

A Guide to Identification and Management of Nutrient Deficiencies & Cultural Practices in Plantation Crops

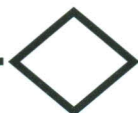


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Correct citation:

A Guide to Identification and Management of Nutrient Deficiencies & Cultural Practices in Plantation Crops, Krishi Vigyan Kendra, ICAR Research Complex for Goa.

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FOREWORD



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Plantation crops, a group of commercial crops mostly cultivated in Humid and Sub Humid rain forest ecosystem in Tropical and Sub Tropical climate, provide enough opportunity for raising, annual, biannual and perennial crops as inter and mixed crops in high density multispecies cropping system.

The major plantation crops in Goa are cashewnut, coconut, arecanut and oilpalm. Majority of plantation crops are owned by both resourceful and marginal farmers. The total cropped area under plantation crops is estimated at **52.36%**. Productivity of these crops is less due to lack of adoption of scientific nutrient management practices. Productivity can be increased by proper soil and nutrient management, besides diversification with sustainable annual and perennial crops, thereby improving and sustaining high income from available land.

Multinutritional deficiency, in Indian soil is a major concern, leading to considerable yield loss of crops. Such deficiency if not corrected with adequate external input, could cause serious damage to the soil quality and productivity. Besides, the dependence on soil and plant testing, emphasis needs to be given for developing trained eyes to detect and interpret nutrients deficiency symptoms on crops. Early detection of nutritional disorder through recognition of visual symptoms facilitates quick correction for opting nutrient management strategy and prevent yield losses.

This extension bulletin, "*A Guide to Identification and Management of Nutrient Deficiencies and Cultural Practices in Plantation Crops*" is designed as field guide to identify nutrient deficiencies and how they can be prevented or corrected. I congratulate the authors for their painstaking efforts and hope that the publication will be very useful to the researchers, students, extension personnel, orchardist/farmers along with all other connected with this field.

I also expect that this technical bulletin will be useful for farmers, extension staff involved in plantation crops and all other related stakeholders.

(N. P. Singh)

PREFACE

Among the horticultural crops, the plantation crops such as coconut, cashewnut, arecanut, oil palm, tea, and cocoa etc are important crops of coastal region. These plantation crops are high value commercial crops of greater economic importance and play a vital role in our Indian economy. They contribute to national economy by way of export earnings. These crops occupy less than 2 per cent of the total cultivated area (3.82 per cent of total crop land) but they generate an income of 12.72 per cent of the total export earnings of all commodities or 75 per cent of total earnings from the export of agricultural produce. The main draw back with this sector of crops in India is that major portion of the area is of small holdings, lower productivity and poor quality. The productivity and quality could be enhanced by adopting scientific package of practices standardized for various crops. The management practices especially nutrient management in crop production is responsible for yield and quality of the produce. Good management practices including nutrient management increases growth, yield and quality which ultimately fetches higher remuneration. Plants require 17 essential elements for normal growth and reproduction. Each nutrients has specific function and required in varying amount in plant. Macronutrients (Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Sulphur) are required in high amount. Micronutrients (Iron, Zinc, Copper, Molybdenum, Manganese, Boron, Nickel, Chlorine) are required in less amount in plant. Other minerals elements which are beneficial to some plants but not considered as essential include Sodium, Cobalt, Vanadium, Selenium and Aluminum. A deficiency occurs when an essential element is not present in sufficient quantity to meet the need of growing plants. Thus elements cannot be under weighted or ignored as their deficiency adversely affects the growth and development of plants and ultimately crop yield.

Authors take this opportunity to acknowledge the timely help extended by Mr. V. Y. Gaonkar, Mr.H. R. Prabhudesai, Mr. H. R. C. Prabhu, Mrs Sunetra Talaulikar and others for their efforts of bringing out this technical bulletin.

This technical bulletin, "***A guide to Identification and Management of Nutrients deficiencies and Cultural practices in Plantation crops***" provides important information on deficiency disorders / symptoms caused by different/ individual element and steps for correcting such deficiencies in order to mitigate yield losses in plantation crops with special reference to Konkan region. The matter has been presented in a lucid manner by collecting maximum available information.

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1. Introduction

Plantation crops are the large group of the horticultural crops. Major Plantation crops are coconut, arecanut, cashewnut, oil palm, tea, coffee and rubber. These are grown over the area of 38.20 lakh hectare in our country (2% of total cropped area) contributing about 7,500 crores to export earning. In Goa, the total cropped area is 165953 ha (45.95%) of which 52.36 % area covered under plantation crops. The major plantation crops in Goa are Cashewnut, coconut, arecanut and oil palm which cover 34.76,16.02 ,1.06 and 0.52% of the total cropped area respectively. Their coverage is comparatively high but mostly they are confined to small and marginal holdings. However, they play an important role in export as well as domestic requirement, and employment generation and poverty alleviation particularly in rural areas. Due to lack of knowledge about nutrient management of plantation crops among the farmers mostly cultivars / plants are facing nutritional deficiency and thereby low productivity of plant yield.

The main reason for increasing instance of nutrients deficiencies all over the country as well as Goa is the total disregard of the replacement of these nutrients as per the crop needs and existing deficiencies of these in soil and crops.

The following denoted by the status of deficiency with respect to various nutrients in their order of magnitude indicated by font size of the symbols of nutrients elements.

NPKS ZnBMoCu....?

Relatively Nutrients deficiency in Goa
(Size and boldness is indicative of relative extent)

The subsequent chapter, the salient features of the deficiency symptoms of major plantation crops and their correction measure along with improves cultural practices are briefly described for easy understanding.

2. Coconut

2.1 Nutrient deficiency symptoms and their corrective measures

2.1.1 Nitrogen Deficiency Symptoms:

- ▲ Dull green, yellowish and reduced leaf size.
- ▲ Dieback of Tip, thin and bushy appearance of tops.
- ▲ V shaped yellowing (Chlorosis) starting from tip toward leave blade on older leaves.

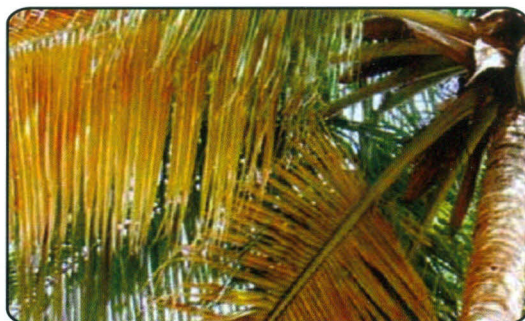


Plate 1: A view of N deficient coconut leaves showing yellowing on older leaves.

