PRACTICAL MANUAL

PRODUCTION TECHNOLOGY FOR FRUIT AND PLANTATION CROPS

Course code: APH-278, 2(1+1)

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SYLLABUS: Production Technology for Fruit and Plantation Crops APH-278, 2(1+1)

Practical: Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, Important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

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Exercise No. 1

Objective: To identify fruits and plantation crops

S. No	Fruit crops	Parameters	Remarks
1	Mango	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
2	A**onla**	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
3	B**er**	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
4	Ba**el**	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	

		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
5	G**uava**	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
6	C**itrus**	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
7	Fig	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	

		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
8	Pomegranate	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
9	Custard Apple	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	
10	Cashew Nut	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	

11	Coconut	Inflorescence shape (Conical, Pyramidal, Broadly pyramidal)	
		Inflorescence colour	
		Position of flower/bearing habit	
		Time of flowering	
		Fruit Shape	
		Fruit colour at maturity	
		Fruit length	
		Fruit breadth	
		Time of fruit maturity	

Exercise No. 2

Objective: To study morphological characters of fruits and plantation crops

Materials and equipment: ……..…...

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General Characteristics:

Common name: ……

Botanical name: ……

Variety: ……..……..

Type of planting material: ……..……

Name of rootstock: ……..

Age of the plant: ……..……

Parentage (if hybrid): ……..

Vegetative characteristics:

Tree height (m): ……..…

Trunk girth (cm): ……..…...

Tree spread (m): ……..…...

Tree shape: ……

Young shoot colour: ……..…

Spines: ……..……..

Leaf petiole: ……

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Leaf blade: ……..

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Flower characters:

Inflorescence position: ……

Time of blooming: ……

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Duration of bloom: ……

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Frequency of blooming: ……

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Type of flowers: ……

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Colour of flower buds: ……

Pedicle length: ……

Calyx: ……

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Corolla: ……

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Stamen: ……

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Gynoecium: ……

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Fruit Characters

Type of fruit: ……

Time of maturity: ……

Size: ……

Peel colour at maturity: ……

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Kind of fruit: ……

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Surface: ……

Shape: ……

Apex: ……

Navel: ……

Rind adherence: ……

Oil glands on the fruit skin: ……..

Segments (Citrus spp): …….

Seed: ……..

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Use of fruits: ……

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Assignment: Study the morphological characters of commercial fruits and their varieties based on the above parameters.

Exercise No. 3

Objective: To select mother plant for propagation

Materials and equipment: ……...

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Procedure: ……

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Flow sheet for selection of mother plants for commercial propagation

1st Step-Orchard Map: ……...

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2nd step-Orchard Survey: ……..

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3rd Step-Preliminary inspection of the individual trees: ……

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4th Step-selection of would be mother plants: ……..……..……

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5th Step-Selection of mother Plants: ……...

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6th Step-Selection of scion wood: ……..….

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Assignment: With the help of flow sheet select mother plants from the orchard.

Exercise No. 4

Objective: To prepare nursery bed for seedling raising

Materials and equipment: ……

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Procedure: ……..

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Preparation of beds:……..……..……

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Sterilization of nursery beds: ……..……

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Physical Methods: ……

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Chemical Methods: ……

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Sowing of seeds: ……..

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Seed treatments: ……..

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Irrigation: ……..

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Care of seedling: ……..

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Assignment:

Exercise No. 5

Objective: To study seed treatment, seed sowing and germination

Hot water treatments:

Materials and equipment: ……

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Procedure: ……

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Acid treatment

Materials and equipment: ……

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Procedure: ……

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Treatments with growth regulators and chemicals:

Materials and equipment: ……

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Procedure: ……..……..….

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Observations on germination of seeds.

Kind of seed	Pre-treatment	Date of sowing	date of observation	No of seeds				Germination (%)
				normal germination	Abnormal germination	Dead or decaying seeds	Poly-embryonic seeds	
	Un-treated							
	Treated: Stratified							
	Scarified							
	Gibberellin							
	Fungicide							
	Heat treatment							

Exercise No. 6

Objective: To study propagation by stem cutting

Method of cuttings: ……………………..…………………………………………………………………..

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Hard wood cuttings/Semi-Hard wood cuttings/Soft-wood cuttings/:

Materials and equipment's: ………………………………………………………..……………………………

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Procedure: ……………………………………………………………………………………………...

