UNIT 1 : INTRODUCTION TO TEA AND ITS CULTIVATION

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 Beginning of Tea Cultivation in India

1.4 The Tea Plant and its Cultivation

- 1.4.1 Classification of Tea
- 1.4.2 Cultivation of Tea Plant
- 1.4.3 Types of Manufactured or Made Tea

1.5 Indian Tea Industry: Production, Consumption and Export

1.6 Small Scale Tea Cultivation in Assam

1.7 Tea Cultivation in Non-Traditional Areas and Other N.E. India States

1.8 Tea Industry and its Role in the National Economy

1.9 Developmental Agencies

1.10 Let Us Sum Up

1.11 Answers to Check Your Progress

1.12 Model Questions

1.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- describe the introduction of tea cultivation into Assam
- describe the different species or types of tea plants
- explain the nature of the tea population under cultivation
- name the tea growing countries of the world and the areas under tea
- list the tea growing states of India
- describe the emergence of the small tea growers in Assam
- discuss the status of small scale tea cultivation in Assam and other N. E. states.
- role of tea industry in the national economy.

1.2 INTRODUCTION

Tea is one of the important beverages and it is drunk by about one third of the population of the world today. Presently, it is considered to be one of the most common and cheapest beverages, which is consumed in more than 65 countries worldwide where people drink 4 billion cups in daily morning. Tea drinking originated in China where initially it was used as medicinal drink and later on as a beverage. In our country, particularly the hill tribes of the North East India drank tea from the ancient past in different forms. This beverage is processed from the young tender leaves of the tea plant. The scientific name of the tea plant is *Camellia sinensis* (L).O.Kunt'ze.

In this unit, we shall discuss the introduction of tea into India, the tea plants and its classification, the tea growing countries of the world and the states of India, the small scale tea cultivation in Assam and its current status and the role of tea industry in our national economy.

1.3 BEGINNING OF TEA CULTIVATION IN INDIA

The British East India Company started tea cultivation in India by importing seeds from China. However, it was not successful. The commercial tea cultivation was successful only after the discovery of the indigenous Assam tea plant in different parts of the then greater Assam viz., the present Mizoram, Nagaland, Manipur and the adjoining areas bordering Myanmar. The indigenous tea plants in India were first discovered by Robert Bruce in the Brahmaputra valley in 1823 when Besa Gam, a Singpho Chief, presented him a few tea plants. Another Assamese noble, Dewan Maniram Dutta Baruah, brought the plant to the notice of Robert Bruce during his visit to Rangpur in 1823. Commercial tea plantation started under the patronage of the East India Company in 1834. Assam tea was first sent for auction in London in 1838 which was sold in the London Auction on 10th of January, 1839. In the year 1839, the first tea company, the 'Assam Company' was established. Since then many tea plantations have flourished under the corporate sector. Although tea was cultivated in China in the ancient past, yet the tea plant had attained the status of a plantation crop only after its

introduction to India. Today, tea is one most important plantation crops in India and the tea industry is one of the finest agro-based industries in our country playing an important role in our national economy.

1.4 THE TEA PLANT AND ITS CULTIVATION

Tea is an evergreen woody perennial plant. From the tender young shoots of the tea plant the beverage, tea is processed.

1.4.1 Classification of Tea

The taxonomists describe the tea plant as *Camellia sinensis* (L.)O.Kuntze, with the implication that all the tea varieties belong to one species.

Tea plants are classified into three different species. They are:

i) Assam tea *(Camellia assamica)*
ii) China tea *(Camellia sinensis)* and
iii) Cambod tea *(Camellia assamica* sub sp*. lasiocalyx*)

Assam tea plant : Assam tea plant under natural condition is a small tree which is about 10-15 m tall with a trunk sometimes up to one third of its height. It possesses a robust branch system. In typical plants, the leaf is droopy, thin, glossy or shining with more or less acuminate apex and distinct marginal veins. Leaf blades are usually 8-20 cm long and 3.5 -7.5 cm wide and light green to dark green in colour.

China tea plant : It is a big shrub; 1-3 m tall with many virgate stems. The leaf is hard, thick and leathery. The surface is mat (dull surface which is not shining), marginal veins are indistinct. The leaf blades of China tea plants are elliptic–oblong or obovate-oblong and dark green in colour. Petioles are short, 3-7 mm long, stout, usually giving the leaf an erect pose.

Cambod tea plant : Cambod tea plant is a fastigate tree, 6-10 m tall with several upright almost equally developed branches. The



Virgate stem : Straight or slender stem arising from the base of the tree near ground level. Typical China tea plant is multi-stemmed shrub with numerous virgate stems.

Fastigate stem : Fastigate means strictly erect and more or less parallel. Cambod tea by habit is a fastigate tree, with more or less equally developed ascending main stems.

leaves of this species of tea plant are more or less erect, glossy, light green in colour, occasionally pigmented with anthocyanin. In size the leaves are intermediate between China and Assam tea plant leaves.

However, the tea plants which are under cultivation at present are the natural hybrids of the three species or races, mainly of Assam and China tea. The hybrids are the result of the free pollination among the three races over a longer period as tea is a cross pollinating crop. In the existing tea population, we find a wide range of phenotypes, some resembling morphologically the Assam and the other the China variety. In fact, there exists no pure form of either China or Assam or Cambod tea. That means, all the tea plants under cultivation are hybrids plants. These hybrids are designated either China hybrids or Assam hybrids on the basis of their morphological closeness to one or the other principal type or cultivar. The Cambod tea is the intermediate between the Assam and China variety. Natural hybrids had their own limitations for both quality and yield. The present planting materials used in cultivation are the clones selected from the natural hybrids or the clonal seeds produced by hybridization using two clones. This is discussed under Planting Materials of tea in unit 3.

1.4.2 Cultivation of tea plant

We have come to know that habitually, tea plants are a small tree or a shrub. But when we cultivate it for commercial use, the plant is trained to form a low spreading bush for the production of green leaves. Because the young tender shoots is the economic yield of tea. Therefore, when tea is cultivated the management practices are directed to induce the plant to produce more and more tender shoots.

Presently, tea is cultivated in more than 55 countries of the world. Different species of tea plants are grown in different situations.

The Assam type tea plants are grown in hot, humid and warm countries. But the China plants are suitable in cold climate. In India, the China hybrid teas are cultivated in high elevation areas like Darjeeling, Nilgiri hills, Kangra valley etc. In Assam and in the plain areas, the tea plants suitable for cultivation are the Assam and the Cambod types.

The major tea growing countries of the world and the areas under tea cultivation are shown in Table 1.1.

Table 1.1 : Major tea producing country in the world

Country	Production (Million kg)
China	3063
India	1343
Keniya	537
Sri Lanka	299
Vietnam	180
Indonesia	127
Others	904

Source: Tea Board of India, 2021

The cultivation practice of tea varies from place to place. The cultivation practices in Japan or China are different from that of Assam. Even the cultivation practices in Darjeeling and South India are different from what we practise in Assam. This is because of the climatic conditions and the products or types of tea that are produced.

It is, therefore, essential to have some basic knowledge of the cultivation of tea on a scientific basis. Being a perennial crop and that too a crop of international importance, the tea growers should have a thorough knowledge about tea cultivation.

1.4.3 Types of Manufactured or Made Tea

Basically three types of made tea are processed. These are the Black, Green and Oolong tea.

Black tea : It is also called fermented tea. The fundamental process

in processing black tea consists of a series of oxidation and condensations of certain substances present in the green leaves mainly the polyphenols. During the process of black tea manufacture, the polyphenols are oxidized to form two coloring products, theaflavins (TF) and thearubigins (TR). These along with the caffeine present in tea leaves give the characteristic properties of black tea.

There are two types of black tea manufacture-Orthodox and CTC.In orthodox manufacture, the green leaves are withered, lightly rolled in rolling machine for initiating fermentation (oxidization) and then dried. In CTC manufacture, the rolling is more severe and the leaves are passed through the CTC machine to cut the leaf mass into small bits. The tea liquor is much thicker and yields much more cuppage. Whereas orthodox tea gives 250 cups per kg, the CTC tea produces more than 500 cups per kg.

Green tea : The green tea is not an oxidized (fermented) product and bears little similarity to black tea. The chief feature in the manufacture of green tea is that the polyphenol oxidase, the enzyme that oxidizes the polyphenols, is deactivated by steaming the green leaves. The colour of green tea liquor is greenish or lemon yellow, with no trace of red or brown colour.A green tea infusion delivers up its caffeine more quickly than one of black tea, and it contains more polyphenolic bodies than a black tea infusion, but these substances are colourless and unoxidised.

Oolong tea : It is also called semi-fermented tea with a unique flavour. In preparing oolong tea, the green leaves are given a brief wither in the sun for an hour or so; then after cooling, the leaves are lightly manipulated by hands till they turn red and develop a slight fragrance. After a short fermentation the process is stopped by roasting it in a hot iron pan.

1.5. INDIAN TEA INDUSTRY: PRODUCTION, CONSUMPTION AND EXPORT

Traditionally, tea has been mainly grown in Assam, West Bengal, Kerala, Tamil Nadu, Karnataka, Himachal Pradesh and Tripura. However,

tea has been introduced to many non-traditional areas like Orrisa, Uttarakhand and the hill states of the entire North East India. Though the industry is dominated by the corporate sector, of late, the common farmers have introduced tea as a cash crop in their farming systems. Of course, tea has been growing in South India and Himachal Pradesh in small scales by the growers from the past. Not only in India, in many tea growing countries of the world like Japan, China, East African countries, tea is still a peasant crop and are grown in small holdings. Of late, small scale tea cultivation by the common farmers in Assam has gained popularity and has proved to be a successful venture.

The different tea Producing states of India and the production of tea are shown in Table 1.2.

State	Production('MKg)
Assam	696.67
West Bengal	420.91
Others	30.14
Subtotal	1147.72
South India (Total)	225.65
TOTAL	**1373.37**

Source: Tea Board of India (2022-23)

India is the second largest producer of tea globally. Northern part of India is biggest producer with maximum production coming from Assam followed by West Bengal.