Likely to occur in:

1. Soil having low organic matter
2. Sandy soil where potassium leached by heavy rainfall or excessive irrigation
3. Soil exhausted by intensive cropping system
4. Waterlogged condition

Correction Measure:

Soil application of urea@1.5 kg/tree/year

2.1.2 Phosphorus Deficiency Symptoms



Plate 2: Phosphorus deficient plant showing purple discoloration on old leaves

- ▲ Symptoms appear on older leaves.
- ▲ The leaves are small and narrow with purplish or bronze discolouration.
- ▲ Leaves develop necrotic areas and fall off.
- ▲ Flowering is affected.

Likely to occur in:

1. Soil having low organic matter
2. Soil exhausted by intensive cropping system
3. Alkaline and calcareous soil
4. Acid soil and highly weathered soil
5. Area with top soil removed by erosion

Correction Measure:

Soil application of Single Super phosphate@1.5-2.0 kg/tree/year

Application of PSB @ 10-15 kg/ha (use of compost near the basin of the tree)

2.1.3 Potassium Deficiency Symptoms:

- ▲ Symptoms begin as a pale yellow area (chlorosis) on the tip of old leaves and cover marginal tissues,
- ▲ Shedding of leaves at blossom, scorching of leaf tips, small brown resinous spots on leaf.
- ▲ Small wrinkled spotted leaves.



Plate 3: Potassium deficient leaf showing marginal yellowing and death of leaflet starting from tip.

Likely to occur in:

1. Soil having low organic matter
2. Sandy soil where Potassium leached by heavy rainfall or excessive irrigation
3. Soil with acute saline condition
4. Acid soil having pH below 6.0

Correction Measure:

Soil application of Muriate of Potash @2kg/tree/year

2.1.4 Magnesium Deficiency Symptoms:

- Yellowish blotch near the base of leaf, midrib and the outer edge of older leaves .
- The leaves become entirely yellow and defoliate.



Plate 4: Magnesium deficient leaf showing yellowish blotch near the base of leaf and midrib of older leaves.

Likely to occur in:

1. Sandy soil that have been leached by heavy rainfall or excessive irrigation
2. Soil having excessive quantity of Calcium and Potassium

Correction Measure:

Soil application of Magnesium sulphate @ 250g/tree/year

2.1.5 Boron Deficiency Symptoms:



Plate 5: Boron deficient leaf showing deformed top leaves.



Plate 6: Malformed and abnormal nut resulted due to boron deficiency



Plate 7: Abnormal nuts from a boron deficient palm showing sterilizing and malformation of reproductive structures.

Likely to occur in:

1. Soil having low organic matter
2. Soil exhausted by intensive cropping system
3. Alkaline and calcareous soil
4. Acid soil and highly weathered soil
5. Area with top soil removed by erosion

Correction Measure:

Soil application of borax 0.2 to 0.5 kg / tree / year or foliar spray of borax 0.2% (2 gms / ltr).

2.2 Cultivation Practices for Coconut Cultivation

Before establishment of a coconut orchard, careful planning is must because it will be a long term investment. Therefore the following management practices should be followed.

2.2.1 Field Preparation

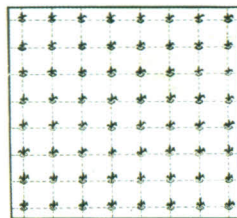
Preparation of land depends upon topography, soil type and water table.

- In undulating and sloppy land after clearing the field, soil conservation measure like levelling, terrace making should be adopted to prevent soil erosion and also facilitate intercropping activities.
- Analysis of the soil before planting to measure the plant nutrients status of soils
- In waterlogged area, adequate drainage is also necessary in the initial years.

2.2.2 Layout of field:

Before opening of pit, proper laying out of field either in square or triangular system has to be done based on the situation of appropriate spacing of different varieties and hybrids.

- ▲ Normal planting in Square system: spacing between row to row and plant to plant is 7m x 7m.
- ▲ High density planting in triangular system: spacing between row to row and plant to plant is 9m x 9m.



Rectangular



Triangular

2.2.3 Pit Preparation

- ▲ Open pits of 1m x 1m x 1m two to three month prior to transplantation during summer.
- ▲ Fill the pit with mixture of top soil, sand and compost at the ratio of 5:1:4. In addition to this, 100 gram Neem cake is applied to protect the seedling from termite and other insects.
- ▲ Addition of 2-3 kg common salt per pit is useful in lateritic soils

2.2.4 Variety and type:

Coconut palms are mainly of two types: Tall and dwarf
 Local or Tall varieties: Calungute, Benaulim
 Dwarf variety: MYD (Malayan Yellow Dwarf)
 Hybrid : DXT, TXD

2.2.5 Selection of seedling:

Selection of healthy and vigorous seedling is utmost important. Selection of superiority of quality of seedling is done based on following criteria;

- ▲ Seedlings resulted from early germination of seed nut and sowing early splitting of leaflets.
- ▲ Seedlings which are ready for transplanting in 9-12 months.
- ▲ Seedlings which having 3-4 functional leaves.
- ▲ Seedlings with well developed root systems.

2.2.6 Planting Time

The proper time for planting of coconut in India is at the advent of monsoon i.e. from May to June and from October to November.

2.2.7 Planting technique

Plant the selected seedling in 30-40 cm deep in the center of the pits the soil around the seedling should be firmly pressed and after that give light irrigation for proper establishment of seedling. Provide proper staking for seedling.

2.2.8 Care of young seedling

Any negligence of newly planted seedling will have detrimental effect on the overall performance of the palm. Young seedling should be protected taking by measures.

- ▲ Field should be fenced to protect from by grazing by local animals
- ▲ Rain water should not stagnate in the pit
- ▲ About one meter radius around the seedling may be kept free from weeds and mulch with coconut husk to conserve soil moisture and regulate soil moisture and temperature.

2.2.9 Manure and Fertilizer Management

Seedlings normally require more nitrogen and phosphorus than the adult palms .Nitrogen is required for growth and development of young palm and phosphorus help root growth and development.

2.2.10 Mulching:

During hot summers the basin should be mulched with dry grass / coconut leaves or other locally available material; it conserve the moisture and reduces the soil temperature.

2.2.11 Weeding:

Weed out the coconut garden as and when weeds appear.

2.2.12 Irrigation:

It is very important to water the seedling regularly and adequately during the first three

2.2.9 Fertilizers Schedules Recommendation for Young Plant

S. No.	Age of plant (year)	Nutrients dose	Quantity of fertilizers to be applied (g)		
			Urea	SSP	MOP
1	3 months after planting	1/4 adult dose	424	250	300
2	2nd Year	3/8 adult dose	637	276	450
3	3rd year	1/2 adult dose	650	370	600
4	4th year	3/4 adult dose	1275	555	900
5	5th year	full	1700	740	1200

SSP - Single Super Phosphate
 MOP - Muriate of Potash

years. During dry season irrigation once in 4 day for better growth and early flowering is to be done.