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Observation: 1

No. of cuttings prepared	Sprouting date (Days)				No. of cuttings sprouted	Average no. of roots/cutting	Success percentage
	25	50	75	100			

Observation: 2

Kind of cuttings	Growth Regulators with concentration	No. of cuttings treated	Average No. roots/cutting	Avg. Length of roots	Success percentage

Exercise No. 7

Objective: To study propagation by layering

Classification of Layering: ……..…….....

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Simple Ground Layering:

Materials and equipment: ……..……

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Procedure: ……...

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Compound or Serpentine Layering:

Materials and equipment: ……..….

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Procedure: ……....

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Air Layering

Materials and equipment: ……………………………………………………………………………………

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Procedure: ……………………………………………………………………………………

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Preparation of growth regulators for air layering: ……………………………………………………

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Observation

Crop name	Date of air layering	No. of air layers made	Date of separation	No. of Air layers rooted	Average no. of roots per layer	Average length of roots

Draw labelled diagrams of each type of layering

Exercise No. 8

Objective: To study propagation by grafting

Materials required:

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Procedure: ……

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Draw labelled diagrams of each type of grafting

Exercise No. 9

Objective: To study propagation by budding

Materials required:

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Procedure: ……

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Draw labelled diagrams of each type of budding

Exercise No. 10

Objective: To study propagation method of coconut

Materials required: ……..……..……

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Mother palm selection Procedure: ……..……..

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Seed nut selection procedure:

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Procedure of seed nut sowing:

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Selection of seedling:

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Precautions: ……

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Exercise No. 11

Objective: To study pretreatment of banana suckers

Materials required: ……

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Procedure: ……

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Assignment: Follow the procedure and present with a neat sketch.

Exercise No. 12

Objective: To study de-suckering of banana

Materials required: ……

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Procedure: ……

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Assignment: Follow the procedure through manual process in field condition.

Exercise No. 13

Objective: To study bearing habit of fruits and plantation crops

Materials required: ……

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Procedure: ……

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Observation to be recorded and draw a neat sketch of studied bearing habit

S. No	Name of the crops	Position of flower on the shoot	Nature of shoot bearing flower	Flower borne in cluster/ solitary	Remarks

Exercise No. 14

Objective: To study preparation and application of growth regulators

Materials Required: ……..……..

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Preparation of growth regulators

Dust form: ……

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Lanolin paste: ……

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Solution form: ……

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Procedure: ……

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Example: Before preparation, the following aspects should be known-active ingredients or strength of pure chemical that is mentioned in the label of the pack, the amount of chemical required for the desired strength and volume are calculated by the following formula.

V1S1 = V2S2
Where V1 = chemical required.
S1 = strength of chemicals/hormone.
V2 = water or powder required.
S2 = concentration or strength of chemical/ hormone required.
[1% = 10,000 ppm]

Solved Problem: ……..

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Assignment: Practice the job and record the calculation

Exercise No. 15

Objective: To apply plant growth regulators in fruits and plantation crops

Materials required:……..……

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Procedure: ……

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Observation-1: Effect of ethrel/ethephon on fruit ripening.

S. No	Fruit	Treatments	No of fruits kept for ripening	No of fruits ripened	Days to ripening	TSS

Observation 2: Effect of PGRs of fruit set and fruit growth.

S. No	Fruit	PGR sprayed	Concentration (ppm)	No of sprays	Date/stage of spray			No of flowers/ brunch	Fruit set (%)	Fruit size at harvest
					I	II	III			

Exercise No. 16

Objective: To identify and manage nutritional disorders in fruits and plantation crops

Materials requited: ……………………………………………………………..……………………………….

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Nutrient Disorders in Fruits and Plantation crops

S. No.	Nutrition	Deficiency Symptoms	Corrective Measures

Crops and their symptoms

S. No.	Name of the crops	Symptoms on the plant	Remarks

Assignment: Diagnose the disorder on the field and observation to be recorded crop-wise

Exercise No. 17

Objective: To identify and manage insects and diseases in fruits and plantation crops

Materials requited: ……..