If we look in to the tea consumption rate of India, then around 80 perent of tea produced in the country consumed by domestic people. However, India is also among the top five tea exporting countries in the world accounting for around 10 percent of global export. In the year 2022, India exported around 227 million kgs of tea. Assam, Darjeeling and Niligiri teas are considered one of the finest tea in the world. The majority of tea exported from India is black tea which makes up to 96 % of total export. tea has been introduced to many non-traditional areas like Orrisa, Uttarakhand and the hill states of the entire North East India. Though the industry is dominated by the corporate sector, of late, the common farmers have introduced tea as a cash crop in their farming systems. Of course, tea has been growing in South India and Himachal Pradesh in small scales by the

growers from the past. Not only in India, in many tea growing countries of the world like Japan, China, East African countries, tea is still a peasant crop and are grown in small holdings. Of late, small scale tea cultivation by the common farmers in Assam has gained popularity and has proved to be a successful venture.

The different tea growing states of India and the area under tea are shown in Table 1.2.

Table 1.2 : Tea growing Areas of India (as in 2021)

State	Area	Production (MKg)
Assam	232961.73	672.14
West Bengal	114479.37	408.73
North India	359557.03	1113.04
South India	61903.67	231.36
Others		32.17
Others	2,141	28.52
Tripura	8,962	7,856
TOTAL	**5,78,458**	**1283.03**

(Source: Tea Board, India)

Of the major tea producing states of India, Assam alone produces nearly 53 percent of the total tea produced in the country.

1.6 SMALL SCALE TEA CULTIVATION IN ASSAM

The concept of small scale tea cultivation in Assam made its appearance during the seventies of the last century, although small scale tea plantation was a popular venture in south India and Himachal Pradesh even in the past. It became the popular farmer's crop during the nineties of the last century. Presently, small scale tea cultivation has become a common phenomenon in all the districts of Assam and it is playing an important role in the growth of tea industry in the country. Small scale tea cultivation was started in Assam in 1975 and it gained momentum during the mid 90's due to the prevailing high prices of tea at that time.

A small tea grower has been defined by the Tea Board of India as a

person who is having tea plantation area up to 10.12 ha.

Its Development : Tea entered into the fields of the common farmers in Assam during the later part of the seventies of the 20th century, though the tea industry has been prevailing since 1840 under the corporate sector. An advisory programme was started in 1988 under the Department of Tea Husbandry & Technology, Assam Agricultural University to provide technical knowledge and skill to the small farmers who took up tea cultivation. The university extended all possible technical help to the tea growers by holding regular training programmes at the university as well as in the grower's field providing advisory services and publishing guide books and extension bulletins. Subsequently, the Tea Board, India, provided financial assistance to the University for the Programme. The Tea Board also opened an advisory service to the small tea growers at the Tocklai Experimental Station, Tea Research Association, Cinnamara.

With the increase in the number, the growers became united and formed the All Assam Small Tea Growers Association which has been working for the development and welfare of the small tea growers since its inception.

Present status : Within a short period of time, the small scale tea cultivation has become a popular farmer's crop not only in Assam but also in all the NE Indian states including Sikkim. In Assam, tea is now cultivated in almost all the districts of the state. The prevailing suitable soil and climatic conditions and availability of the infrastructure facilities for tea cultivation have encouraged the common farmers to take up tea as a profitable cash crop. At present there are more than 65,000 small tea growers in Assam contributing nearly 25 per cent of the total tea production of Assam.

The major concentration of the small tea growers in Assam is confined to the five upper Assam districts *viz.,* Tinsukia, Dibrugarh, Sibsagar, Jorhat and Golaghat (Table 1.4). More than 80 percent small tea holdings are in these five districts. The other districts where small tea growers are seen are Nagaon, Mariagaon, Darrang, Kamrup, Karbi Anglong, Goalpara, Lakhimpur, Dhemaji, Dhubri, Odalguri, Nalbari, Bongaigaon and Kokrajhar.

Table 1.3 : Distribution of Small Tea Growers in different Districts of Assam

District	No. of Small Tea Grow
Tinsukia	23,511
Dibrugarh	26,724
Sibsagar	4,952
Charaideu	10,522
Golagaht	13,578
Jorhat	**8713**
Sonitpur	3877
Biswanath	10,739
Lakhimpur	3006
Udalguri	7519
Other	8534
Total	**1,21, 675**

(Source: Statistical Handbook, Assam 2023)

Status of the small scale tea sector of Assam :

- The number of the small tea growers in the Sate is around 1.22 lakhs.
- Samll Tea Sector accounts for around 52 % of the total tea production of the State
- Small scale tea sector covers about one lakh ha area
- Concentrated in Upper Assam districts mainly in Tinsukia, Dibrugarh, Sibsagar, Jorhat and Golaghat have remarkable number of small tea growers . Udalguri, Sonitpur, Nagaon and Karbi Anglong districts have in rising trend.

Problems : There are, however, varieties of problems in the growth and development of this sector involving the small tea growers. Lack of technical knowledge due to inadequate advisory service, non settlement of land documents, and lack of proper price fixation policy for green leaf, lack of motivation for scientific tea cultivation and the apathy of the bought leaf

factory owners are some of the major problems being faced by this sector.

Prospects : Small Scale tea cultivation has brought remarkable changes in the socio-economic condition of the common farmers. There is ample scope and prospects in small scale tea cultivation. This sector has invited many other investors to get involved in the transportation of green leaf, supply of plantation accessories, establishment of mini tea factories, cultivation of organic tea, insurance companies, and many other enterprises. This sector has also opened up avenues for self employment and the employment of the rural youths. This sector under the patronage of the state government and financial help from the Tea Board is likely to play a crucial role in the growth and development of the tea industry in India.

1.7 TEA CULTIVATION IN NON-TRADITIONAL AREA AND OTHER N.E.INDIA STATES

In Tripura, there are 58 big tea estates with planted area spread over the districts of Dholai, South, North and West Tripura. There are about 1,500 registered small tea growers and 11 workers' co-operative gardens.Tripura Tea Developmental Corporation is the nodal body for tea development in Tripura.

Arunachal Pradesh has taken a lead over the other non-traditional tea growing states of the N. E. region. Teas grown in the hill slopes of Arunachal Pradesh have distinct characteristics and are comparable with the Darjeeling. At present there are 42 registered tea estates with a total planted area of 837.39 ha. There are 50 small growers who have registered with the Tea Board. Arunachal Pradesh Forest Corporation Ltd. acts as the nodal agency and has received substantial grants from the Tea Board for the development of nurseries and also for disbursing loan and subsidy among the growers. The project areas where planting has been taken up are located in the districts of Lohit, Tirap, Changlang, Lower Subansiri, Dibang valley and East Siang

In Meghalaya, Tea Experimental Centres at Umsning, Rongram and Riangdo were established in 1976-77 with the support of Tea Board and in

1978 planting was carried out with materials brought in from Assam and Darjeeling. The Tea Board of India has been extending grant in aid for setting up nurseries since 1982-83. There are 69 registered tea growers covering an area of 577.86 ha.

In Nagaland, tea is grown in seven districts *viz.*, Kohima, Zunhebhoto, Muckokchung, Mon, Phek, Twensang and Dimapur. Small scale tea cultivation has been taken up as an alternative to *jhum* cultivation. The Tea Board has given registration to 2,753 small farmers covering an area of 19,264.36 ha

There are old tea plantations of more than 75 years at Biate and Ngopa in Mizoram extending over an area of about 140 ha. The State Govt. launched Tea Development Schemes in 1992-93 and targeted 2,000 ha at Biate, Ngopa, Pawlrang, N.E. Bualpui, Khawdungsei, Tlungvel, Darlawng and Selling. So far Tea Board has given registration to nine tea estates covering an area of 391 ha. There are 697 registered small tea growers covering a total area of 1,934.34 ha. Presently, tea is processed in traditional methods and marketed locally.

In Manipur, Tea is grown in the districts of Senapati, Tamenglong, Ukhrul and Jiribam. The Tea Board assisted the Manipur Plantation Crops Corporation Ltd. In 1982 and about 233.03 ha have been brought under tea cultivation. The Tea Board has also provided financial assistance for setting up of tea nurseries. Of late, a number of NGOs have been promoting the small farmers to take up tea plantations. About 484 small tea growers covering an area of 1,362.61 ha are so far been registered by Tea Board.

Traditionally, the tea growing region in north eastern India included Assam, Tripura and West Bengal. However, at present, after the introduction of tea in the non-traditional states of this region, N.E.India includes those states also where tea is being grown now. Consequently, the north eastern region as a whole has been playing an important role in the country's tea industry. Assam is one of the finest tea growing regions of the world.

The following are some of the facts about the tea industry in N.E.region:

North Eastern States account for :

- 55% of the total area under tea in the country
- 53 % of the total production
- 3.37 lakh ha under tea cultivation
- 526 m.kg tea production
- Employment of about 6.2 lakh people in tea
- 535 registered tea estate factories and 206 bought leaf factories
- Assam and Tripura are the traditional tea growing states in North East including West Bengal.
- Assam alone accounts for 3.21 lakh ha of tea area
- Assam produces 511 million kg
- Tripura with only 8,962 ha under tea produces 7.85 million kg.



1.8 TEA INDUSTRY AND ITS ROLE IN NATIONAL ECONOMY

Tea is an important plantation crop in India and the tea industry is one of the finest agro-based industries and it plays an important role in the national economy. It is traditionally an important foreign exchange earner which earns substantial amount of foreign exchange and makes a significant contribution to state and central exchequers. India earns foreign exchange of over Rs. 2000 crores from tea annually which is over 3 per cent of the total foreign exchange.

India is the second largest producer, the biggest consumer and the second largest exporter of tea in the world. Tea is recognized as the most popular and the cheapest beverage in India. As the major beverage consumed in India, tea enjoys penetration of 65 percent in rural areas and 73 percent in urban areas.

