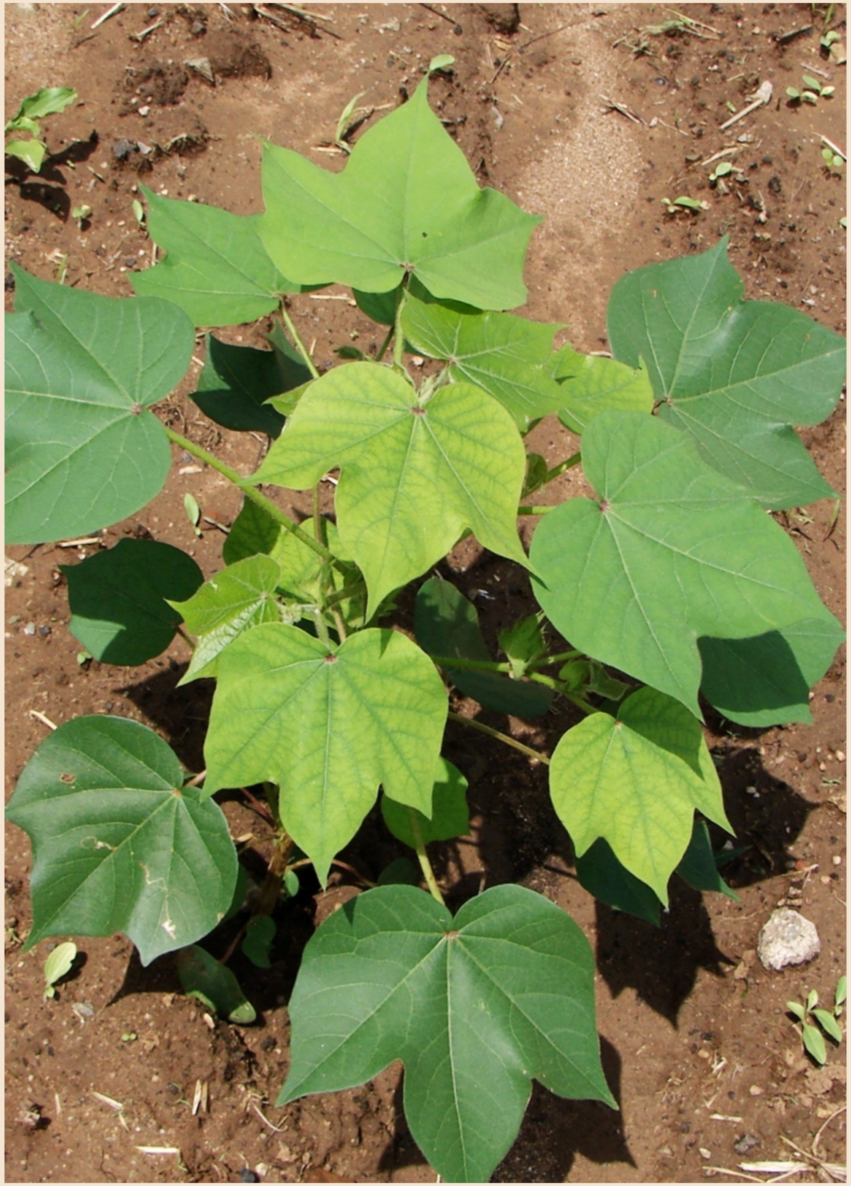

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

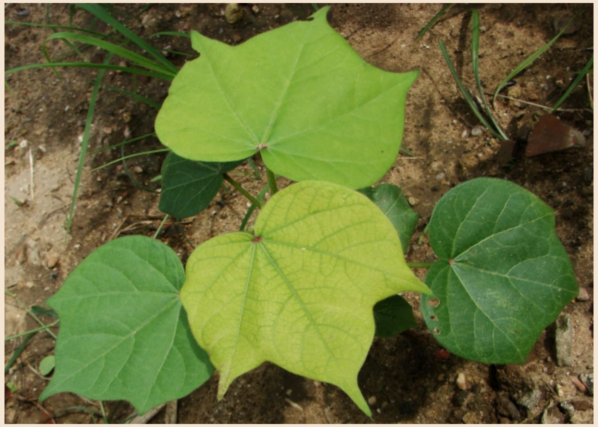

Plate 2- As close up of top leaves.

Plate 3- A closeup of leaf showing Interveinal chlorosis.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Saccharum officinarum Linn.

(Sugarcane)

Plate 2- As the symptom advances, prominent veins also fade.

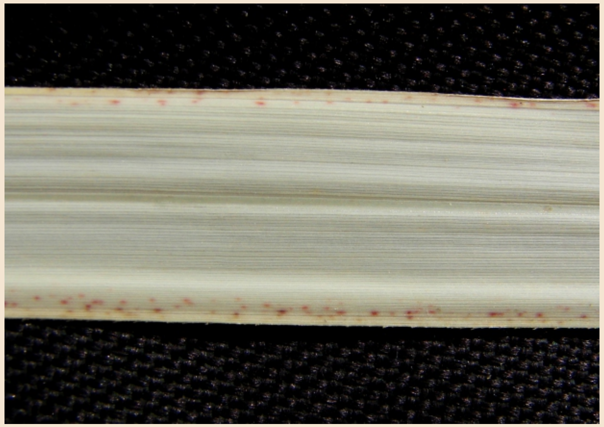

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Iron chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Solanum tuberosum Linn.

(Potato)

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Plate 2- A closeup of affected leaves.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Photographs by- Dr Prakash Kumar and Dr Manoj Kumar Sharma

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Iron chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Ipomoea batatas Linn.

(Sweet Potato)

CPDM

Plate 2- A closeup of leaf showing Interveinal chlorosis.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Medicago sativa Linn.

(Lucerne)

Plate 2- A closeup of leaf showing Interveinal chlorosis.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Brassica oleracea var. botrytis

(Cauliflower)

Plate 2- A closeup of leaf showing Interveinal chlorosis .

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Solanum melongena Linn.

(Brinjal)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- A closeup of top leaves.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Lagenaria siceraria (Molina) Standl

(Bottle Gourd)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- A closeup of leaf showing Interveinal chlorosis.