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Major insects and control methods of Fruits and Plantation crops

S. No.	Name of the crops	Name of the major insects	Control Measures

Major diseases and control methods of Fruits and Plantation crops

S. No.	Name of the crops	Name of the major diseases	Control Measures

Exercise No. 18

Objective: To study production economics for commercial cultivation of banana and mango

Items for calculating the cost of cultivation of Banana for 1 ha. area

S. No.	Component	Proposed Expenditure
1.	**Plantation Expenses**	
	Cost of planting material (Suckers and tissue culture plants)	
	Cost of Manures & fertilizers	
	FYM	
	Nitrogen	
	Phosphorus	
	Potassium	
	$FeSO_4$	
	$CuSO_4$	
	$FeSO_4$	
	Cost of any others nutrients and plant growth regulators	
	Cost of Insecticides & pesticides	
	Cost of labour for application of manures, fertilizers and pesticides. Weeding and harvesting	
	Others, if any, (Power)	
2.	**Irrigation**	
	Tube-well/submersible pump	
	Cost of Pipeline	
	Others, if any, please specify	
3.	**Cost of Drip/Sprinkler**	
4.	**Infrastructure**	
	Store	
	Labour shed & Pump house	
	Farm Equipment	
5.	**Land Development**	
	Soil Leveling	
	Digging	
	Fencing	
	Others, if any, please specify	
Grand Total		

Total expenditure

Total yield of Banana ……..

Sold @ ……..

Net income = gross income – expenditure

Net income growing one ha. Banana will be …..

Benefit cost ratio: Net income / total cost

Items for calculating the cost of cultivation of Mango for 1 ha. area

S. No.	Component	Proposed Expenditure
1.	**Plantation Expenses**	
	Cost of planting material (Based on planting density)	
	Cost of Manures & fertilizers	
	FYM	
	Nitrogen	
	Phosphorus	
	Potassium	
	Cost of any others nutrients and plant growth regulators	
	Cost of Insecticides & pesticides	
	Cost of labour for application of manures, fertilizers and pesticides.	
	Others, if any, (like Training, pruning and weeding and harvesting)	
2.	**Irrigation**	
	Tube-well/submersible pump	
	Cost of Pipeline	
	Others, if any, please specify	
3.	**Cost of Drip/Sprinkler**	
4.	**Infrastructure**	
	Store	
	Labour shed & Pump house	
	Farm Equipment	
5.	**Land Development**	
	Soil Leveling (Hiring tractor for plowing and leveling)	
	Digging (Hiring JCB for pit digging)	
	Fencing (permanent/temporary)	
	Others, if any, please specify	
Grand Total		

Total expenditure **Net income = gross income – expenditure**

Total yield of Mango ……..

Sold @ ……..

Net income growing one ha. Mango will be …..

Benefit cost ratio: Net income / total cost

Conclusion: ……

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Exercise No. 19

Objective: To visit an orchard and diagnosis of maladies in fruit crops

Materials required: ……

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Procedure of observation: ……

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Observation

Type of malady	Symptoms	Suggestion for remedial measure

MAJOR COMPONENTS OF THE MODEL ORCHARD

Land Development: This is the labour cost of shaping and dressing the land site.

Fencing: It is necessary to safeguard the orchard by a barbed wire fencing.

Irrigation Infra-structure: For effective working with drip irrigation system, it is necessary to install a bore well with diesel/electric pump set and motor. This is post cost of tube-well.

Drip Irrigation: This is average cost of one-acre drip system for apple inclusive of the cost of fertigation equipment. The actual cost will vary depending on location, plant population and plot geometry.

Implements: For investment on improved manually operated essential implements a provision of another Rs.15 thousand is included.

Building and Storage: A one-acre orchard would require minimally a labour shed and a store-cum grading/packing room & pump house.

FUNCTIONS AND DEFICIENCY SYMPTOMS OF MAJOR AND MINOR ELEMENTS

On the basis of mobility of nutrients in the plants the nutrients are grouped as follows:

1. **Nutrients being highly mobile:** Deficiency symptoms appear on older leaves. The elements are: Nitrogen, Phosphorus, Potash, Zinc, and Magnesium.
2. **Nutrients being less mobile:** Deficiency symptoms appear or younger leaves or bud leaves the element are: Calcium, Boron, Copper, Iron, Sulphur, Manganese.

NITROGEN

Functions	Deficiency symptoms
1. Essential constituent of protein, chlorophyll, hormone, vitamins, alkaloids & amides. 2. Promotes auxin synthesis 3. Helps in the uptake of potassium, phosphorus and other elements 4. Promotes vegetative growth.	1. Lower leaves turn yellowish or light green. 2. Fruit drop before ripening and poor fruit sets 3. Chlorosis of leaves and poor growth.

PHOSPHORUS

Functions	Deficiency symptoms
1. Important constituent of nucleic acid and phospholipids, phytin & phosphoprotein. 2. Helps in transformation of energy, fat and carbohydrates metabolism. 3. Promotes early root growth there by helps into establishment of seedlings 4. Prevent lodging. 5. Promotes the activity of oxidase enzymes. 6. Stimulates flowering and seed formation. 7. Helps in formation of nodules there by increases fixation of atmospheric nitrogen in legume.	1. Generally, leaves dark green but lower leaves become purple or yellowish. 2. Leaves become small and growth suspends. 3. Petioles becomes violet.