Tea industry employs more than one million workers directly making it one of the most labour intensive agro-industries. The tea plantation workers are from the rural areas and half of the workers comprise women workers. Some three million people are also indirectly dependent on the tea industry indirectly. It also supports many ancillary industries in the country. Tea plantations help in maintaining ecological balance in different ways.

Contribution of tea industry to the economy of Assam : The contribution of the tea industry to the economy of Assam is significant. Tea is not only the most important cash crop and a major source of revenue and employment, but is also the most important industry in Assam. The Government of Assam collects revenues from the tea industry through taxes collected under The Agricultural Income Tax Act, The Assam General sales Tax Act, The Central sales Tax Act, and The Assam Taxation (on specific land) Act, 1990.The total amount of tax collected from the tea sector constitutes a good share of the total tax collected from different sources in the state.

Many other ancillary industries like coal, fuel, construction, fertilizer and other agro-chemicals are dependent on the tea industry to a great extent.

1.9 DEVELOPMENT AGENCIES



Tea is a commodity of commerce under the Ministry of Commerce and Industry. Tea Board, India has to look after the sustainable development of this sector. Tea Board reserves the right of controlling the production and export of tea through its official network based in Kolkata. The Board has different developmental plans and programmes and implements these through its offices situated in different tea growing states of India.

The Assam Agricultural University has a cell called Small Tea Growers' Advisory Programme (STAP) through which the University provides technical knowledge and skill to the small tea growers through training, visits and demonstrations. The Tocklai Experimental Station also offers advisory services to the small tea growers.

CHECK YOUR PROGRESS

Q.1: Who introduced tea into India and when?

,,,.....

Q.2: Name the three species of the tea plant.

.....

Q.3: What are the three forms of processed tea?

.....

Q.4: Name three leading tea producing countries of the world.

.....

Q.5: Where is tea grown in India?

.....

.....

Q.6: Who is a small tea grower?

.....

Q.7: State true or false

a) The indigenous tea plants in India were first discovered by Robert Bruce in 1823. (True/False)

b) In Assam and in the plain areas, the tea plants suitable for cultivation are China types. (True /False)

c) India manufactures only black tea. (True/False)

d) Small tea grower has been defined by the Tea Board of India as a person who is having tea plantation area up to 10.12 ha. (True/False)

e) Tea was initially used as a medicinal drink in China (True/ False).

Q.8: Select the correct answers :

a) Tea is cultivated in 66/45/55 countries in the world.

b) Among the southern states of India tea is not grown in Tamil Nadu / Kerala / Andhra Pradesh.

c) The number of the small tea growers in Assam is around one lakhs/65,000/45,000/25,000.

d) Tea is processed from the mature leaves/tender leaves of tea plants.

1.10 LET US SUM UP

- Tea is considered to be one of the most common and cheapest

beverages, which is consumed in more than 65 countries worldwide where people drink 4 billion cups in the morning daily. Tea drinking originated in China where initially it was used as medicinal drink and later on as beverage.

- The British East India Company started tea cultivation in India by importing seeds from China. The commercial tea cultivation was successful only after the discovery of the indigenous Assam tea plant in different parts of the then greater Assam.
- The indigenous tea plants in India were first discovered by Robert Bruce in the Brahmaputra valley in 1823 with the help of Besa Gam, a Singpho Chief, and another person an Assamese noble, Dewan Maniram Dutta Baruah.
- Commercial tea plantation started under the patronage of the East India Company in 1834.
- Tea is an evergreen woody perennial plant. From the tender young shoots of the tea plant the beverage, tea is processed.
- Tea plants are classified into three different species. They are: Assam tea (*Camellia assamica),* China tea *(Camellia sinensis)* and Cambod tea *(Camellia assamica* sub sp. *lasiocalyx*).



- However, the tea plants which are under cultivation at present are the natural hybrids of the three species or races, mainly of Assam and China tea.
- Presently, tea is cultivated in more than 55 countries of the world. Different species of tea plants are grown in different situations.
- Assam type teas are grown in hot humid and warm countries. But the China plants are suitable in cold climate. In India, the China hybrid teas are cultivated in high elevation areas like Darjeeling, Nilgiri hills, Kangra valley etc. In Assam and in the plain areas, the tea plants suitable for cultivation are the Assam and the Cambod types.
- The major tea growing countries are India, Bangladesh, Sri Lanka, Indonesia, China, Japan, Vietnam, Kenya, USSR and Argentina.
- Basically, three types of made tea are processed. These are: Black tea, Green tea and the Oolong tea.



- Traditionally, tea was mainly grown in Assam, West Bengal, Kerela, Tamil Nadu, Himachal Pradesh and Tripura. However, tea has been introduced to many non-traditional areas like Orissa, Uttarakhand and the hill states of the entire North East Indian region.
- Of the major tea producing states of India, Assam alone produces nearly 53 percent of the total tea production of the country.
- Presently, small scale tea cultivation has become a common phenomenon in all the districts of Assam and it is playing an important role in the country's tea industry. The small scale tea cultivation was started in Assam in 1975 and it gained its momentum during the mid 90's due to the prevailing high prices of green leaves at that time. There are around 65,000 small tea growers in Assam.
- The major concentration of the small tea growers in Assam is confined to the five upper Assam districts *viz.,* Tinsukia, Dibrugarh, Sibsagar, Jorhat and Golaghat .More than 80 percent of the small tea holdings are in these five districts.
- The area under the small tea grower sector is about one lakh ha. The small growers produce about 127 m kg of tea which accounts for about 13 % and 25 % of India's and Assam's total productions respectively.
- This sector engages about 3 lakh labourers and 11 thousand other employees.
- Among the other north eastern states Arunachal Pradesh is taking a lead role.
- In India, the north eastern region has been playing an important role in the country's tea industry. Assam is one of the finest tea growing regions of the world.
- Tea is an important plantation crop in India and the tea industry is one of the finest agro-based industries .It earns substantial foreign exchange besides providing employment to million of people in the rural areas and also supporting many ancillary industries in the country.

1.11 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : The British East India Company in 1834

UNIT 2 : SOIL AND CLIMATIC REQUIREMENTS

UNIT STRUCTURE

2.1 Learning Objectives

2.2 Introduction

2.3 Soil Requirements

- 2.3.1 Physical Properties
- 2.3.2 Chemical Properties
- 2.3.3 Biological Properties

2.4 Land Features

- 2.4.1 Slope
- 2.4.2 Altitude
- 2.4.3 Aspects

2.5 Climatic Requirements

- 2.5.1 Rainfall
- 2.5.2 Air Temperature
- 2.5.3 Relative Humidity
- 2.5.4 Day Length
- 2.5.5 Wind velocity

2.6 Selection of a Suitable Site for Tea

2.7 Soil and Water Conservation

- 2.7.1 Soil Conservation Methods
- 2.7.2 Drainage Requirement
- 2.7.3 Drought Symptoms and Management

2.8 Let Us Sum Up

2.9 Further Reading

2.10 Answers To Check Your Progress

2.11 Model questions

2.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- describe the soil and climatic requirements for the tea cultivation.

- select a suitable site for tea cultivation
- explain the practices needed to conserve the soil and water.

2.2 INTRODUCTION

Though tea can be cultivated in a wide range of soil and climatic condition, profitable cultivation can be done only in the areas where the tea plant grows well with high yield and quality. With the expansion of tea cultivation in the farmers' field in the non traditional areas, the farmers have to be careful in selecting the land so that this venture can be continued profitably over the decades as it is a perennial crop.

In this unit, we shall discuss the soil and climatic requirements for tea cultivation.

2.3 SOIL REQUIREMENTS

The soil selected for tea cultivation should possess some special physical, chemical and biological properties to ensure the sustainability of the plantation.

2.3.1 Physical Properties

The range of soil types on which tea can be grown is remarkably wide. However, some of the physical properties of soil play an important role for the success of the commercial tea cultivation. Some of the important physical properties are discussed below.

Soil Depth : The soil intended to be used for tea cultivation should be deep and friable. The depth of the soil from the surface to the bed rock or compact zone should at least be 1.5 m or more. Shallow soil hinders the growth of roots. Tea plants grown in shallow soil suffer more from drought.

Soil texture : The relative proportions of various soil particles (separates) like sand, silt and clay in a particular soil determine the soil texture. Texturally a soil may be termed as a heavy, medium or

light textured soil. In heavy soils, the proportion of the clay particles is more and with the increase in the proportion of sand particles, the soil becomes lighter and lighter. Tea soils should not be very sandy (light) or very clayey (heavy). Sandy loam to silty loam soil is suitable for tea cultivation. The texture of a soil may roughly be determined in the field simply by rubbing the soil between thumb and fingers. A light textured soil gives a gritty or coarse feel while a fine textured soil gives a smooth and fine feel.

Soil Structure : Structure relates to the grouping or arrangements of soil particles into granules or aggregates. Soils with plenty of organic matter usually have good structure. A good structured soil should have about 50% pore space. Such soils are porous and usually more productive because the structure of the soil has pronounced effect on the porosity, infiltration, water holding capacity and erodibility etc. The removal of vegetation during land clearing exposing the barren land to the sun and rain destroys the soil structure. The common management practices for maintaining a good structure includes mulching, addition of organic matter, liming, irrigation etc.

Soil porosity : The space in between soil particles is known as pore space. A well aggregated soil possesses a large pore space which allows gaseous exchange, easy percolation and penetration of raindrop to the subsoil region. Such soils have good aeration and are suitable for plant growth.

Bulk Density : It refers to the compactness of soil. It has great influence on the water holding capacity of the soil. In virgin soils, the bulk density is low.

Water holding capacity : When a soil is saturated with water i.e. after free flowing water is drained away, it is said to be at its moisture holding capacity. It is an important physical property of soil. The moisture holding capacity of a soil varies with the texture and structure of the soil. The finer the texture and greater the content of organic matter, the higher is the moisture holding capacity.

Organic matter : Soil organic matter includes plant and animal residues at various stages of decomposition, living or dead cells and tissues of microbes and the substances synthesized by the soil population. The soil organic matter has profound influence on the fertility status of the soil. A soil having above 0.8 percent organic carbon is considered to be satisfactory fertility status suitable for tea cultivation.