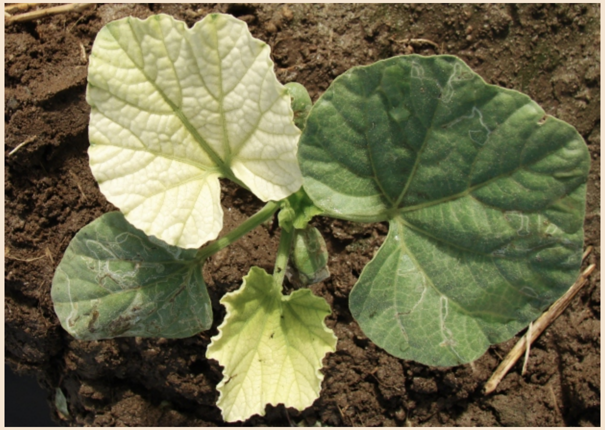

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Abelmoschus esculentus L. (Moench)

(Okra)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- A closeup of leaf showing Interveinal chlorosis .

Plate 3- In acute deficiency conditions the leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Lycopersicon esculentum

(Tomato)

Plate 1 - Iron chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- A close up of top leaves.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Capsicum annum Linn.

(Chilli)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Plate 1 - Iron chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Iron Deficiency

Coriandrum sativum

(Coriander)

Plate 2- A closeup of top leaves.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Citrus limon

(Lemon)

Plate 1 - Interveinal chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)

Plate 2- As the symptom advances, prominent veins also fade.

Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron Deficiency

Psidium guajava Linn.

(Guava)


Plate 1 - Iron chlorosis of top leaves. Lower leaves remain normal (Pattern of Appearance)


Plate 2- A closeup of top leaves.


Plate 3- In acute deficiency conditions entire leaf bleach to papery white.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Part-7

Iron Deficiency:

Broad Management Strategies

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron:

Presence and Availability in Soils

Iron is invariably present in all soils in **enormous** amount. But most part of this **iron** is in **insoluble** form and hence not available to plants. The content of soluble Fe in soil is extremely low in comparison with the total Fe Content present in the soil. The iron in the free space may be present in **ionic** forms or as **chelate**, these are the only available forms of iron to the plants.

The plant available forms of the iron are-

1. Inorganic (Ionic) forms-

Fe^{3+} (Ferric)

Fe^{2+} (Ferrous)

$Fe(OH)_2^{+}$ (Ferrous hydroxide)

2. Organic forms-

Iron Chelates.

Most common, available and non available transformation of Iron in soil solution-

$$Fe^{3+} + 3OH \rightleftharpoons Fe(OH)_3$$

Fe^{3+} (available form); $Fe(OH)_3$ (Solid and non available form)

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron:

Soil pH and Iron availability

Availability of Iron to the plants is highly dependable on soil pH. In high pH range (7-9 pH) - $Fe(OH)_2^+$, $Fe(OH)_3$, $Fe(OH)_4$ are formed .

Iron availability is sufficient below **pH- 6.5**

Iron availability is moderately low between - **pH- 6.5- 7.5**

Iron availability is severely low above - **pH- 7.5**

Fe^{3+} activity in solution decreases 1000 folds for each pH unit rise.

(Lindsay, W.L. and Schwab, A.P : The chemistry of Iron and its availability to plants. J. Plant Nutr. 5, 821-840 (1982)

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron:

Functions of Iron in Plants.

The well-known function of iron is in enzyme systems in which haem or haemin act as prosthetic groups where iron plays a somewhat similar role to Mg in the porphyrin structure of chlorophyll. The haem enzyme systems include catalase, peroxidase, cytochrome oxidase, and various cytochromes. Iron- sulfur proteins play a major role in redox reactions. Ferredoxin functions as a redox system in photosynthesis, nitrite reduction, sulfate reduction, and nitrogen assimilation.

Chlorophyll synthesis and Iron

Though iron is not a **constituent part** of chlorophyll, but iron is essential for the synthesis of **chlorophyll** in plants. Machold and Stephan (1969) have reported that Fe is necessary for the oxidation step from coproporphyrinogen in chlorophyll synthesis.

(**Machold, O. and Stephan U. W.** (1969). The function of iron in porphorin and chlorophyll biosynthesis. Phytochemistry, 8: 2189-2192)

Snow - White (white similar to snow) is an acute Fe deficiency condition, where leaves are completely devoid of chlorophyll.

Book Number - **CPDM.PDS 001** (Iron Deficiency Monograph)

Iron:

Availability and utilization (Lime induced chlorosis)

In calcareous soils or where lime is applied in the soil as a soil amendment, there is a huge possibility of Iron deficiency even in conditions where available iron is present in the soil.

This physiological hindrance is termed **lime-induced iron chlorosis**. The HCO_3^- is the most important factor that induces iron chlorosis by depressing iron uptake and translocation in the plant. The iron chlorosis found on calcareous sites results primarily not because of low Fe availability in the soil, but because of physiological disorder induced by excess HCO_3^-.

Iron chlorosis of plants grown on calcareous soils is not induced by an absolute Fe deficiency but rather results from a physiological disorder which affects the mobility of Fe in the entire plant. Evidence is provided that this Fe immobility is caused by an alkaline nutrition which means NO_3^-; as the major, if not as the sole N source combined with HCO_3^-. Such alkaline nutritional conditions prevail in calcareous soils. It is supposed that alkaline nutrition results in high pH levels in the leaf apoplast which may bring about a precipitation of Fe. It is also feasible that a high leaf apoplast pH inhibits the plasmalemma located FeIII reductase which is responsible for the Fe transfer across the plasmamembrane. Measurements which decrease the apoplastic pH such as NH_4^+ nutrition, the application of indole acetic acid or fusicoccin resulted in a regreening of Fe chlorotic leaves. **(K. Mengel & G. Geurtzen (1986) Iron chlorosis on calcareous soils. Alkaline nutritional condition as the cause for the chlorosis, Journal of Plant Nutrition, 9:3-7, 161-173, DOI: 10.1080/01904168609363434)**

Iron :

Reasons for depletion in soils.