2.2.13 Care of Adult fruit bearing plant

After the young palm has reached the bearing stage they will continue to give regular fruit throughout the year and all through their productive phase which may extend to 60 year or more. But during this period higher level of productivity can be maintained consistently only by devoting proper attention to the manuring.

2.2.14 Manuring

- ▲ Annual basal dressing of compost at 20 to 40 kg per palm is necessary for obtaining better result.
- ▲ Adequate quantity of organic manure like compost supplemented with recommended dose of inorganic fertilizers is the best combination for an adult bearing coconut palm
- ▲ One to two kg of sodium chloride (common salt) per palm per year may prove useful in light soils and in area receiving good rainfall but not suitable for heavy soil type and in alkaline soils.
- ▲ The fertilizers of adult dose as shown in table (1.9)

2.2.15 Fertilizer Application Technique

- ▲ Fertilizers should be applied only when soil has optimum moisture in soil and when there is no possibility of the applied nutrients being washed out in the rains
- ▲ In case of bulky organic manures, the best time for application for manure is during monsoon when there is sufficient moisture in soil to facilitate normal decomposition
- ▲ Among the primary nutrients, nitrogen and potash have maximum influence on growth and fruit setting in coconut palm.

2.2.16 Irrigation and Drainage:

In the West Coast condition irrigation is to be given once in 10 days during summer in red and sandy loam soil and in lateritic soil once in 5 days.

2.2.17 Insect pest Management

The coconut palm in the different stages of growth is prone to the attack of number of pests.

The most common pests given are:

Rhinoceros Beetle: This pest is very common in all the coconut growing states. The adult beetle bore into soft tissue of the bud by cutting and chewing the tender unopened leave and inflorescence and damages entire inflorescence

Management: Mechanical removal of the beetle using a metal hook.

Leaf leveling the inner most 2-3 leaf axil around the spindle with mixture of Sevidol; Linden / Savin with fine river sand 200gm / tree during May, September, December.

Leaf axil feeling with naphathelin ball 10.5g / palm to repel the beetle.

Red palm Weevil: This is also a most dangerous pest of the coconut palm. The damage caused by grubs which spend all the time inside the palm feeding on the soft tissues.

Management: Trapping of adult weevil using installation of pheromones traps is recommended (1 trap/ha).

Injection of carbarly at 1 % (10 g/ltr) concentration into the stem is found to be very successful to control of pest.

Rat Damage: The rats enter the crown of palms and burrow the immature nut and eat soft materials. The attacked nuts are damaged and are eventually shed.

Management: Use of poison baits is considered more effective than other control measure

2.2.18 Disease Management:

Bud Rot: Bud rot is fatal disease of the coconut palms characterized by the rotting of terminal bud and surrounding tissues. Young palm are most vulnerable. The disease is severe during monsoon when the relative humidity is high

Management: Spray with 1 % (10 g/ltr) Bordeaux mixture or regular spray with any other copper fungicides at 40 days interval especially before and after monsoon is an effective preventive measure

2.2.19-Inter and Mixed cropping

A well spaced in coconut garden provides

adequate inter-space where it is possible to grow a variety of inter crops both seasonal and perennial.

But excessive inter crop cultivation in the gardens is to be avoided as these operation are likely to damage the root system and cause a depletion of soil fertility status.

- ▲ The common intercrops that can be grown during the pre-bearing or the early stage of growth of palm are pine apple, banana, groundnut, chillies, yam, tapioca, sweet potato and other root crops, turmeric, ginger.
- ▲ The common intercrops for older plantation are cocoa, pepper cinnamon, clove, nutmeg, etc.

2.2.20 Yield:

National average yield is 40 nuts per palm per year. But 100-180 nuts per palm per year can be easily obtained under good management practices.

3. CASHEWNUT

3.1 Nutrient deficiency symptoms and their corrective measures

3.1.1 Potassium Deficiency Symptoms

- ▲ Symptoms begin as a pale yellow lesion on the tip of old leaves and cover marginal tissues.
- ▲ Severe symptoms will lead to the whole leaf becoming brown in color.



Plate 8: Potassium deficient leaf showing marginal yellowing and drying of leaf tip.

Likely to occur in:

1. Soil having low organic matter
2. Sandy soil where potassium is leached by heavy rainfall or excessive irrigation
3. Soil with acute saline condition
4. Acid soil having pH below 6.0

Correction Measure:

Soil application of Potassium Chloride @ 2kg / tree / year

3.1.2 Molybdenum Deficiency

Symptoms:

Yellowish blotch in entire old leaves .The leaves become entirely yellow and defoliate.

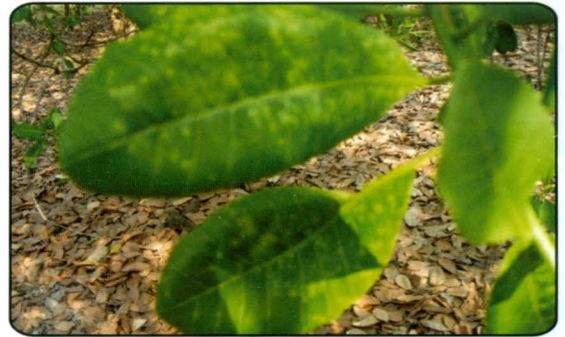


Plate 9: Molybdenum deficient leaf showing Yellowish blotch in entire old leaves

Likely to occur in:

1. Sandy soil that have been leached by heavy rainfall or excessive irrigation
2. Soil having excessive quantity of Calcium and Potassium

Correction Measure:

Soil application of Sodium Molybdate @ 250g / tree / year.

3.1.3 Zinc Deficiency Symptoms:

Symptoms will appear in young leaves, Occurrence of yellowish blotch in leaf, younger leaves remain small.

Likely to occur in:

1. Sandy soil that have been leached by heavy rainfall or excessive irrigation
2. Excessive application of Phosphorus in soil.
3. Alkaline soil having pH more than 7.5

Correction Measure:

Foliar spray of Zinc Sulphate @0.5% (5gm / ltr)



Plate 10: Zinc deficient leaves showing yellowish blotch on entire old leaves

3.2 Cultivation Practices for Cashewnut Cultivation

Cashew is one of the most important plantation crops in India. It is cultivated widely throughout tropics for its kernel. Before establishment of a cashewnut orchard, careful planning is a must because it is a perennial crop, requiring long term investment. Therefore, scientific recommended production practices need be followed.

3.2.1 Field Management

For the planting of new orchards, the land has to be cleared of thorny bushes, shrubs and other weeds well before the premonsoon shower (April to May).

3.2.2 Pit Preparation

- ▲ Normal Planting in square system: pits of 60 x 60 x 60 cm size a spacing of 7 x 7m (200 grafts / ha)
- ▲ High Density Planting System in square system: pits of 60 x 60x 60 cm size a spacing of 5 x 5m (400 graft/ha).