In a tea garden, pruning litters, leaf fall of shade trees and tea bushes, green crops (rehabilitation crops), decay of weeds, mulch materials etc. are the sources of the building up of the organic matter.

2.3.2 Chemical Properties

Soil pH : One of the most important chemical properties of soil is its reaction which is measured by a scale of pH value. In the scale 7 denotes neutrality, whilst figures from 7 downward indicate increasing acidity and above 7 indicates increasing alkalinity. Soil pH has significant influence on the availability of plant nutrients as well as microbial activity. Microbial activity is at its optimum above pH 5.5.

Tea grows well in acidic soils , pH ranging from 4.5 to 5.5. However, if the soil pH falls below 4.0 and goes above 5.8, the soil acidity level can be corrected by the application of lime and Aluminium sulphate respectively.



Mulching : Covering the soil or base of a plant with a mass of leaves or any other vegetative materials.

Nutrient requirements : There should be enough reserve of various nutrient elements in the soil for the growth and development of the plants. For better growth of the tea plant, the soil should have the following range of nutrients.

Nutrient	Content Range (ppm)
Total Nitrogen	> 1000 ppm
Available Nitrogen	> 200 ppm
Available P_2O_5 (Phosphate)	> 40 ppm
Available K_2O (Potash)	> 100 ppm
Organic Carbon	> 10000 ppm
Available Sulphur	> 40 ppm

Available Magnesium	> 10 ppm
Available Zinc Sulphate	> 20 ppm

The critical limit of some of the micronutrients is as follows:

Nutrient	Critical Content (ppm)
Iron	4.5 ppm
Copper	0.2 ppm
Manganese	1.0 ppm
Boron	0.36 ppm
Molybdenum	0.05 ppm

2.3.3 Biological Properties

Soils biological properties are controlled by various organisms such as soil micro flora (bacteria, fungi, protozoa and algae) and micro fauna (earthworm, different insects and mites).Mineralization (conversion of organic to inorganic forms), fixation of atmospheric nitrogen etc. are biological properties of soil. Soils rich in biological activities are always preferable for tea cultivation.

To sum up, a well drained (medium textured) soil with adequate depth (1.5 m), rich in the organic matter and nutrients, having pH 4.5 to 5.5 is considered suitable for tea cultivation. The virgin land under natural vegetation is most suitable for tea cultivation.

2.4 LAND FEATURES

A well-drained highland is suitable for tea cultivation. Water logging, heavy soil erosion, drought and land slides create great problems in tea cultivation.

2.4.1 Slope

Tea can be cultivated in the areas where the slope is up to 50 percent .However, in areas where the slope is more than 2 percent, contour planting and contour drainage should be followed.

2.4.2 Altitude

Tea can successfully be cultivated in altitudes up to 2500 m above the mean sea level .At higher elevations, the air temperature falls at the rate of 2 °C with increase in elevation by 300 m. The growth of tea plants at higher elevation is slow.

2.4.3 Aspect

In hilly areas, special care should be taken while cultivating tea in the southern aspects.



CHECK YOUR PROGRESS

Q.1: What should be the minimum depth of soil for growing tea?

.....

.....

Q.2: What is the optimum range of soil pH for tea?

.....

.....

Q.3: State true or false

a) A soil having above 0.8 percent organic carbon is considered to be a satisfactory fertility status suitable for tea cultivation. (True / False)

b) The finer the texture and greater the content of organic matter, the lower is the moisture holding capacity of the soil. (True / False)

2.5 CLIMATIC REQUIREMENTS

The climatic conditions prevailing at a particular region influence the productivity and quality of tea. Rainfall, temperature, relative humidity, day length, light intensity, wind, occurrence of hail etc. influence tea productivity.

2.5.1 Rainfall

Tea is basically a rain-fed crop. The lower limit of rainfall for successful tea cultivation is 1200 mm, if other factors are not limited. However, the distribution of rainfall over the year is as vital as the total annual rainfall. Therefore, the well distributed rainfall is essential for commercial tea cultivation. Tea should not normally be cultivated in areas where the rainfall is below 1150 mm, unless irrigation is available.

2.5.2 Air Temperature

Air temperatures above 30^0 C and below 13 ^{0}C are harmful for the growth of tea plants. However, in the plains of north east India including Assam, the air temperature remains above 30^0C for a greater part of the harvesting period and hence shade trees are interplanted in tea garden to keep the temperature below a level where it can not affect the photosynthesis adversely.

2.5.3 Relative Humidity

The mean relative humidity throughout the year should not fall below 60 percent for the better growth of tea. Relative humidity of 80-90 percent is favorable during the growth period of a tea plant .With 50 percent of relative humidity, the shoot growth is inhibited and when it is below 40 percent, the growth is adversely affected.

2.5.4 Day Length

Day length and temperature influence the growth and dormancy of the tea bush. In the equatorial region there is no seasonal variation of day length and temperature and devoid of dormancy period. Tea plants enter into the seasonal dormancy (winter dormancy) when the temperature falls below 13^o C and the day length is shortened to 11 hours 15 minutes. In Assam, tea plants remain dormant for about three months.

2.5.5 Wind Velocity

Wind velocity is useful in reducing high leaf temperature. The velocity of wind in the Brahmaputra valley in Assam is low due to the shelter effect of hills on either sides and for that shade trees are grown in tea plantation to keep down the leaf temperature. However, in those areas where air temperature is high but the wind velocity is also high, shade is not needed.

Thus, hot and humid climate with more or less well distributed rainfall is suitable for tea cultivation. In Assam, the prevailing climate is favourable during the main growing period of tea. However, in some years due to late arrival of monsoon, tea plantation suffers from drought. Excessive rainfall received during the summer months also lead to drainage problem in tea areas .On hot and clear days during the summer months sun scorch may occur due to a rise in leaf temperature as the wind velocity is low in Assam. Therefore, shade is needed to protect the bushes from sun scorching. During winter, tea bushes in Assam stop flushing and become dormant. It is called winter dormancy. The period of dormancy lasts for 3 to 4 months starting from late December to February.

2.6 SELECTION OF SITE SUITABLE FOR TEA

The suitability of an area for tea cultivation can be judged from the existing vegetation. This is important for planting tea in non-traditional areas. The plant and soil indicators can provide some guidance in selecting lands suitable for tea cultivation.

a) *Albizzias* (koroi*)* are reliable indicators of land suitable for tea. The area is suitable where *Albizzia* species form a part of the natural vegetation.

b) Aluminium accumulator plants of the families of *Melastomaceae* and *Rubiaceae* can provide some information about the tea soil. *Melastoma malabathricum* (*Phutuka)*, a shrub bearing pink coloured flowers is an indicator plant which grows abundantly in tea growing

areas of Assam.

c) The forest with deep rooted trees indicates well depth soil which is suitable for tea growing.

Accumulator Plant : Species of plants having unusual affinities for relatively rare elements, most of them heavy metals, which may or may not be essential to them, e.g. Tea is an aluminium accumulator plant.



CHECK YOUR PROGRESS

Q.4: What is the lower limit of annual rainfall for successful tea cultivation?

.....

Q.5: What is the range of relative humidity favorable for growth of tea?

.....

Q.6: Why is shade needed in tea plantation in Assam?

.....

.....

.....

.....

Q.7: What is the reason for winter dormancy?

.....

Q.8: Name two indicator plants which indicate suitability of an area for tea cultivation?

.....

2.7 SOIL AND WATER CONSERVATION

From our foregoing discussion, you have come to know what should be the ideal condition for commercial tea cultivation. However, any faulty management practices may lead to deterioration of soil. Further, under some situations special management practices need to be undertaken for soil and water conservation.

2.7.1 Soil Conservation Methods

The washing away of the top soil along with organic matter is very common in the tea plantations particularly at the time of land clearing and during the early stage of the plantation when ground cover is not achieved by the tea bushes. Suitable measures such as providing ground coverage with cover crops such as *Mimosa invisa*, *Pueria* etc should be grown in the initial years. Mulching with suitable material should be undertaken in young tea areas.

To prevent soil erosion, citronella, weeping love grass etc. can be planted on both sides of the drains, if the soil is sandy type. In sloppy land, contour planting must be adopted. Planting of shade trees also helps in conserving soil moisture during the dry period. Moreover, soil stirring, hoeing, forking, etc should be avoided during the dry season.

2.7.2 Drainage Requirement

Tea plant cannot thrive under waterlogged condition. In Assam due to asymmetrical distribution of rainfall, the tea areas suffer from both water excess in summer and water deficit during winter. During summer heavy rainfall causes problem in tea areas. The water table rises up to the root zone in many areas. Therefore, drainage is one of the most important practices in tea cultivation. The main objectives of drainage are to remove excess water from the root zone to create a favorable environment for roots and to facilitate safe disposal of surface water to prevent soil erosion. To remove excess water different drains are dug within the plantation.

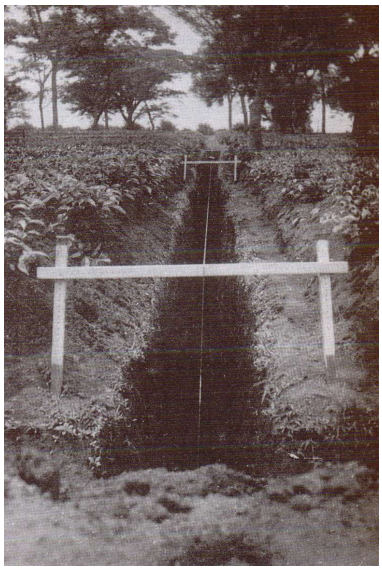


Fig.2.1 : Field drain in tea plantation

The rise in the water table and the surface water logging affect the normal growth of the tea plants due to the reduced rate of mineralization, lower microbial activity, low soil temperature under wet conditions and lack of aeration. The response to applied fertilizers is poor in waterlogged areas. To cope with the situation it is necessary to provide artificial drainage facilities to drain the excess water from the surface as well as below the root zone.