1. Use of poor quality ground water in irrigation.

2. Low organic matter in soil (Absence of chelated forms of Iron)

3. High soil pH.

4. Soil parent material is calcareous in nature.

5. High intensity cropping with exhaustive crops.

6. Low microbes activity in the soils.

7. Lime application as soil amendment.

Iron Deficiency:

Soil Correction strategies (Large area approach)

1. Rain water harvesting and use of rain water.

2. Avoid use of poor quality groundwater.

3. Improve soil organic matter.

4. Green Manuring to improve soil health.

5. Reclamation of alkaline soils.

6. Reclamation of saline soils.

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Iron Deficiency:

Crop Crisis Management strategies (crop field approach)

Fundamentals for a plant doctor to manage iron deficiency-

1. Iron is present in all soils in enormous amounts. So, it is not the presence of iron but its availability to plants that is the issue to handle in Iron deficiency Crisis.

2. Use of poor quality groundwater, Low organic matter in the soil, Alkaline soils with High soil pH, Calcareous soils high in calcium compounds, lime application, etc. are the major issues to monitor before providing management recommendations.

3. Iron is not readily mobile in the plant body and so does not move smoothly from lower to upper parts. Upper plant parts are deprived of Fe and soon become chlorotic whilst the older tissues remain green and normal. Yunger tissues are therefore dependent on a continuous Fe supply in the xylem or by a foliar application. The major form in which Fe is translocated in the xylem appears to be **ferric citrate**. (Tiffin, L.O. 1972. Translocation of micronutrients in plants. p. 199–229. In J.J. Mortvedt et al. (ed.) Micronutrients in agriculture. SSSAJ, Madison, WI.)

Management Recommendations for Iron deficiency-

1. Application of **inorganic Fe salts** as fertilizer to the soil is not very effective as applied salts rapidly become insoluble in soil. Mixtures of Fe salts with organic matter such as compost or Farm Yard Manure are more effective as soil additives. *(Chen,Y and Barak,P : Iron nutrition of plants in calcareous soils..Ad.Agron.35,217-240 (1982)*

2. Foliar treatment with ferrous salts is also not satisfactory as many sprays are required at short intervals to fulfill the needs of the growing crop.

3. One of the most effective choices of iron supplements is **Fe chelates** to manage iron deficiency crises. Fe chelates may be used as an iron fertilizer either as a **soil additive** or as a **foliar spray**. The **Fe EDDHA** (ethylenediamine di o-hydroxyphenyl acetic acid) is the best known Fe chelate as fertilizer as this iron chelate is stable throughout the pH range 4 to 10, whereas the stability of Fe EDTA (ethylene diamine tetra acetic acid) falls above pH 7.

Part-8

Original Academic Works:

These are being used in the professional course of Plant Doctor Services

*Academic Releases (Videos & PDFs) being released **free** under the professional course of **Plant Doctor Services** are drawn from the original works of Dr Prakash Kumar and other authors.*

*After completing the professional courses being taught under the Consultant Plant Doctor Mission, the practicing professionals in the fields may need more details and a specialized level of learning about the subject concerned. In such situations, the knowledge of original reference books (Original Works) related to Academic Releases of CPDM is important from an academic point of view. So, for further readings, all **original works** being used in the professional course **Plant Doctor Services** are being listed here.*

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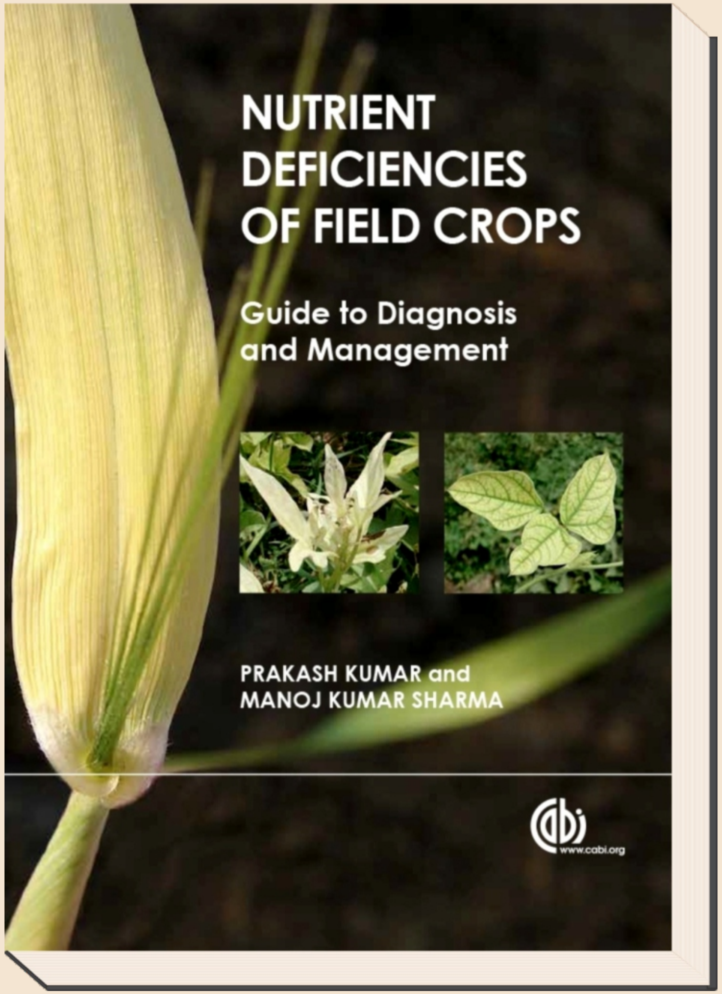