3.2.3 Varieties

Vengurla -4, Goa-1 (Balli-2), Vengurla-7, Vengurla-8, Tiswadi-2 (Goa-2), Bhaskara

3.2.4 Planting time and method

- ▲ The most ideal time for planting under rainfed conditions is second fortnight of June to July. Planting during this season ensures better establishment of graft in the field.
- ▲ Planting can be done any time under irrigated conditions 9 -12 months old grafts should be used for planting.

3.2.5 Soil conservation:

The continuous contour trench with or without vegetative barriers should be adopted in case of sloppy land

3.2.6 Manure and Fertilizer Application

Cashew responds well to fertilizers application. The schedule for different age group is as given 3.2.6:

3.2.6 Manure and Fertilizer Application

Age (Year)	Manure	Nutrients (g/tree/year)			Fertilizer (g/tree/year)		
		Compost / FYM (Kg)	N	P ₂ O ₅	K ₂ O	Urea	Rock Phosphate
1	15	250	50	50	500	175	85
2	30	500	100	100	1000	350	165
3	40	750	200	200	1500	750	330
4 and onward	50	1000	300	400	2000	1500	660

FYM - Farm Yard Manures

3.2.7 Inter cultivation

- ▲ First four years suitable inter crops can be grown in the interspaces in cashewnut plantation of regular spacing under mild undulated or plain fields.
- ▲ Groundnut, cucurbits bhendi, turmeric, ginger, chillies can be cultivated to get income during juvenile period of plantation
- ▲ Pineapples can also planted as inter crops in the initials year.

3.2.8 Plant Protection

- ▲ **Major Pest:** Tea mosquito bug (TMB) and Cashew stem and root borer (CSRB)
- ▲ **Minor Pest:** Thrips, Leaf Minor, Fruit and Nut Borer and Mealy Bugs

Management of Tea Mosquito Bug

- ▲ Spray Nimbicide 1%(10 gm / ltr) during new flushing stage in (November to December)
- ▲ Spray Carbaryl 0.2% (2 gm / ltr) during flowering stage in (January to February)

- ▲ Spray Chloropyriphos 0.1% (1ml / ltr) at fruit setting stage in (February to March)

Management of cashew stem and root borer

- ▲ Mechanically remove the grubs from the infected trees and destroy
- ▲ Inject 0.30 % Monocrotophos (3ml / ltr) by padding method.
- ▲ Drenching of stem upto 1m height with Chloropyriphos 0.1% (1ml / lit)

3.2.9 Yield performance of cashewnut

It is advisable to harvest fruit from fourth year onwards, before which flowers if any may be removed to encourage proper vegetative growth

The harvesting commences from February and continues till May.

3.2.9 Yield performance of cashew over the years

Age of Tree (Year)	Nut yield	Apple yield	Yield per ha (tonnes)	
	(Kg / tree)	(Kg/tree)	Nut	Apple
4 th	0.5	3.5	0.1	0.70
5 th	1.0	7.5	0.2	1.40
6 th	2.5	17.5	0.5	3.50
7 th	5.0	35.0	1.0	7.00
8 th	7.5	60.0	1.5	10.00
9 th	10.0	70.0	2.0	15.00
10 th	12-15	85.0	2.5-3.0	15.0-20.0

About 10-15 kg per tree (2-3 tonnes/ha) of row nut yield may be expected at 10 year and onward and about 70-100 kg per tree (15-20 tonnes/ha) of cashew apple yield may be expected.

4. Arecanut

4.1 Nutrient deficiency symptoms and their corrective measures

4.1.1 Nitrogen Deficiency Symptoms:

- ▲ Plants are stunted and generally yellowing of lower leaves.
- ▲ Older leaves show golden yellow color.



Plate 11: Nitrogen deficient leaf showing marginal tip yellowing and dying of leaf tip.

Correction Measure:

Foliar application of 2% (20 gm / ltr) urea thrice at fortnightly interval or soil application of 1-2 kg urea/tree

4.1.2 Potassium Deficiency Symptoms:

- ▲ Symptoms first appear on older leaves and later spread to younger leaves.
- ▲ Translucent yellow or orange spots develop on leaflets. The tree appears yellow, the trunk become slender with few short leaves.
- ▲ Leaflets with necrotic areas along the margins which later wither off.



Plate 12: Potassium deficient leaf showing marginal yellowing and drying of leaf margin and leaf tip.

Correction Measure:

Soil application of Potassium Chloride at the rate of 1.3 kg/tree.

4.1.3 Magnesium Deficiency Symptoms:

- ▲ Broad light yellow band along the margin of older leaves, the center of the leaf remaining green.
- ▲ In severe cases leaflet tips may become necrotic.
- ▲ Older leaves become bronzed and show dry appearance.
- ▲ Leaflets show necrosis and turn to reddish brown with translucent spots.



Plate 13: Magnesium deficient leaf showing yellowing of leaflet

Correction Measure:

Soil application of Magnesium Sulphate at the rate of 1-2 kg/tree/year.

4.1.4 Copper Deficiency Symptoms:

- ▲ Reduced growth and dark green colour of leaves, twist malformed leaves.
- ▲ New leaves shrivelled, bushy growth.



Plate 14: Copper deficient leaf shows malformed

Correction Measure:

Foliar spray of Copper Sulphate @0.5% (5gm/ltr)

4.2 Cultivation Practices for Arecanut cultivation

Since arecanut palm is very delicate, the field should have protection from exposure to south western sun scorching by way of either hillock or tall evergreen trees. The land should have irrigation facility. Feasibility of drainage is another prerequisite where water table is high.

4.2.1 Varieties: Mangala, Sumanagla, Sreemangla, Mohitnagar

4.2.2 Planting time and method

- ▲ The spacing of 2.7m x 2.7m is ideal.
- ▲ About 10-12 months old seedling are used for planting
- ▲ May–June period with onset of monsoon is best time for planting
- ▲ Pit of 90cm x 90 cm x 90cm size are dug and filled with a mixture of top soil, farm yard manure and sand to height of 50-60 cm from the bottom.
- ▲ The seedlings are planted in the centre of pit covered with soil to collar level and firmly pressed.

4.2.3 The quantity of Manure / fertilizers recommended

Year of application	Nutrients dose (g/palm/year)			
	FYM	Nitrogen (N)	Phosphorus (P ₂ O ₅)	Potash (K ₂ O)
First	12,000	35	15	45
Second	12,000	70	20	95
Third onward	12,000	100	40	140

4.2.3 Manuring: Manuring is done around the palm in the basin 15-20 cm deep and 1 m wide

4.2.4 Seedling protection:

- ▲ Protecting the stem from sun scorching is important since plant once damaged can't be recouped
- ▲ Young seedling is best protected by raising banana crop during the early year. This also helps the farmers to get some income till the area palm starts giving revenue
- ▲ Palms are also protected by dry leaves of arecanut

4.2.5 Irrigation

- ▲ Arecanut is grown as a rainfed crop .In west-cost, watering once in 7 days during November-December, once in 6 days during January-February and once in 3 days during March-May.