Symptoms of waterlogging : During the summer months due to heavy rain, the ground water table rises to the root zone and in many cases flood may occur if the drainage is not proper. In waterlogged tea areas the following symptoms are observed:

i) Growth of the tea bushes is poor and the flush is uneven
ii) Plants die in patches
iii) Yellowing of leaves and premature defoliation occur
iv) Die back in plucking points is observed
v) Response to fertilizer becomes poor
vi) Tolerance to drought becomes poor
vii) Bushes become susceptible to pests and diseases
viii) Unusual infestation of weeds is observed
ix) Root growth is retarded

Specification of different drains : To drain out both surface and

sub surface excess water, different types of drains are dug. All the drains should be dug before planting tea. The field drains that are dug in the tea sections may be made shallow (say 30 cm deep) initially and after planting tea, these can be deepened to the recommended depth (105 cm).

i) **Field drains :** Field drains remove the excess water from the surface and the root zone and discharge to the collector or main drain. The field drains should be 105 cm deep and 30 cm wide.

ii) **Collector drains :** Collector drains discharge water to the main drain or into an outlet. The collector drains should be 120 cm deep and 45 cm wide.

iii) **Main drain :** The main drains which discharge the water to an outlet should be 150 cm deep and 90 cm wide.

The shape of the collector and the main drain should be trapezoidal to prevent the bank slip. In light soil, the field drains may also be trapezoidal in shape.

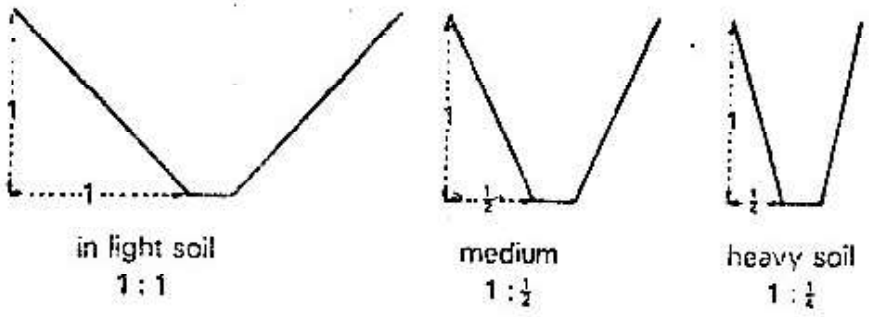


Fig. 2.2 :Shape of the drain in different types of soil

The main drain should be connected with a natural drain such as a '*holla'* or a stream or a river etc.

The spacing of different drains varies according to the texture of the soil. In flat land (upto 3% slope), the spacing of the field drains should be as follows:

i) For heavy textured soil : Clay loam: 9 m
Silty loam: 12 m

ii) For Medium textured soil : Loam: 15 m
Sandy loam: 18 m

iii) For light textured soil : Loamy sand: 25 to 30m

The length of the field drain should not be more than 75m.

2.7.3 Drought Symptoms and Management

Drought is a common phenomenon in some parts of the NE Indian tea areas. An average rainfall of 18-19 cm is essential during November- December, whereas 40-45 cm is required during January to March. However, rainfall during these five critical months is scanty which affects both the early and the total crop. When tea plants suffer from drought, the leaves become flaccid, leaf blade thickness is reduced, lateral and terminal buds stop growing and in severe drought the bark splits, the stubs die back, leaves wilt and finally fall off.

Measures to overcome drought :

i) In the drought prone areas drought tolerance variety/clone should be planted.

ii) Mulching is a must in these areas. Mulching with suitable materials like Guatemala grass lopping should be done when the soil is sufficiently moist.

iii) Pruning and plucking need to be manipulated in the droughty years and in the drought prone areas. Unprune or light skiffed tea areas suffer the most.

iv) Shade should be adequately maintained. If needed, temporary shade tree species should be planted where permanent shade stand is not sufficient.



CHECK YOUR PROGRESS

Q.9: Why is drainage required in tea plantation?

,,,,,,.....

.....

.....

.....

Q.10: What should be the depth of field drains?

.....

Q.11: State true or false.

a) Unusual infestation of weeds is a symptom of water logging. (True/False)

b) In flat land, the spacing of the field drains in light textured soil should be 12m. (True /False)



2.8 LET US SUM UP

- A well drained (medium textured) soil with adequate depth (1.5 m) rich in organic matter and nutrients having pH 4.5 to 5.5 are considered suitable for tea cultivation. Virgin land under natural vegetation is most suitable for tea cultivation.
- Tea can be cultivated in flat areas and also in sloppy land upto 50% slope and upto an elevation of 2500 m above the mean sea level. However, contour planting must be adopted when the slope is more than 3%.
- Hot and humid climate with more or less well distributed rainfall is suitable for tea cultivation.
- Tea is basically grown as a rain-fed crop. The lower limit of rainfall for successful tea cultivation is 1200 mm, if other factors are not limited.
- Tea should not normally be cultivated in areas where the rainfall is below 1150 mm, unless irrigation is available.
- Air temperatures above 30^0 C and below 13^0C are harmful for the growth of the tea plants.
- In the plains of north east India including Assam, the air temperature remains above 30^0C for a greater part of the harvesting period and hence shade is required in tea gardens to keep down the leaf temperature.

- Tea plants enter into the seasonal dormancy (winter dormancy) when the temperature falls below 13 °C and the day length is shortened to 11 hours 15 minutes. In Assam, tea plants remain dormant for about three to four months.
- The wind velocity in the Brahmaputra valley is low due to the shelter effect of hills on either sides of the valley and for that shade trees are grown in tea plantations to keep down the leaf temperature.
- The suitability of an area for tea cultivation can be judged from the existing vegetation i.e. there are some plant and soil indicators. *Albizzias* (koroi) and some other species like Melastoma *malabathricum (*Phutuka*)* are good indicators for suitable tea areas.
- Erosion of top soil along with organic matter is common in the tea plantations particularly at the time of land clearing and during the early stage of the plantation when the ground is not covered by the tea bushes. Suitable measures need to be adopted.
- In Assam due to asymmetrical distribution of rainfall, the tea areas suffer from both water excess in summer and water deficit during winter. During summer heavy rainfall causes drainage problem in tea areas. Therefore, drainage is one of the most important practices in tea cultivation.
- The main objectives of drainage are to remove excess water from the root zone to create a favorable environment for root growth and dispose off the surface water safely to prevent soil erosion.
- To remove excess water different drains are dug within the plantation. Field drains are dug inside the tea sections to remove excess water from the surface and the root zone and discharge it to the collector or main drain. The field drains are 105 cm deep and 30 cm wide. The collector drains should be 120 cm deep and 45 cm wide. The main drains which discharge the water to an outlet should be 150 cm deep and 90 cm wide.
- The shape of the collector and main drain should be trapezoidal. The spacing of different drains varies according to the texture of the soil.
- Drought is a common phenomenon in some parts of the NE Indian tea areas. Special management is needed in such drought prone areas.



2.9 FURTHER READING

1) *Science and Practice in Tea Culture* By D.N. Barua .Tea Research Association, Kolkata, Jorhat

2) *Tea Cultivation-Comprehensive Treatise* By N.Ghosh Hajra. International Book Distributing Co., Lucknow.



2.10 ANSWER TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : The depth of soil from the surface to the bed rock or compact zone should at least be 1.5 m or more.

Ans. to Q. No.2 : Tea grows well in acidic soil ranging from pH 4.5 to 5.5.

Ans. to Q. No. 3 : a) True, b) False

Ans .to Q. No. 4 : 1200 mm

Ans. to Q. No. 5 : 80-90 per cent

Ans. to Q. No. 6 : Air temperature during the growing period is above 30^0C and the wind velocity is low in Assam. So, during summer, leaf temperature rises causing scorching and hampering the photosynthesis. Shade is, therefore, needed in Assam to keep down the leaf temperature.

Ans. to Q. No. 7 : Short day length and also low temperature

Ans. to Q. No. 8 : *Albizzias* (koroi), *Melastoma malabathricum (*Phutuka*)*

Ans. to Q. No. 9 : Tea plant can not thrive under waterlogged condition. During summer, heavy rainfall causes water excess which needs to be removed from the surface and the root zone. Also in sloppy areas, drainage is needed for a safe disposal of the excess water to check soil erosion.

Ans. to Q. No. 10 : 105 cm

Ans. to Q. No. 11 : a) True, b) False



2.11 MODEL QUESTIONS

Q.1: What are the soil and climatic requirements for commercial tea cultivation? How does rainfall distribution affect the tea plantation in Assam?

Q.2: Why is shade tree needed in tea plantations in Assam? Give the reasons.

Q.3: What is winter dormancy? What are the reasons of it?

Q.4: Why is drainage needed in tea? Describe the dimension of different types of drains.

*** ***** ***

3.8 Nursery Techniques for Seed Propagation

UNIT 3 : PLANTING MATERIALS OF TEA AND PROPAGATION

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Planting Materials

- 3.3.1 Clone
- 3.3.2 Clonal Seed
- 3.3.3 Differences Between Clone and Clonal Seed

3.4 Choice of Planting Materials

3.5 Propagation

- 3.5.1 Seed Propagation
- 3.5.2 Vegetative Propagation

3.6 Tea Nursery

- 3.6.1 Site
- 3.6.2 Layout of Nursery

3.7 Nursery Techniques for Vegetative Propagation

- 3.7.1 Type of Soil
- 3.7.2 Preparation of Beds
- 3.7.3 Sleeve Filling and Placing Sleeves on Beds
- 3.7.4 Planting Cuttings and Watering
- 3.7.5 Construction of Overhead Shed
- 3.7.6 Care and Maintenance of Nursery

3.8 Nursery Techniques for Seed Propagation

- 3.8.1 Bed Preparation for Tea Seed and Green Manuring Crop
- 3.8.2 Sowing of Green Manuring Crops
- 3.8.3 Sleeve Filling
- 3.8.4 Pre-germination of Seed or Cracking
- 3.8.5 Sowing of Seeds
- 3.8.6 Mulching and Watering

3.8.7 Overhead Nursery
3.9 Nursery Management
3.10 Let Us Sum Up
3.11 Further Reading
3.12 Answers To Check Your Progress
3.13 Model Questions

3.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- name the different types of planting materials of tea
- define clone and clonal seed varieties
- describe the different tea clones
- name the parents of different biclonal seed varieties
- differentiate the clones from seed varieties
- narrate the criteria of choosing the planting materials
- describe the establishment of clonal nucleus plot
- describe the establishment of seed *baries* for seed production
- describe the procedure of seed collection and packing.