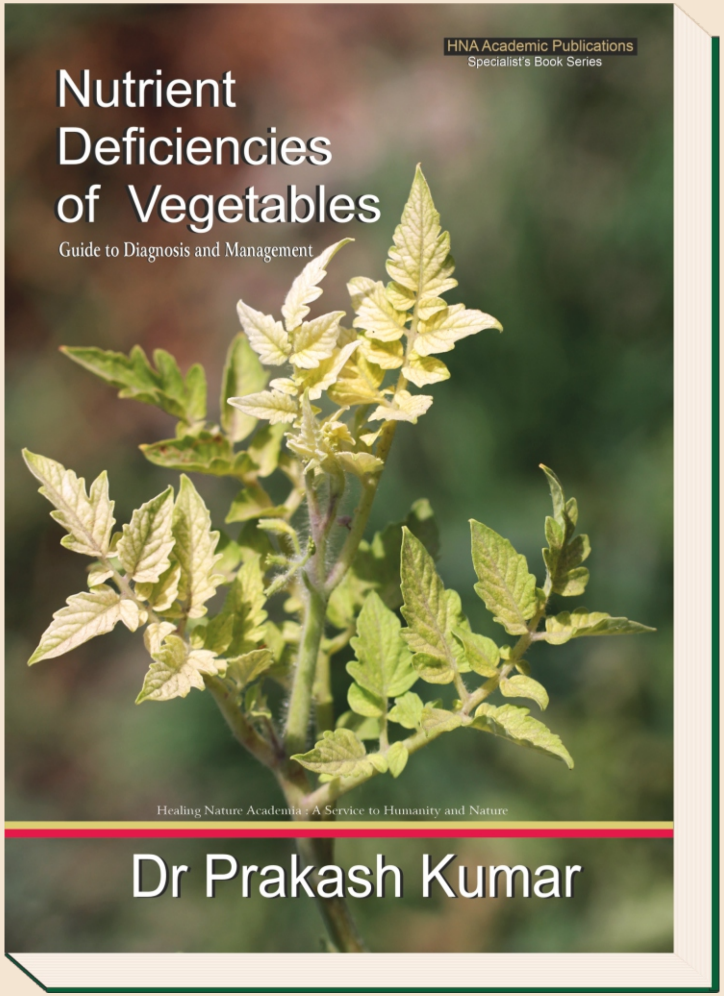

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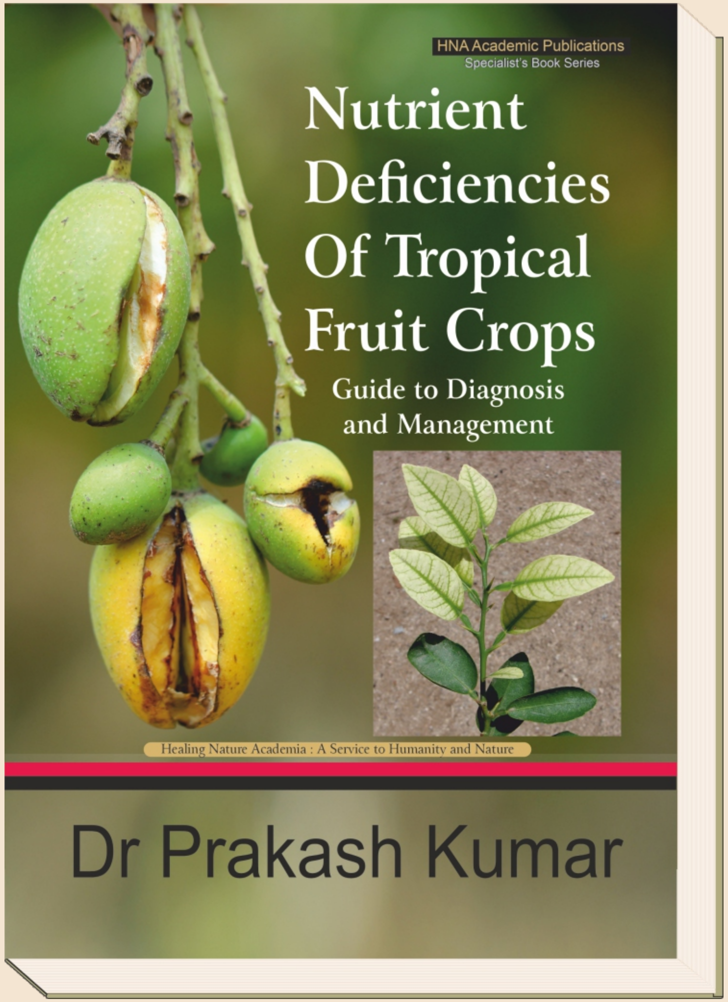