Multiple Cropping: Multiple Cropping and intercropping in arecanut gardens provide additional income

- ▲ Cocoa is most popular for multiple cropping system.
- ▲ Black pepper trained on arecanut is another popular multiple cropping system component.
- ▲ Banana ,Pineapple elephant foot yam tapioca, sweet potato, ginger and turmeric are ideal crops for inter cropping depending upon the region where cultivated.
- ▲ The bunches are harvested when they are fully mature. By adopting good agricultural practices, yield can be expected upto 200q/ha.

5. Oil Palm

5.1 Nutrient deficiency symptoms and their corrective measures

5.1.1 Potassium Deficiency Symptoms:

- Yellowing and bronzing of leaves become twisted, wrinkled and spindly twigs.
- Smaller leaves, twigs die, scorching of leaf tips, small brown resinous spots on leaf.
- Small wrinkled spotted leaves.



Plate 15: Yellowing and bronzing of leaves

Correction Measure

- ▲ Soil application of Muriate of Potash @ 2kg/tree

5.1.2 Magnesium Deficiency Symptoms:

- ▲ Yellowish blotch near the base of leaf, midrib and the outer edge.
- ▲ The leaves become entirely yellow and defoliate.

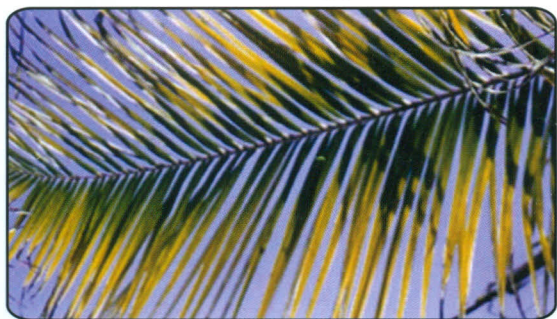


Plate 16: Yellowing of leaves

Correction Measure

- ▲ Soil application of Magnesium Sulphate @ 250g / tree

5.1.3 Boron Deficiency Symptoms:

- ▲ Young and newly developing leaves become deformed.
- ▲ Leaflets become abnormal which do not split as usual. Leaves have a serrated zigzag appearance.
- ▲ The apical shoot exhibits blackening and death.
- ▲ Sterilizing and malformation of reproductive structures.
- ▲ Low and abnormal fruits.



Plate 17: deformed young and newly developing leaves

Correction Measure

- ▲ Soil application of borax @ 0.5kg/tree/year

5.2 Cultivation Practices for Oil palm cultivation

Oil palm is the highest oil yielding plant among perennial oil yielding crops, producing palm oil and palm kernel oil. These are used for culinary as well as industrial purpose.

5.2.1 Preparation of Pit and Planting

- ▲ Oil palm seedlings can be planted during any season of the year under assured irrigation.
- ▲ Rainy season spanning from June to September is ideal for planting under rainfed conditions.
- ▲ If the planting has to be done during summer, ensure adequate source of water for irrigation.
- ▲ Cultivation of cover crops like Dhaincha reduces the intensity of summer heat and protects seedlings from severe sun scorching.
- ▲ Healthy seedlings of 12 to 15 months, with about 13 functional leaves and 1 meter height, disease free must be planted.

- ▲ The planting pits size is 60x60x60cm (length x width x depth).
- ▲ At the time of planting, apply following fertilizers properly in pit and mix :
- ▲ 250 g of DAP or 250 g of rock phosphate, 50 g of phorate
- ▲ 9m x 9m x 9m triangular planting will hold 143 plants in a hectare. Triangular spacing ensures proper spreading of canopy.

5.2.2 Management of Seedling Plants after Transplanting

- ▲ Basin management: During first year of planting, basin of 1m radius are to be made around the palms, remove the soils from inside so that the soil does not accumulate at the collar region.
- ▲ Basin has to widen to 2 m radius during second year and 3 m radius from third year onwards.
- ▲ Sunhemp seeds can be sown in the basin to reduce weed growth and evaporation, prevent wind speed and add N to the soil.

5.2.3 Weeding:

Basin area of oil palm is active zone of root which has to be kept weed free by hand weeding or by spraying Weedicide like Glyphosate @ 1.5 ml ltr.

5.2.4 Mulching:

It conserves soil moisture adds organic matter and nutrients. Mulching can be done with dried leaves and grasses.

5.2.5 Pruning:

All dead and diseased leaves should be pruned with the help of a sharp chisel by giving clear cutting close to stem.

5.2.6 Ablation:

Removal of male flowers to gain adequate stem girth, vigor and develop adequate root system in the initial period

5.2.7 Irrigation:

Oil palm requires sufficient irrigation. When water is not constraints, basin irrigation can be taken up once in 5 days or by drip irrigation should be taken four drippers are sufficient to discharge 150 to 200 litres within 5-6 hrs/palm.

5.2.8 Application of Fertilizers and Manure

- Nitrogen (N) is required for leaf production and increases the fruit bunches and yield.
- Phosphorous (P) helps to increase the fruit bearing bunches, weight of bunch and number of female flowers, good rooting and healthy growth.
- Potash (K) helps in increasing the female flowers, bunch weight and early maturity, enhances pest and disease resistance.
- 50 to 100kg of farm yard manure, 100kgs of green manure per plant. 5kgs of neem cake can also be applied per plant.
- Borax @ 100g/ palm/year is recommended when the deficiency symptoms are noticed

5.2.9 Common pest and diseases

- ▲ Rhinoceros Beetle

Management :

- ▲ Trapping the adults by using phermones traps.
- ▲ Place phorate 10G 3 gms mix with sand in innermost leaf axil two times at 6 months interval.
- ▲ Red Palm Weevil

5.2.8 Application of Manures and Fertilizers

Plant age (years)	Nutrients in gms / per plant / year				
	FYM	Nitrogen	Phosphorous	Potash	Magnesium
1st	12,000	400	200	400	125
2nd	12,000	800	400	800	250
3rd & onwards	12,000	1200	600	1200	500

Management :

- ▲ Truck injection of Carbaryl (Sevin) 50 % WP effective curative treatment.
- ▲ Bud Rot, Spear Rot are the major diseases of oil palm.

Management:

- ▲ Sprayed with Blitox - 3gm/ ltr.
- ▲ Rodents Porcupine damage the field planted seedlings up to 3-4 years of age and rats damage the seedlings and destroy the FFB's of oil palm.