POTASSIUM

Functions	Deficiency symptoms
1. Helps in protein synthesis. 2. Activator of enzyme responsible for energy metabolism, starch synthesis and nitrate reduction. 3. Helps in transformation of carbohydrate. 4. Promotes the formation of sugars, starch in leaves. 5. Checks transpiration thereby regulate the water losses. 6. Increasing resistant to certain disease.	1. Appearance of burnt edge of older leaves. 2. More defoliation during flowering in citrus. 3. Premature leaf fall.

CALCIUM

Functions	Deficiency symptoms
1. Necessary in cell division and formation of tissues. 2. Helps in protein synthesis and activator of enzymes. 3. Neutralizing plants organic acid by detoxifying. 4. Promotes seed formation. 5. Helps in transformation of carbohydrates.	1. Young leaves are widely distorted small and abnormally dark green. 2. Terminal bud deteriorates with breakdown of petiole. 3. Leaves may become cup shaped and crinkled. 4. Roots malformed and stem growth in markedly impaired. 5. Death of terminal buds, followed by ‘dieback'.

MAGNESIUM

Functions	Deficiency symptoms
1. Constituent of chlorophyll thus gives green colour to leaves. 2. Helps in uptake and transformation of phosphorus. 3. Necessary for fatty acid and oil synthesis. 4. Activator of enzymes in carbohydrate metabolism. 5. Helps in transformation of sugar and starch in the plant.	1. Symptom usually on older leaves producing interveinal chlorosis. 2. Leaves become small, britle and curved upward at margin. 3. Twig become weak, premature leaf fall.

IRON

Functions	Deficiency symptoms
1. Helps in chlorophyll formation. 2. Helps in absorption of other nutrients. 3. As a constituent of enzyme systems bring about oxidation reduction in plant regulates respiration, photo-synthesis, reduction of nitrates and sulphates. 4. Essential for cell-division and the synthesis of protein contained in the chloroplast 5. Fruit drop before ripening or light colour of fruits.	1. Chlorosis appearance on new twig and leaves 2. Plant dwarf and weak. 3. Centre vein of leaves become yellowish as well as twig dry up. 4. Yellowish colour between the vein on the leaves.

SULPHUR

Functions	Deficiency symptoms
1. Necessary for cystine, methionine and protein synthesis. 2. Constituent of some vitamin, coenzyme 'A' and glutathione. 3. Help in chlorophyll formation 4. Promotes nodulation in legume crop 5. Promotes the action of papainase.	1. Young leaves turn between vein light green in colour.

MANGANESE

Functions	Deficiency symptoms
1. Help in chlorophyll formation. 2. Supports movement of iron in plant. 3. Act as catalyst in oxidation and reduction reactions within the plant tissues. As a constituent of enzymes, help in respiration and in protein synthesis in the chloroplasts.	**1.** Chlorotic spot on the upside portion of leaf and become brown later. 2. Growth suspends. **3.** Appears first on new leaves.

Zinc

Functions	Deficiency symptoms
1. Constituent of several enzyme system which regulate various metabolic reactions in the plant. 2. Influence the formation of growth hormones in the plant. 3. Helpful in reproduction of certain plants.	1. Older leaves become cup shaped. 2. Gum like viscous material is stored in the fruits.

COPPER

Functions	Deficiency symptoms
1. Helps in form of compounds with amino acid and protein. 2. Act as electron carrier of enzyme. **3.** Helps in utilization of iron in chlorophyll synthesis.	1. Older leaves become cup shaped. 2. Gum like viscous material is stored in the fruits.

COBALT

Functions	Deficiency symptoms
1. Required by rhizobia for fixation of elemental nitrogen. 2. Necessary for the activity of enzymes	1. Same as nitrogen deficiency.

BORON

Functions	Deficiency symptoms
1. Helps in absorption of nitrogen. 2. Constituent of cell membranes and essential for cell division. **3.** Act as a regulator of potassium, calcium ratio. **4.** Necessary for translocation of sugar. 5. Tends to keep the calcium soluble. 6. Helps in salt absorption, hormonal movement, flowering & fruiting.	**1.** Young leaves being thick and curved. **2.** Phloem and xylem burst resulting in death of plants. **3.** Checks flowering and fruit setting. **4.** It caused cracked stem, yellow tip, brownish, top sickness, internal cork.