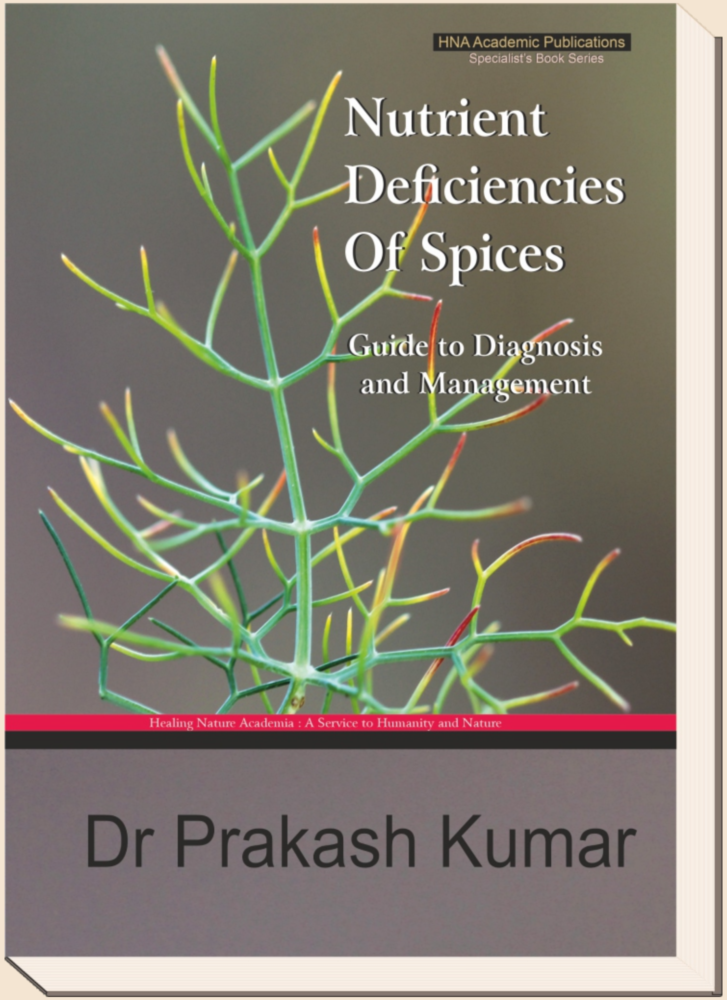

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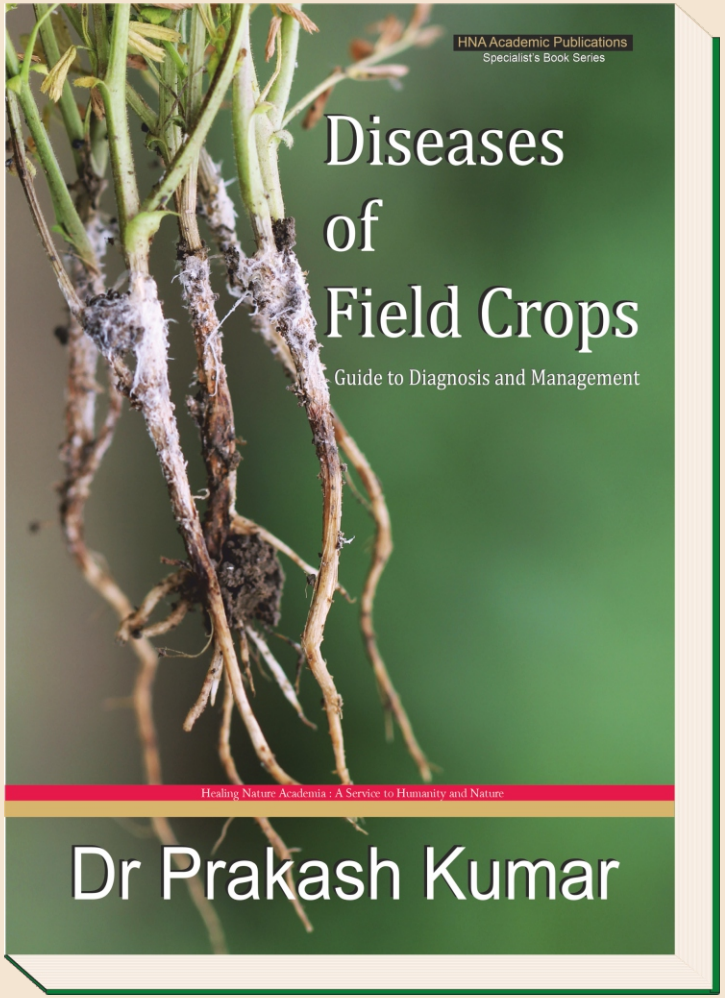

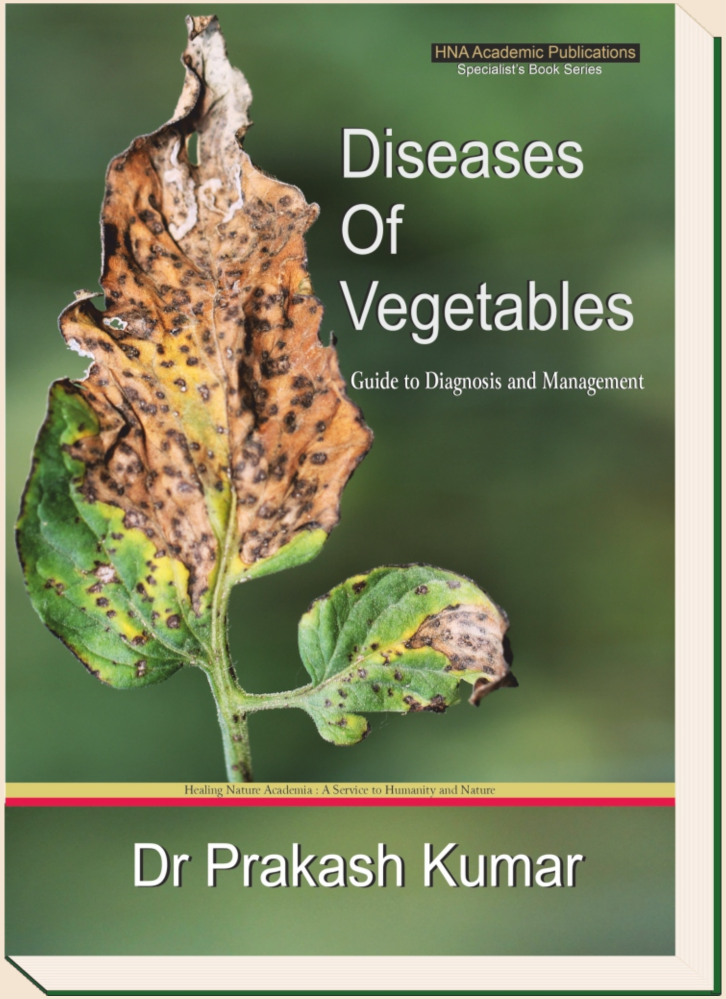

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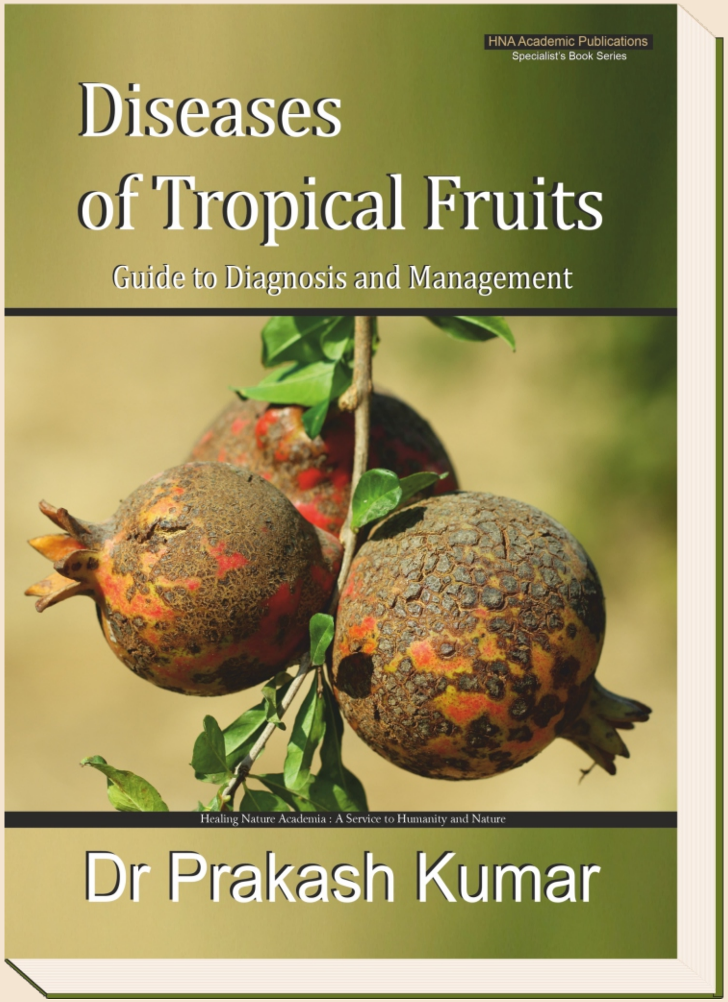