Management:

- ▲ Orchard sanitation with poisons baiting (Aluminum Phosphate) mechanical barrier (fencing with barbed wire)
- ▲ Amongst the wild animals, Wild Boar, Bison damage the field planted palms.

5.2.10 Harvest and Yield

- ▲ Ripe and ready to harvest fruit bunches turn to attractive orange yellow colour and about 5-10% fruitlets drop down. When such fruits are pressed hard, orange red colored oil comes out.
- ▲ Harvest bunches with the stalk not more than 5cm long.
- ▲ Harvest at an interval of 7 to 15 days depending upon the season. They can be harvested within 6 to 7 days during rainy season since fruits ripen very quickly after severe summer.
- ▲ A sharp harvesting sickles attached to aluminum pipe/ultra light pole is needed to harvest fruit bunches from taller plants.

6. Tea

6.1 Nutrient deficiency symptoms and their corrective measures

6.1.1 Nitrogen Deficiency Symptoms

- ▲ Older leaves become yellow in color; size of the leaf will be affected.



Plate 18: Yellowing of older leaves

Correction Measure:

- ▲ Foliar spray of urea@1% (10 gm / ltr).

6.1.2 Phosphorus Deficiency Symptoms:

- ▲ Bronzing pigmentation seen in older leaves; stunted plant growth



Plate 19: Bronzing pigmentation in older leaves

Correction Measure:

- ▲ Foliar spray of DAP @ 1.0%

6.1.3 Potassium Deficiency Symptoms:

- ▲ Marginal chlorosis occur in old leaves.



Plate 20: Marginal chlorosis in old leaves.

Correction Measure:

- ▲ Foliar spray of Potassium Sulphate @1.0% (10 gm/ ltr)

6.1.4 Magnesium Deficiency Symptoms:

- ▲ Yellowing symptom seen in older leaves



Plate 21: Yellowing of older leaves

Correction Measure:

- ▲ Foliar spray of Magnesium Sulphate@1.0% (10 gm / ltr).

6.1.5 Sulphur Deficiency Symptoms:

- ▲ Yellowing of young leaves; elongation of leaf growth will be affected.



Plate 22: Yellowing of top leaves

Correction Measure :

- ▲ Foliar spray of Calcium sulphate @1-2% (10-20 gm / ltr).

6.2 Cultivation Practices for Tea cultivation

This is a very delicate operation and needs adequate planning and proper supervision. Correctly planted tea plants establish in the field quickly, grow vigorously and come into full bearing earlier.

6.2.1 Time of planting

Planting can be done in April-June and September-October or October-November with adequate irrigation. Periods of heavy rains should be avoided.

Only healthy plants 40-60 cm high with at least 12 good mature leaves and of pencil (0.5 cm) thickness (at collar) should be taken for planting in field. In general, 9 to 12 month old plants attain this stage.

6.2.2 Type of planting

There are two types of planting, i.e., pit planting and trench planting.

- ▲ **Pit planting:** Pits should be about 45 cm wide and 45 cm deep, circular and straight walled. The excavated soil is conditioned by mixing with 4-5 kg well-decomposed cattle manure or 150-200g well-decomposed oil cakes and returning the soil into the pits. No other manure is used except 30 g rock phosphate or 30g SSP at the time of planting.
- ▲ **Trench planting:** This method is adopted for closer spacing and in heavy soils. Trenches 30 cm wide and 45 cm deep are dug along the rows

6.2.3 Method of planting

There are two methods of planting, for plants raised in nursery beds. They are:

- 1) Bheti planting 2) Stump planting.

Spacing: About 14000-16000 (up to 17000 in hilly areas) plants per hectare have been found to be ideal bush population with spacing of 105-110 cm between rows and 60-75 cm between plants.

6.2.4 Young Tea management-

Various field management practices are followed in post-planting care to encourage early

establishment and vigorous growth of tea plants as well as to increase their radial spread and longevity.

1. After planting, the area should be mulched adequately with green vegetative matter leaving a 10 cm distance from the collar of the plants uncovered. Sowing of green crops, e.g., *Crotalaria anagyroides*, *Tephrosia candida*, *Priotropis cytisoides*, etc.,
2. The young plants should also be protected from pests and diseases using high volume sprays of suitable pesticides
3. Weed growth is most vigorous in young tea fields during April to October warranting adequate control measures.

4. Young tea fields should be adequately drained to avoid retention of excessive soil moisture and to promote root development.

6.2.5 Manuring of young tea

After planting as soon as the plants have produced two or three new leaves, they can be foliar sprayed with NPK or NK mixture at fortnightly intervals till the plants have produced 4-5 new leaves. Well-established plants can be manured with YTD mixture (NPK 10:5:10 or 10:5:15 depending up on soil available potash status) A general guide line is as follows:

6.2.5 Manuring of young tea

Age of planting (Year)	Nitrogen (kg/ha)	Manure (Kg/ha)	No. of splits	Application method
0 year	20-40	200-400	2-3	Ring
+ 1 year	80-100	800-1000	4	Ring
+ 2 year	100-120	1000-1200	4	Ring
+ 3 year	120-140	1200-1400	4	Ring
+ 4 year	140-150	1400-1500	2	Strip
+ 5 year	140-150	1400-1500	2	Strip

6.2.6 Bush Frame

In the young tea plants, formation of a proper frame is achieved by the following three operations:

- a) Decentering, lung prune, or debudding,
- b) Formative prune 20-26 months after planting
- c) Final Frame formation prune.

The objective of the first two operations above are to suppress centrally dominating apical growth.

The permanent frame is formed at a height, that will ensure optimum coverage of the ground as well as convenience in harvesting, by the pluckers.

6.2.7 Manuring of mature plant

It is important to ensure adequate replenishment of nutrients in the soil removed by harvest.

6.2.8 Time of manuring

The best time for fertilizer application is after the first rain in spring has moistened the soil to a depth of 45 cm.

6.2.9 Method of Manuring

Fertilizers are applied uniformly on the ground as broadcast. It is recommended to apply N and K fertilizers in two splits. The 60% of the dose of N and K should be applied in March-April (1st split) and the second split (i.e. the remaining 40%) should be applied in August-September.

Foliar nutrition: Foliar nutrition is beneficial under stress condition. NPK mixture 2-1-2 or 2-1-3 where potash status is low, @ 0.5-1 percent can be sprayed during this period.

6.2.10 Plucking

Plucking in tea is synonymous with harvesting in other crops. The tender apical portions of shoots consisting of 2-3 leaves.