MOLYBDENUM

Functions	Deficiency symptoms
1. Act as in enzyme systems which bring about oxidation-reduction reaction. 2. It is essential for the process of atmospheric nitrogen fixation, both symbiotic & non-symbiotic. 3. It is essential for vitamin C & sugar synthesis. 4. Necessary for ammonium nitrate reduction.	1. Same as nitrogen deficiency symptom.

PLANT GROWTH REGULATORS

Natural	Synthetic	Uses
AUXINS Indole-3-acetic acid (IAA) Indole aceto-nitrile (IAN) Indole Pyruvic acid (IPA)	2-Chlorophenoxy acetic acid (2 CPA) 2,4-dichloro phenoxy acetic acid (2,4-D) Indole-3-butyric acid (IBA) α-Naphthalene acetic acid (NAA) β-Naphthoxy acetic acid (NOA) p-Chlorophenoxy acetic acid (CIPA) β-Indole propionic acid (IPA)	stimulation of rooting in stem cuttings and air layers, promotion of fruit setting, checking fruit and flower drop, fruit thinning, induction of parthenocarpy, modifying sex expression in vegetable, weed control, inhibition of lateral buds, delay in leaf abscission, seedling growth, control of flowering.
Gibberellins (GA)		Seed germination, promotion of stem elongation, increasing vegetative growth, overcoming the genetic and physiological dwarfism, induction of flowering, induction of flowering in plants with specific day-length requirement and cold requiring, breaking seed dormancy, increasing fruit setting and thinning, grape berry elongation, promotion of cell elongation, retardation of chlorophyll break-down, delaying post-harvest ripening, pollen growth, inducing parthenocarpy fruits.
Cytokinin	6-furfurylaminopurine (Kinetin) 6-benzyladenine	Promotion of cell division, lateral bud development, improving fruit setting, promotion of seed germination, protein synthesis.
Ethylene	Ethephon, 2-chloroethylphospoic acid (CGA 15281)	hastening ripening, induction of abscission, induction of flowering in pineapple.
Abscisic Acid (ABA)	B-Chlorethylmethyl bis-benzloxy silne	induction of dormancy, delayed germination.

SYNTHETIC GROWTH REGULATORS

Growth retardants	Chlormequat or cycocel (CCC)	retards plant growth, stimulates fruit production.
Gameticides	2,3-dichloroisobutyric acid	induction of male sterility
Morphactins	Chlorofluocrecol mythyl, 2,3,5-triodobenzoic acid (TIBA)	encourages lateral branches, inhibits apical dominance, promotes flowering in apple.

SEED TREATMENT

It is desirable to use seeds that have been pretreated for protection with a fungicide such as captan or thiram or enhanced for germination by seed coating or priming treatments. Many woody species seeds must be pretreated to overcome dormancy. Most common treatments are:

STRATIFICATION (moist chilling)

Imbibed seeds are subjected to periods of chilling to after ripen the embryo. Usual stratification temperature is 0-10°C (32 - 50°F) and period varies from 1-4 months. This type of stratification is practiced in apple, pear, peach, plum and cherry. Tropical and subtropical species (e.g., palms) require warm-moist stratification of several months.

Scarification: It is any process of breaking, scratching, mechanically altering or softening the seed covering to make them permeable to water and gases. Seeds of the species with hard seed coat (e.g., guava, nuts) require this treatment. Scarification may be done by one of the following methods.

Mechanical scarification: Chip hard seed coats by rubbing with sand paper, cutting with file or cracking with hammers.

Acid scarification: Place dry seeds in concentrated H,SO (sp. gravity 1.84) in a ratio of about 1 part seed to 2 part acid, stir and keep for 10 minutes to six hours depending on species.

Hot water scarification: Place seeds in 4-5 times their volume of hot water at 77 to 100°C (170-212°F). Remove heat source immediately and soak in gradually cooling water for 12 to 24 hrs. Sow the seeds immediately after treatment.

HORMONAL TREATMENT

Gibberellins (GAs) comprise the class of hormones most directly implicated in the control and promotion of seed germination. Gibberellins (GA. GA GA) in a concentration range of 10-8 to 10-3 moles per litre are used for enhancing germination.

SEED PROTECTANTS

Chemical (broad-spectrum fungicides such as captan, thiram etc.) and heat treatment (immersion of seeds in hot water with a temperature of 45-57°C for 15 minutes are given for protection against pathogens and insects.