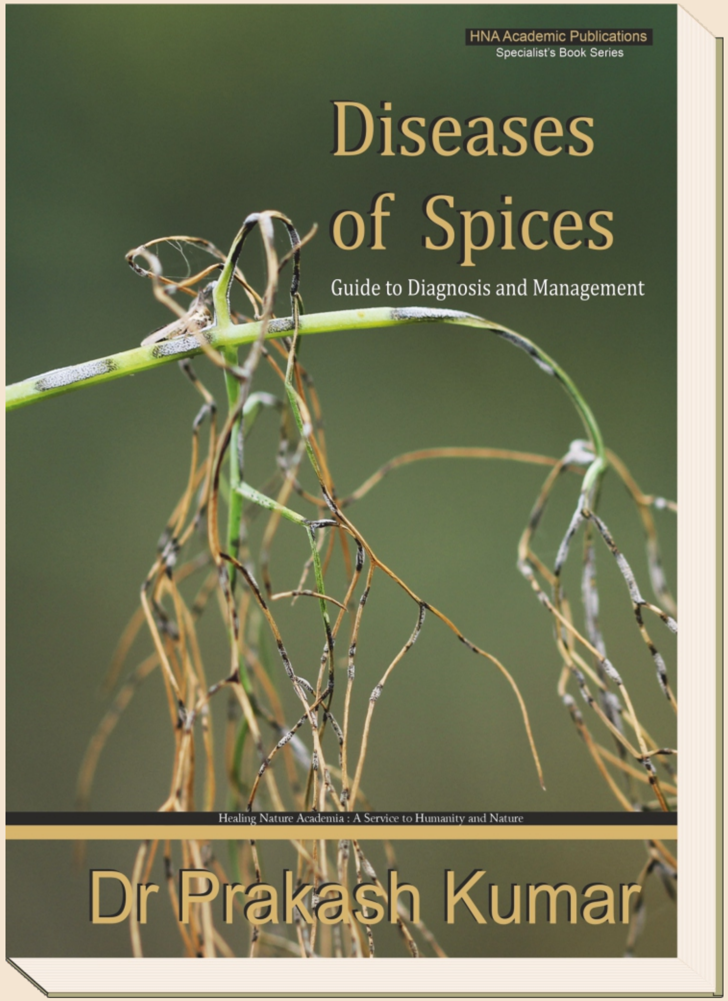

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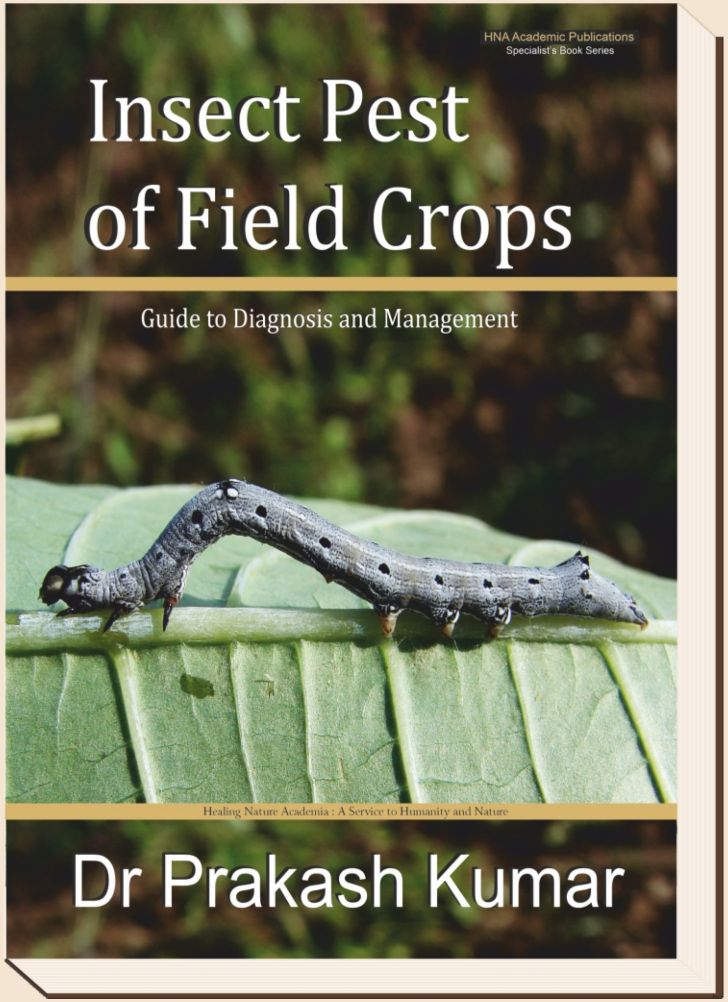
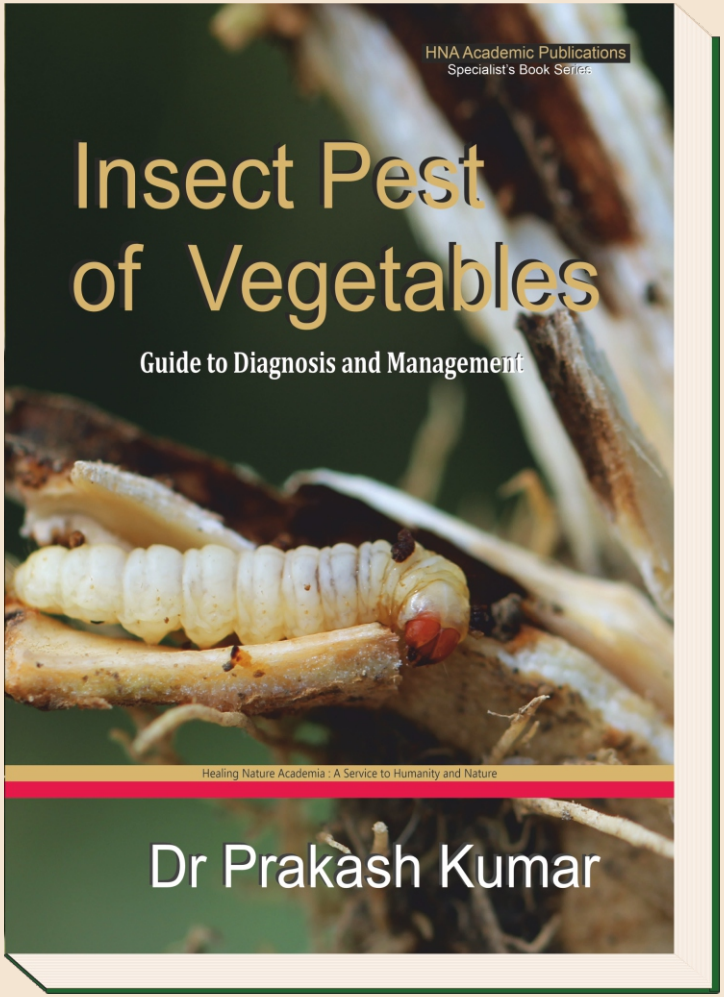
Insect Pest