3.2 INTRODUCTION

Tea cultivation in Assam was started in the beginning of 19th century by importing seeds from China. However, the commercial cultivation was started only after the discovery of the Assam type tea in 1823. Early plantations in Assam were done by collecting seeds from the indigenous tea plants which were growing in the hills of the then Assam, mostly in the present Manipur, Nagaland and Mizoram and in areas bordering Myanmar. Subsequently, the planters started to improve the planting materials by selecting superior plants in the nursery and the selected plants were planted out for establishing seed *baries*(orchards).Thus, a good number of improved seed varieties with higher yield and better quality and morphological uniformity were developed. Such varieties having distinct characteristics were popularly known as *Jats*. Betjan, Dhonjan, Khorijan, Tingamira are

some of such seed jats which were the primary planting materials of tea for over a century. However, now a days these *Jats* are not recommended for commercial planting after the release of high yielding superior planting materials.

In this unit, we shall discuss the different types of planting materials of tea, their characteristics and selection for different situations and also their multiplication.

3.3 IMPROVED PLANTING MATERIALS

Two types of improved planting materials of tea are available for commercial planting. These are (a) the clones and (b) the clonal seeds.

3.3.1 Clone

A clone is the indefinite extension of a single plant. That means a selected plant having the desirable characteristics are multiplied by vegetative means and so all the plants retain the characteristics of the mother plant. The mother plant is a clone.

Clones are selected from the existing seed populations, which are genetically very heterogeneous, through clonal selection programme. The selection of clones is a laborious process and usually takes 7 to 10 years before a clone could be released for commercial planting. Clones may also be selected from a population raised after a certain degree of hybridization among the selected clones.

Tocklai Experimental Station has so far released 31clones under TV-series (TV-Tocklai Vegetative). However, all the clones are now not recommended for planting. The recommended clones with their category and characteristics are shown in Table 3.1.

Similarly, different tea growing areas and countries have selected different clones suitable for respective situation.

Category of Clones : The clones are released under three different categories viz., Standard, Yield and Quality clone.

Standard Clone : A standard clone is one with above average yield and quality, with yield potential of 3000-3500 kg made tea per ha under the agro-climatic situation in the plains of North East India.

Yield Clone : A clone with high yield and average quality, with yield potential of above 4000kg made tea per ha.

Quality Clone : A quality clone is one with high quality and average yield, with yield potential of 2500-2800 kg per ha.

Table 3.1 : Recommended TV-series clones for planting in Assam

Clone	Category	Type	Frame	Leaf character	Drought response
TV 1	Standard	Assam China	Compact and	Erect leaf of	Tolerant
		hybrid	moderately	medium size	
TV 9	-do-	Cambod type	spreading Spreading frame	Medium size	Moderately tolerant
Clone	**Category**	**Type**	**Frame**	**Leaf character**	**Drought response**
TV 14	-do-	Assam type	-do-	-do-	-do-
TV 16	-do-	Assam hybrid	-do-	-do-	-do-
TV 17	-do-	Assam China	Compact,	-do-	Tolerant
			hybrid	moderately	
TV 18	Yield	Cambod type	Spreading frame	spreading -do-	Moderately tolerant
TV 19	-do-	-do-	-do-	Large leaf dark green	Tolerant
				in colour	
TV 20	Standard	Cambod type	-do-	-do-	-do-
TV 21	Quality	Assam type	Moderately spreading,	Large size	Susceptible
TV 22	Yield	Cambod type	compact Spreading frame	-do-	Moderately tolerant

TV 23	-do-	-do-	-do-	-do-	Tolerant
TV 24	Standard	Cambod type	Compact and moderately spreading	Medium size light green in colour	Moderately tolerant
TV 25	Yield	-do-	-do-	Medium size dark green in colour	-do-
TV 26	-do-	-do-	Spreading frame	Medium size	Tolerant
TV 27	Standard	-do-	Compact and moderately spreading	-do-	Moderately tolerant
TV 28	-do-	-do-	-do-	-do-	-do-
TV 29	-do-	Cambod, Triploid	-do-	Large size	-do-
TV 30	-do-	Cambod	-do-	Medium size	-do-
TV 31	Quality	-do-	-do-	-do-	Tolerant

Tea Varieties

According to the present classification, three varieties or species of tea are recognized viz., Assam Tea (*Camellia assamica*), China tea (*Camellia sinensis*) and Cambod tea (*Camellia assamica spp.lasiocalyx*). The leaves of Assam tea are large in size that is 13 -16 cm long and 4.5 -6.0 cm wide, droopy, thin, glossy and light to dark green in colour. Leaves of China tea are erect, hard, thick and leathery; the surface is mat (not shining); 10-14 cm long and 4-6 cm wide and dark green in colour. In cambod tea, leaves are more or less erect, glossy; light green in colour; 12.5-15.5 cm long and 4.5 -6.5 cm wide.

However, in the existing tea population, no pure plant of any of the three varieties exists; all are hybrids of the three varieties, particularly of Assam and China. Such hybrid plants are generally described as Assam hybrids or China hybrids considering their nature.

Besides the TV series clones, some area specific clones have been developed under TRA/Garden series. Under this scheme, tea gardens of Assam in collaboration of Tea Research Association have selected some 106 such area specific clones. A few such clones which are recommended for planting are: Longai 17, Kaliapani 25, Baghmari 35, Nagrijuli 6/24, Barmajan 2 and Barmajan 5, Gahpur 33, Heeleakha 2214, Kalani 26 etc.

Moreover, there are about 100 industry clones (released by individual tea company) which are also approved by the Tea Board for planting. Panitola 126A, Tinali 17/1/54, S_3A_3, S_3A_1, T_3E_3 etc. are a few examples of popular industry clones.



CHECK YOUR PROGRESS

Q.1: Name the two types of improved planting materials recommended for commercial planting?

.....

Q.2: What are the tree categories of clones?

.....

Q.3: Name one Quality clone released by Tocklai

.....

Q. 4: Name four popular Industry clones

.....

Q.5: TV stands for what?

.....

3.3.2 Clonal Seed

The second group of planting materials recommended for commercial planting is the clonal seeds. Tocklai Experimental station has so far developed 14 biclonal and one polyclonal seed variety using the technique of line breeding and hybridization. The polyclonal seed variety, TS 203(Gaurisankar) was released for Darjeeling. However, due to its unpredictable performance, this was discontinued

for planting. Now only the bi-clonal seed varieties are recommended for commercial planting.

The bi-clonal seed varieties are essentially the hybrid seed of F_1 generation produced by natural hybridization of two selected clones under natural condition. The clones may be either vegetative or generative. Vegetative clones are used for propagation for planting and the generative clones are generally used for breeding purposes.

The parentage of the biclonal seed varieties are shown in Table 3.2.

Table 3.2 : Parentage (Clones involved in crossing) for different biclonal seed varieties

Biclonal seed varieties	Parentage Cross between)
TS 378	14/5/35 x 14/6/28
TS 379	14/5/35 x 14/12/16
TS 397	19/29/13 x TV 1
TS 449	19/29/13 x TV 1
TS 450	20/23/1 x TV 2
TS 462	19/29/13 x TV 1
TS 463	TV 1 x TV 19
TS 464	TV 1 x19/29/2
TS 491	TV 1 x S_3 A_1
TS 506	TV 1 x 19/22/4
TS 520	TV 19 x TV20
TS 557	TRA/AV2 x TA 17/1/54
TS 569	TRA/AV2 x TRA/T 78
TS 589	TV 20 x HK 22/14

The seed varieties developed by Tockali are prefixed by TS, which stands for Tocklai Stock. The characteristics of a few biclonal seed varieties recommended for Assam are described in Table 3.3.

Table 3.3 : Characteristics of a few biclonal seed varieties

Biclonal seed Variety	Characters
TS 449	It is a cross between TV 1 and a dark leaved Assam (generative) clone, 19/29/13. It is fairly uniform growth habit and leaf size. Suitable for drought prone ares of Assam and Cachar
TS 450	It is a cross between TV 2 and a Cambod generative clone, 20/23/1.It is high yielding having tolerance to drought
TS 462	It is a cross between TV 1 and a Cambod generative clone,19/29/13.Vigorous in growth with high yield potential. Fairly tolerant to drought.
TS 463	It is a cross between TV 1 and TV 19.Vigorous in growth with fairly uniform growth habit with above average yield and quality. Tolerant to drought.
TS 464	It is a cross between TV1 and a quality generative clone, 19/29/2 with high yield potential and above average quality. Fairly tolerant to drought.
TS 491	It is a cross between TV 1 and a light leaved Assam clone, S_3A_1. It gives yield of above average with moderate tolerance to drought.
TS 506	A cross between TV1 and a hybrid Cambod clone.It is high yielding and with above average quality.
TS 520	It is a cross between two high yielding clones (TV 19 and TV 20). It is vigorous in growth with high yield potential and tolerance to drought.
TS 589	It is a cross between TV 20 and a standard garden clone, HK22/14. It is a high yielder with good quality and is tolerant to drought.

3.3.3 Differences Between a Clone and a Clonal Seed Variety

It is important to know the differences between a clone and a clonal seed variety. The differences are given in Table 3.4.