Plucking systems

Three plucking systems are presently in vogue. They are:

- Janam plucking
- Fish leaf plucking
- Single leaf plucking

Plucking rounds

The time interval between two successive plucking is called plucking round. Plucking round may be extended from 4 to 14 days, but to keep a balance between crop and quality, normally 6-8 days plucking round is practised in North East India depending on the growth rate as well as quality of tea one desires to produce.

7.1 Cultivation Practices for Rubber cultivation

The natural habitat of Rubber is situated in the warm and humid tropic.

Rubber is very versatile in its adoption to a wide range of agroclimatic condition. South region Konkan region, Coromandal coast in the east. north western, north eastern and Andaman and Nicobar Island are potential area. The following mentioned management practices should be followed.

7.1.1 Planting Time and Method

1. Planting will start with first rains received just before the south west monsoon.
2. Soil and Water conservation technique during the first year
3. The planting density should be around 420-445 trees per hectare.
4. Pit of 75x75x75 or 90x90x90 cm size are filled with top soil
5. The base of young plants in the field should be mulched using dried leaves, grass or cover crop.
6. Mulching should be done leaving 5 to 7.5 cm from the plant base.
7. Mulching will help the plants to protect the plant base from scorching in the severe summer.

After planting, care should be taken to ensure that no sprout will develop from the root stock portion and that only one strong shoot of the scion is allowed to grow.

7.1.2 Manure and Fertilizers

While preparing the nursery beds 25 kg of compost and 3.5 kg of rock phosphate are incorporated into the nursery bed at 10 m². Six to eight weeks after planting 25 kg NPK mixture (10:10:4). During pit filling 12 kg compost and 150 gram rock phosphate per pit incorporated into the soil.

7.1.3 Diseases:

- In powdery mildew, disease-prone areas, arrangements for procuring sulphur and servicing the dusters may be made in advance of the wintering.
- Branches dried due to pink disease should be cut and the cut surface be applied with Bordeaux paste.

7.1.4 Weed Control:

About 4-5 Hand weeding are required during first 2 years.

7.1.5 Irrigation:

Rubber is mainly grown as rainfed crop. However the minimum life saving irrigations in early years are to be given.

7.1.6 Harvesting and Yield :

Latex produced in the bark tissues is harvested yield. By adopting best management practices yield upto 2,400 kg/ha/year can be expected.

7.1.2 Fertilizers schedules for Rubber

Year of Planting	Time of Application	Amount of NPK (2:12:6) (g/plant)
First	April - May	280
Second	September- October	500
Third	April - May	500
Fourth onward	September- October	600

8. Coffee

8.1 Nutrient deficiency symptoms and their corrective measures

8.1.1 Nitrogen Deficiency Symptoms

^ Older leaves become yellow in color; reduced leaf size

Plate 23: Yellowing of older leaves

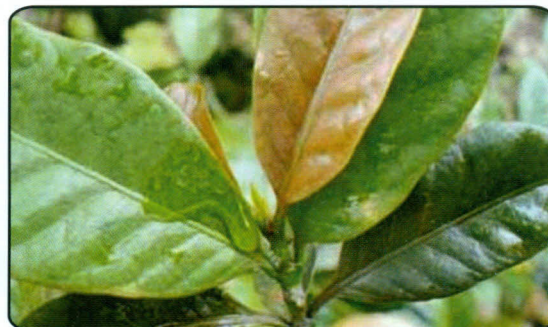


Correction Measure:

^ Foliar spray of urea@1% (10 gm /ltr).

8.1.2 Phosphorus Deficiency Symptoms:

^ Pink or purple pigmentation appear in old leaves
Plate 24: Pink or purple pigmentation appear in old leaves



Correction Measure:

^ Foliar spray of DAP (Diammonium phosphate)@ 1.0% (10 gm/ltr)

8.1.3 Potassium Deficiency Symptoms:

- ▲ Occurrence of marginal chlorosis in older leaves



Plate 25: Occurrence of marginal chlorosis in older leaves

Correction Measure:

- ▲ Foliar spray of Potassium Sulphate @1% (10 gm/ ltr)

8.1.4 Magnesium Deficiency Symptoms:

- ▲ Characterized narrow band of marginal chlorosis of leaves turning into necrotic fallow. Leaves become small, growth shunted. Youngest leaves with thickened. Midrib interveinal and marginal chlorosis.



Plate 26: Magnesium Deficiency Symptoms

Correction Measure:

- ▲ Foliar spray of Calcium chloride@1-2% (10 gm / ltr - 20 gm / ltr).

8.1.5 Boron Deficiency Symptoms:

- ▲ Young and newly developing leaves become deformed called as little leaf. The apical shoot exhibits blackening and death. Sterilizing and malformation of reproductive structures. Few and abnormal fruits.



Plate 27: Magnesium Deficiency Symptoms

Correction Measure:

- ▲ Foliar spray of borax 0.2% (2gm / ltr).

8.2 Cultivation Practices

Coffee (*Coffea canephora* / *Coffea arabica*) belonging to family Rubiaceae is the important beverage raking second among the trade commodities.

Commercially production of coffee comes from two spp. viz., (*Coffea canephora* / *Coffea arabica*) popularly know as Arabica coffee and Robusta Coffee

8.2.1 Soil and climate

The deep well drained slight acidic in reaction and rich in organic matter content soil are good for coffee plantation. Most of hilly and forest soil is suitable for its cultivation in India especially in South India. It is well grown under shade of forest cover. The well distributed rainfall and good shade of evergreen/trees are suitable for coffee cultivation.

8.2.1 Soil and climate requirement

Parameter	Arabica	Robusta
Elevation (M)	1000-1500	500-1000
Annual Rainfall (mm)	1600-2500	1000-2000
Blossom Rain	March- April (25-40 mm)	February- March (20-40 mm)
Backing rain	April- May (50-75 mm)	April-May (50-75)
Shade	Medium to light shade	Uniform thin shade
Temperature	15-25°C	25-30°C Ideal Hot Humid
Relative Humidity	70-80 %	80-90 %
Soil	Deep friable,porous reach in organic matter moisture retentive slightly acidic	Deep friable,porous reach in organic matter moisture retentive slightly acidic
Aspect	Northern and eastern	Flat to gental slope

8.2.2 Varieties

Many varieties and hybrids in coffee have been developed and recommended for cultivation, some of them are given below:

1. Arabica Varieties S.5, S.6, S.7, S.8, S.9, S.10, Cauvery
2. Robusta Varieties Sel-1 R (S 274) Sel-2 R (S 270) Sel-3 R (S 274)

8.2.3 Propagation

Generally coffee is propagated through seeds. Of late in Robustas, clonal propagation through rooted cutting and grafting is also being practiced.