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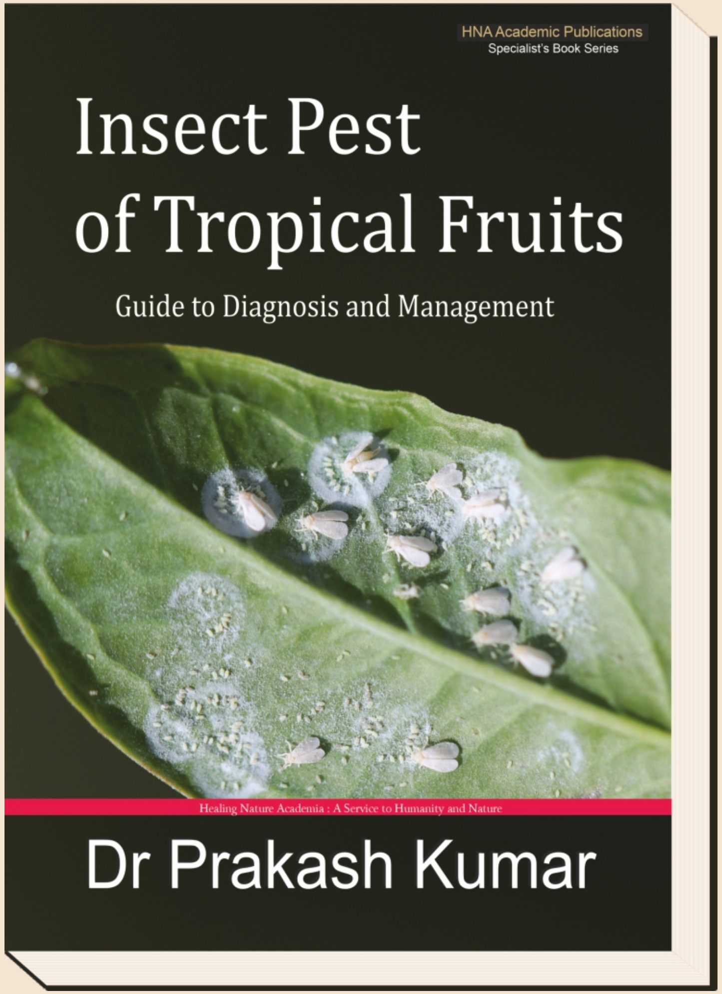