Table 3.4 : Differences between a clone and clonal seed variety

Sl.No.	Clone	Seed variety
1	Needs special technique in the nursery for propagation	Can be grown easily and no special technique is required
2	pH and organic matter content of soil affects rooting of the cuttings and overall growth of the plant	No reflection of soil characteristics in germination of seed
3	Clones are genetically uniform	All plants in a clonal population are genetically variable
4	Yield fluctuations are less pronounced	Yield fluctuations are marked
5	Clones are mostly specific to an area or environment	Seed varieties are more adaptable to divergent ecological and growing conditions.



CHECK YOUR PROGRESS

Q.6: What is a biclonal seed variety?

.....

.....

Q.7: How many biclonal seed stocks have been released by the Tocklai Experimental Station?

.....

Q.8: State true or false

a) Seeds collected from bushes of TS 450 can be used as seeds of TS 450. (True / False)

b) All plants in a biblical seed population are genetically variable. (True / False)

c) All biclonal seed varieties are the cross between two generative clones. (True / False)

d) TS 520 is a cross between two vegetative clones. (True / False)

3.4 CHOICE OF PLANTING MATERIALS

At present, there are a large number of improved planting materials of tea, both clones and clonal seed varieties, released by Tocklai Experimental Station and the tea industry to suit the requirements of different agro-climatic conditions. However, it is very important to be careful while choosing the right type of materials.

A clone lacks elasticity, which makes it more selective to environment. It is, therefore, essential to take extra care for selecting clones for a particular area or region. On the other hand, seed varieties which are composed of a large number of genetically distinct units are elastic and can be grown under a wide range of environmental conditions without much change in its overall performance.

The following guidelines are suggested for selecting the planting materials for planting:

a) Minimum 5 to 6 clones suitable for the area should be selected for planting at any point of time.

b) No clone should exceed 20% of the total area of the plantation

c) Clones should be selected according to their suitability for growing conditions like drought, sub marginal soils, high pH and high fertility conditions and infilling

d) Clones should be selected according to their cultural needs like spacing, pruning, plucking etc.

e) Clonal and seedling planting may be done in the ratio of 1:1 to avoid the narrowing of the genetic base.

3.5 PROPAGATION

3.5.1 Seed Propagation

Propagation by seed was the only method of multiplication of tea plants before 1950.The vegetative propagation of tea became popular after he release of the first batch of tea clones by Tocklai in 1949 and standardization of vegetative propagation technique in tea.

3.5.1.1 Source of Seed

Seeds used for commercial planting are biclonal seeds produced by different tea estates in their own seed baries and also by some commercial tea seed producers. These clonal seed stocks are released by the Tocklai Experimental Station.

For the establishment of a seed barie of a particular seed stock, the parents are supplied by Tocklai, if any one or both the parents are generative clones. If both the parents are vegetative clones, the seed producers may use the clones from their own source. Such seed producers or the seed baries are approved by Tocklai Experimental Station and the seed producers have to follow certain rules and regulations. While seedlings of a particular seed stock variety are to be raised, seeds should always be procured from the approved seed baries or seed producers. Seeds of unknown origin should not be used.

3.5.1.2 Procurement of Seed

Tea seeds of different biclonal seed stocks look alike. Different seed baries produce different stocks. Stocks selected for propagation should be booked during July, August with approved

seed producers so that seeds can be procured during November, December and January. Seeds should be procured directly from these producers and not through the middlemen.

3.5.1.3 Seed Testing

Seeds are packed either in wooden boxes or in bags filled with charcoal powder containing 20 kg seeds in each box or bag, which is called one unit. Seeds are tested just after arrival. Size of seeds should not be less than 8 mm in diameter. Tea seeds lose their viability very soon; hence the seeds should be sown in the nursery immediately after the receipt of the seeds.

Seeds may be tested before sowing by sinker-floater test.

- **Sinker-Floater Test :** Seeds are placed in a bucket or container half filled with water. All good seeds sink; however, some seeds may be semi-floater. Such semi-floater seeds may be allowed to remain in the water overnight .Such seeds or some of such seeds become sinker. Percentage of sinker seeds is determined by calculating the number of sinker seeds in one unit.

Germination test may also be conducted to assess the germination percentage. For that 100 sinker seeds are placed in moist sand and allowed to crack and germinate. The percentage germination can be determined in this manner. The germination percentage should be at least 90 of the procured seeds.

3.5.2 Vegetative Propagation

The most popular and easy method of vegetative propagation in tea is by cutting which consists of a single leaf with a piece of internode of the current years' growth. Propagation by single leaf internodal cuttings is widely accepted throughout the tea growing regions of the world with local modifications. Tea plant propagated through cuttings retains all the characteristics of the plant from where the cuttings are taken. The plant is referred to as mother plant or bush.

Mother Bush

For vegetative propagation, the mother bushes of different clones are maintained in Nucleus plots. The nucleus plots are not shaded by growing any shade trees like normal plantation. Mother bushes are frequently monitored so that pests and diseases cannot attack them. Cuttings are taken from mother bushes which are in the age group of 3 to 15 years.

Methods of Taking Cuttings

The mother plants (bushes) in the nucleus plot are pruned and skiffed twice a year so that cuttings can be taken in two seasons of the year. Cuttings can be taken from the mother bushes in April-May when bushes are light pruned in November. After taking cuttings in April-May, the bushes are deep skiffed in May-June and the cuttings from those bushes can be taken in September-October.

- **Preparation of Cuttings :** Shoots coming out from the pruned or skiffed bushes are used for taking cuttings after 5-6 months of pruning /skiffing. Shoots which have not developed laterals and are in the banjhi stage are suitable for taking cuttings.

Growth periodicity in tea

In tea, the freely growing shoots grow through alternate phases of growth and dormancy. As the apical bud grows, it unfolds first two scale leaves, called *janam* followed by a fish leaf or *gol pat*, then 4-5 normal leaves. After that the apical bud enters into a resting period or dormancy and the bud becomes small. This bud is called a *banjhi* bud and the shoot *banjhi* shoot. After some time, the *banjhi* bud swells up and start growing unfolding first two *janams*, then one fish leaf, and then the normal leaves and again the bud becomes *banjhi*. This is called the phasic growth in tea. The amount of growth produced by a growing apical but between two phases of *banjhi* stage is called

a flush. The *janams* usually fall off just after unfolding leaving a scar mark on the shoot. The fish leaf is partly serrated and lack an apex and is photosynthetically very efficient. The position of *janams* and fish leaf on the shoot is of great importance in considering different plucking systems.

For vegetative propagation of tea the most suitable type of cutting is the internode cutting consisting of a leaf containing about 2.5 cm of stem below it and about 0.5 cm of stem above it.

Leaves which are very young and tender do not make good cuttings and only those leaves, which have become hard are taken for making cuttings. For this purpose, the long pruned branches are tested by bending them between thumb and fingers.

The soft top portion with one or two leaves, which bend easily and the very hard and woody bottom portion of the stem are not suitable and discarded. The flexible middle portion yields the good cuttings.

The cuttings are prepared by giving a top cut immediately above the axillary bud parallel to the leaf blade. The basal cut should be given obliquely more or less parallel to the leaf blade about 2.5 cm below the node.



(a) **(b)**

Fig. 4.1 : (a) A Single leaf internode cutting (b) A rooted cutting

- **Season of Vegetative Propagation :** There are two seasons of taking cuttings for successful vegetative propagation of

tea in Assam - spring season from April to June and autumn season from September to Mid November.

- **Time of Taking Cuttings and Transportation :** The best time for taking cuttings is early morning. The shoots selected for taking cuttings should be severed from the mother bush and immediately put in water in a bucket and transported to the nursery where cuttings will be prepared. Direct sunlight should be avoided. Spraying of water may be done on the bushes in the previous evening. During the hot and dry period, the spraying of water may be given about half an hour before taking cuttings so that the leaves remain turgid.
- **Precautions while preparing Cuttings :**
  a) Cuttings should preferably be prepared during morning and evening hours under good shade.
  b) Prepared cuttings should be kept in a bucket of water or wrapped in wet hessian cloth to prevent desiccation.
  c) The cut should be sharp. The knife used for making cuttings should be sharp enough not to bruise the stem.



CHECK YOUR PROGRESS

Q.1. When the seeds of a seed stock variety should be booked with the seed producers?

.....

.....

.....

Q.2. Name the two seasons of vegetative propagation.

.....

.....

Q.3. How to select cuttings from a shoot?

.....

.....

.....

.....

Q.4. What precaution should you take while preparing cuttings?

.....

.....

.....

.....

3.6 TEA NURSERY

Establishment of a tea nursery for vegetative or seed propagation requires special techniques which are discussed hereunder:

3.6.1 Site

Well drained highland area with a perennial water source for irrigation should be selected for setting up a tea nursery. The selected site should preferably be in an open space, away from tall trees or jungle, which is accessible from the main road and near the farm house.

In hilly areas, setting up of tea nurseries on the southern and south western slopes should be avoided.

3.6.2 Layout of Nursery

The nursery area should be divided into two major parts, with a motorable road for loading and unloading. Further sub divisions may be made according to the size of the nursery. One small sub division should not have more than 10 (ten) beds. See that all the beds are easily connected by a footpath.

A water source/ reservoir and pump should preferably be at the centre of the nursery. A shed is essential for performing nursery work or for storing materials. The germination pit for seeds may be dug in one corner of the nursery. Drains should be dug according to the slope of the site. Fence the boundary of the nursery and provide a gate for entry.

3.7 NURSERY TECHNIQUES FOR VEGETATIVE PROPAGATION

Tea cuttings can be propagated directly in sleeves under overhead nursery with proper adjustment of shade.

3.7.1 Type of Soil

The best soil for tea nursery is sandy loam soil. It should not be very sandy nor very heavy. It should rather be virgin soil as far as possible. The soil should not be very rich in organic matter. The soil should be acidic having the pH of 4.5 to 5.5.The nematodes (eelworm) in the soil should not be more than 6 per 100 g soil sample. However, vegetative propagation nursery may be established in any site and the type of soil does not come into consideration because now days cuttings are normally planted directly into the sleeves.

3.7.2 Preparation of Beds

Nursery beds should be of 1.2 m width and of any convenient length. The beds should be laid out in East-West direction. Each bed should be separated by 30 cm wide and 30 cm deep drains which are connected to the collector drains in the nursery.