8.2.4 Raising and Nursery

Seed beds of 6m x 1m size raised 15 cm from ground level are prepare under a overhead pandal,using a mixture of well sieved forest soil FYM and Sand in 6:2:1 proportion. Seed are usually sown during December-January at a distance of 2.5 -3.0 cm in regular rows and covered a thin layer of finely sieved soil. The bed is mulched with paddy straw and watered

daily. Seeds germinate in 40-45 days under optimum condition. The seedling at button stage (before opening of cotyledonary leaves) are transplanted to secondary nursery or polythene bags (22.5 cm x 15 cm) finely filled with forest soil FYM and sand in 6:2:1 proportion and arranged in bamboo pandal with regular watering with a pinch of urea in each bag. The polybags seedling attains 5-6 pairs of leaves in about 6 months and become ready for planting.

8.2.5 Planting and Aftercare

For planting, pits of 45 cm x 45 cm x 45 cm size are dug after first summer showers. The pits should be exposed for weathering for 15-20 days then closed with top soil, FYM @ 1 kg per pits with small quantity of rock phosphate is essential.

Healthy and vigour's seedling (6-8 months old) are selected for planting during monsoon (July to September) in centre of pits .Seeding should be protected from sun-scorch with cut branch of shade trees.

Spacing is varied from variety to variety. The optimum plant spacing is '6x6', '7x6', '7x7' and '5x5' semi dwarf and tall varieties of Arabica group. Whereas 10'x10' for S274, 8'x8' or 9,x9, for CxR varieties of Robusta group are ideal for better growth and development

8.2.6 Training and Pruning

Training of coffee bush is essential to build up a strong framework which promotes the production of bearing wood for subsequent years. Generally two type of training viz, Single stem and multiple stem training are adopted for coffee.

Pruning is thinning process which not only induces better productive efficiency in the plant but also help in regulation and prevent over bearing. Pruning is commenced after harvesting (June-July and August –September).

8.2.7 Fertilization

Coffee, being a perennial crop, optimum nutritional supply is essential to cope with the twin function of berry development and fresh wood growth for succeeding crop concurrently. To get one ton clean coffee, 12:90:120 kg and 80:60:80 kg NPK/ha (3-4 splits in (pre-blossom, mid monsoon and post monsoon application) is adequate for Arabica and Robusta coffee plantation respectively, in an unit area. Foliar application of nutrients (1 % urea or 2 % DAP, 1% SSP, 0.1 % MOP, 0.25 % Zinc sulphate) in addition to soil application during cropping year is proved beneficial.

8.2.8 Disease and Insect Management

8.2.8.1 Disease Management

Leaf Rust: Small pale yellowish spots are first appearing symptoms. These spots soon increase in size

8.2.7 Fertilization

Coffee (Age)	Pre- Blossom			Post- Blossom			Post Monsoon		
	March			May			August		
	N(Kg/ha)	P(Kg/ha)	K(Kg/ha)	N(Kg/ha)	P(Kg/ha)	K(Kg/ha)	N(Kg/ha)	P(Kg/ha)	K(Kg/ha)
1 year	15	10	15	15	10	15	15	10	15
2year	20	15	20	20	15	20	20	15	20
3year	30	20	30	20	20	20	30	20	30
4year	40	30	40	40	30	40	40	30	40

Source: Peter, KV (2002) Plantation crops, National Book Trust India, New Delhi.

and number. Later many spot coalesce and entire leaves yellowish-orange with spot mass and later form necrotic spots. Defoliation is common in affected plants.

Management:

Bordeaux mixture 0.5 % (5 g/ltr) spray during pre-monsoon (May-June) plantvax20 EC (0.03 %), followed by mid July-august and post monsoon

(September-October) spray either any one of these to control this disease.

Black Rot or Koleroga (Koleroga noxia):

Blackening and rotting of affected leave, wings and developing berries are seen in infected plants. Affected leave get detached from branches.

Management :

Spray Bordeaux mixture 1 % (10 g/ltr).

8.2.9 Insect management

Coffee berry borer larva feed on the beans making small tunnels. Its damage both young and ripe berries

Time and complete harvesting, collection of gleanings, burying infested berries and maintain optimum shade and good drainage are phytosanitary measure to prevent the infestation.

Spray of Quinalphos 25 EC @ 340 ml/200 lit or lamda cylothrin 5 EC 120 – 160 ml / 200 lit. to control this insect

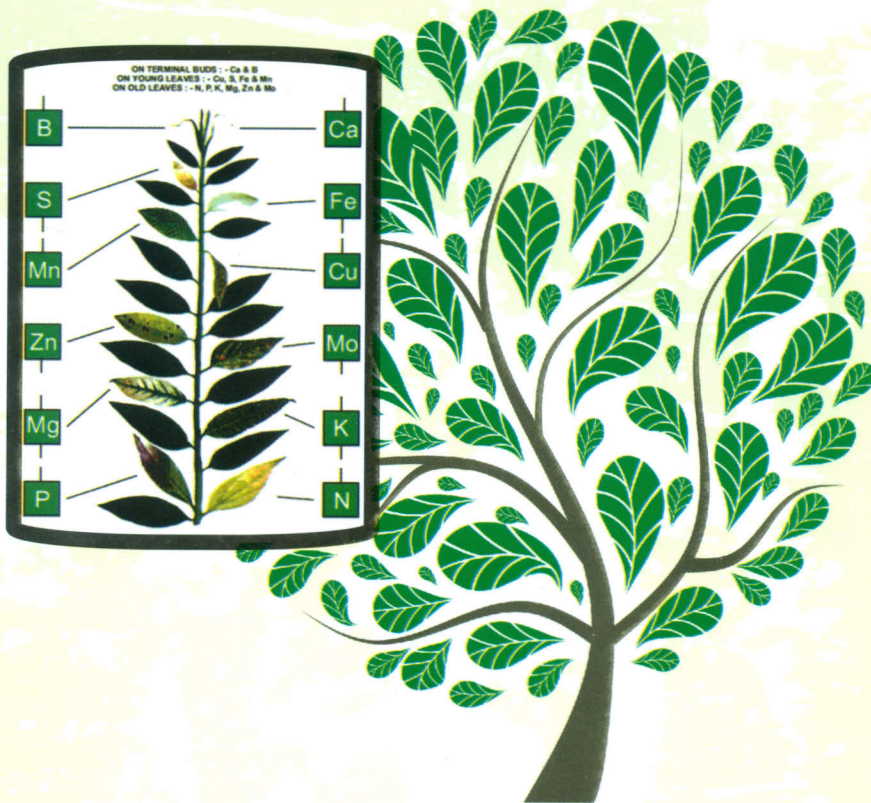
Harvesting and Yield :

Coffee start yield from fifth year onward but full yield obtained only after 10-12 years .An average yield of 1.25 tonnes/ha can be obtained from moderate plant stand .The yield can be increased up to 2.25 to2.50 tonnes / ha from a well maintained plantation.

Suggested Readings / References :

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