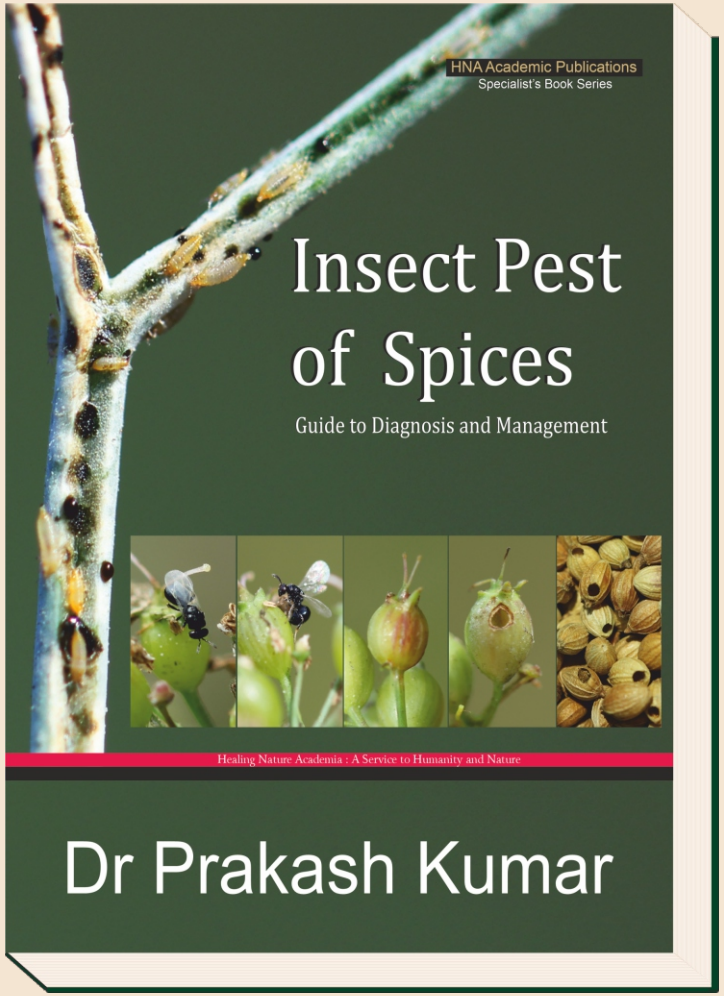

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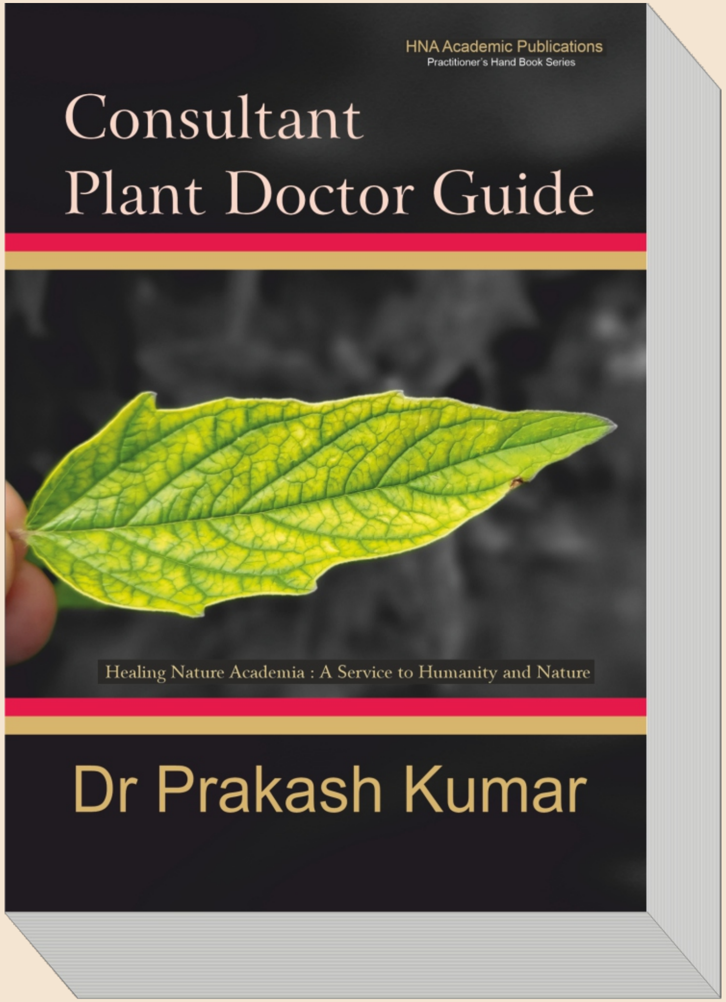

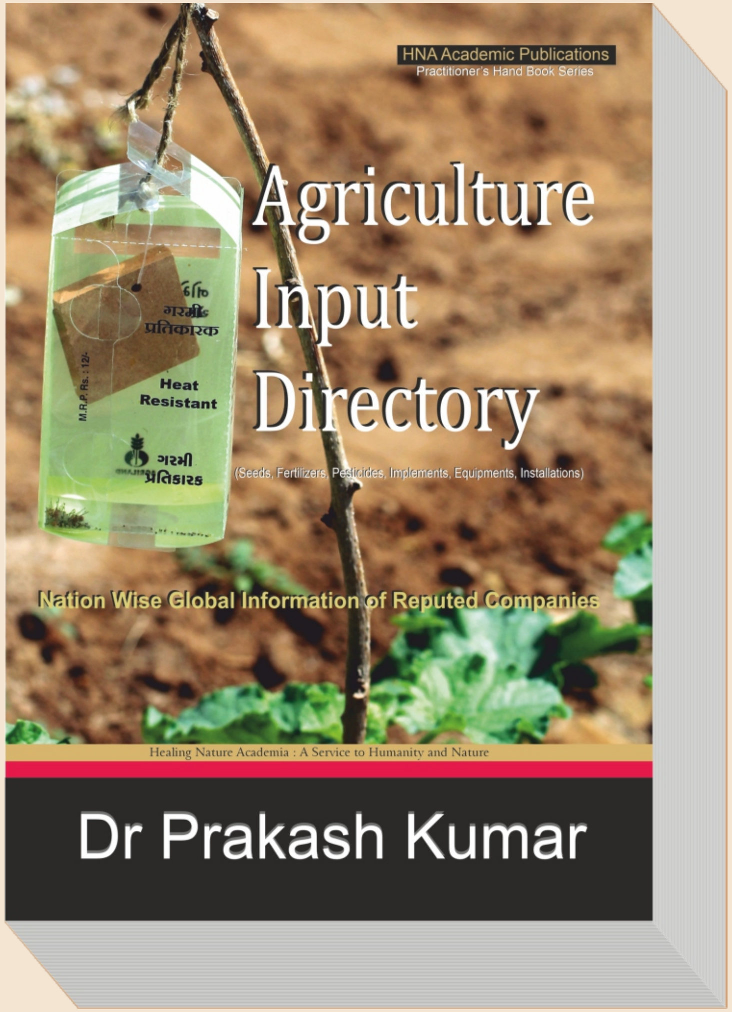

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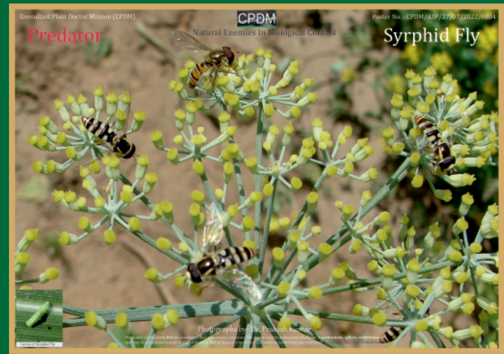

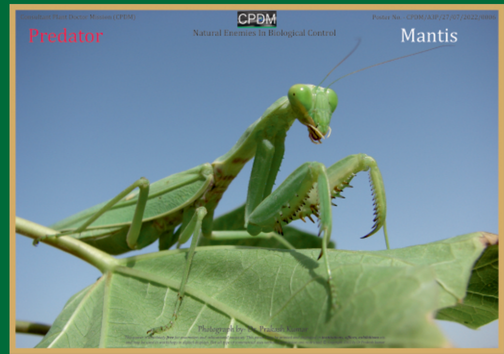

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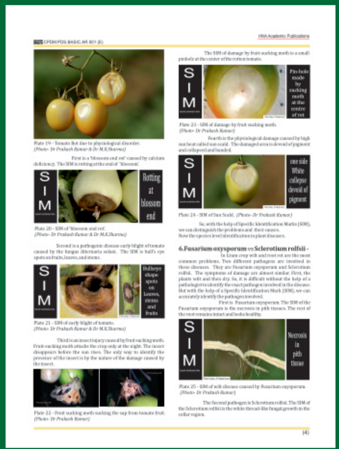

Iron Deficiency Monograph

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