In hilly areas, beds are to be constructed along the contours. Preparation of beds should be completed before monsoon.

3.7.3 Sleeve Filling and Placing Sleeves on Beds

The polythene sleeves of 12.5 cm lay flat wide and 20 cm long are suitable for planting cuttings .For plants to be raised for only one year,150 gauge recycled polythene sleeves are sufficient

For filling up the sleeves, the sleeve mixture consisting of three parts of top virgin soil and one part of well decomposed sieved cattle manure is used. To 1 cubic metre of the mixture, 500g of single super phosphate (SSP) is added with this mixture. Filled up

sleeves are placed on nursery beds at least 2 months before planting of cuttings so that the soil mixture is well settled inside the sleeve.



Fig. 4.2 : Polythene sleeves filled up with sleeve mixture



Fig. 4.2 : Polythene sleeves filled up with sleeve mixture



Fig. 4.3 : Polythene sleeves placed on the bed of the nursery

3.7.4 Planting Cuttings and Watering

The cuttings should be planted in a slightly slanting manner so that the leaf does not touch the soil of the sleeve. The internode part under the soil should be firm. Watering should be done regularly or as and when necessary, on the planted cuttings. However, excessive watering may lead to over callusing in cuttings which hinders rooting.



Fig. 4.4 : Planting of cuttings in sleeves

3.7.5 Construction of Overhead Shed

Shade is essential for raising vegetatively propagated tea plants in the nursery. The overhead shed is a roof like structure provided above the beds at a height of about 160 cm to 220 cm. The most suitable type of overhead shed is the North high type shed, where the roof is kept higher on the northern side with a slope towards south. Sheets of agro shade net can be used for construction of sheds. A shed of these agro shade nets (dimension 5.3m X25m) can cover as many as 20 beds of size 1.2m X 30m.



Fig. 4.5 : Overhead shed in nursery

Overhead shed may be constructed with locally available materials like bamboo, *ekara*, and thatch as roofing materials. On the east, west and southern sides, side screen should be erected with any of the above materials to prevent direct sun.

3.7.6 Care and Maintenance of Nursery

Maintenance of proper shade in a nursery is very important.

The north high type shade allowing 40 to 50% light should not be disturbed until about 10 weeks before the removal of the plants to the field for planting. The shade should be gradually thinned out with the removal of side screens so as to harden the plants for field planting.

All weeds in the sleeves should be removed by hand regularly. Topping up of the sleeves with clean soil may be done, if needed.

3.8 NURSERY TECHNIQUES FOR SEED PROPAGATION

It is easier to propagate tea from seeds. Seed can be directly sown in beds or raised in polythene sleeves. When planting materials are raised in sleeves, transportation is easier.

When seeds are to be sown directly on beds, ploughing of the soil up to 45 cm is necessary. Care should be taken so that the land is leveled properly following ploughing.

3.8.1 Bed Preparation for Tea Seed and Green Manuring Crop

The beds should be of 1.2 m in width and of any convenient length. The soil of the nursery bed should be mixed with 50g SSP per running metre of bed length. There should be a narrow bed of 30m width between two broader beds for sowing of green manuring crop. Two drains of dimension 45 cm depth and 30 cm width are to be laid out on both sides of the bed.

3.8.2 Sowing of Green Manuring Crops

Seeds of *Crotalaria anagyroides, Dhaincha* or *Arahar* (tall variety) are to be sown in the smaller beds to provide shade to the tea seedlings.

3.8.3 Sleeve Filling

Sleeve mixture consisting of three parts of virgin top soil and one part of well decomposed cattle manure plus 500 gm SSP per one cubic meter of the mixture is used for filling up the sleeves. For seed propagation the dimension of the sleeves should be 12.5 cm laid flat wide and 20 cm long. Filled up sleeves are placed on beds.

3.8.4 Pre-germination of Seed or Cracking

A pit of size 2 m X 2 m length and breadth and 1m depth should be dug. A layer of 5-7 cm sand is placed at the bottom of the pit. Sand is moistened by sprinkling water. Tea seeds are placed inside the sand layer and covered with banana leaves. The pit is protected from rain or direct sunshine by a thatch roof at the top. Seeds start cracking within a week. The cracked seeds are collected for sowing directly in beds or in sleeves.

3.8.5 Sowing of Seeds

Seeds are sown by placing the eye downward, at 1-2 cm below the soil either in sleeves or in beds. When sown in beds, a spacing of sowing the seeds should be 2.5cm X 2.5cm in triangular manner.

3.8.6 Mulching and Watering

Mulching with thatch or other green/dry materials is necessary just after sowing the seeds. Regular watering should be done. The frequency of watering should be reduced as the plants grow up. The mulch materials should be removed immediately after germination of seeds.

3.8.7 Overhead Nursery

An overhead shed helps in protecting the young seedlings

when raised in sleeves. The structure of the nursery may be similar to that used for vegetative propagation.

3.9 NURSERY MANAGEMENT

Regular inspection of nursery is a must. Attack of any pest and disease should immediately be taken care of by spraying recommended chemicals or by adopting recommended cultural practices.

The nursery beds and the sleeves should be watered regularly so as to soak the bed soil upto a depth of 10 cm.In any case excess watering should be avoided. Any depression at the base of the plant in sleeves should be topped up with clean soil.



CHECK YOUR PROGRESS

Q.5. State true or false

a) The nursery beds should be laid out in East-West direction. (True/False)

b) No fertilizer is added to the sleeve mixture. (True/False)

c) The polythene sleeves of 12.5 cm lay flat wide and 20 cm long are suitable for planting cuttings (True/False)

Q.6. How to sow tea seed in bed or polythene sleeves?

.....

.....

Q.7. Why is the green crops sown in tea seed nursery?

.....

.....



3.10 LET US SUM UP

- Commercial plantings are exclusively done by biclonal seeds and clones .Biclonal seeds are used for raising seedlings and clones are propagated by cuttings. Biclonal seeds are produced by different tea

estates and also by commercial tea seed producers which may be approved by Tocklai Experimental Station. Seeds should always be procured from the approved producers.

- Order for procurement of seeds should be placed with the seed producers well ahead of time. On receipt of the seeds, these should be sown immediately as tea seeds loose their viability soon. The procured seeds should have at least 90 percent germination.
- The mother bushes of the clones are maintained in the nucleus plot for taking cuttings. The nucleus plot should not be shaded and the mother bushes should be free from the attack of any pest and diseases.
- Propagation by cutting is the most common method of propagation. There are two seasons of propagation *viz.,* April-May (spring propagation) and September–November (Autumn Propagation). Mother bushes are light pruned in November and the primary shoot-sarising from the pruned bushes are used for taking cuttings in April–May. After taking cuttings, the bushes are deep skiffed and the new shoots developed are used for taking cuttings in September-October.
- Single leaf internode cuttings are prepared in the morning or late evening. The cuttings should not be exposed to direct sun. Before taking cuttings, the bushes may be sprayed with water to keep the leaves turgid at the time of preparing cuttings. The leaves in the middle portion of the banjhi shoots are most suitable for taking cuttings. Hence the top most succulent portion and basal woody portion of the shoot are discarded. The cutting should be made with sharp knife so that the stem is not bruised.
- The nursery site should preferably be in an open space, away from tall trees or jungle, which is accessible from the main road and near the farm house. Water source/ reservoir and pump should preferably be at the centre of the nursery. A shed is essential for performing nursery work or for storing materials. The germination pit for seeds may be dug in one corner of the nursery. Drains should be dug according to the slope of the site. Fence the boundary of the nursery and provide a gate to enter.

- Cuttings are directly planted in polythene sleeves. Sleeves of 12.5 to 15.0 cm lay flat wide and 15 to 20 cm long of 150 gauge polythene are used for raising cuttings. Sleeves are filled up with a mixture of top soil (3 parts); well decomposed cattle manure (I part) and Single super phosphate @ 500g per one cubic meter of mixture. Cuttings are planted in the sleeves and the sleeves are placed in beds under overhead shed. The overhead shed may be erected by Agro Shade Net or by local materials. Regular watering is necessary in cuttings, however, over watering is detrimental.
- Tea seeds may also be sown directly in sleeves or in beds. In seed nursery, in between two seed bed, green manuring crops are sown in a narrow bed for providing shade to the nursery seedlings. Before sowing, tea seeds are cracked in a germination pit and only the cracked seeds are sown in polythene sleeves or beds. The seeds are sown at 1-2cm below the soil pointing the eyes downwards. If sown in bed, the spacing should be 2.5 cm x 2.5 cm in triangular pattern. The polythene sleeve nursery should be shaded by overhead shed like vegetative propagation nursery.



3.11 FURTHER READINGS

- *Tea Cultivation– Comprehensive Treatise* by N.Ghosh Hajra. International Book Distributing Co., Lucknow.
- *Field management*, Published by Tockali Experimental Station, TRA, Jorhat.



3.12 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Seed Varieties selected for propagation should be booked during July, August with approved seed

producers so that seeds can be procured during November, December and January.

Ans .to Q. No. 2 : April–May (spring) and September-October (autumn)

Ans. to Q. No. 3 : Primary shoots of 5-6 months old are selected for taking cuttings. The top most 2-3 tender leaves on shoots with growing buds and bottom leaves on the hard and rough reddish brown portion of the stems are discarded. Cuttings are prepared from the middle portion of the shoot which is neither hard nor soft.

Ans. to Q. No. 4 : Cuttings should preferably be done during morning and evening hours under good shade. Prepared cuttings should be kept in a bucket of water or wrapped in wet hessian cloth to prevent desiccation**.** The cut should be sharp; the knife should be sharp enough not to bruise the stem.

Ans. to Q. No. 5 : a) True, b) False, c) True

Ans. to Q. No. 6 : Seeds are sown by placing the eye downward, at 1-2 cm below the soil in sleeves.

Ans. to Q. No. 7 : Green manuring crops are grown in between beds of tea seed beds for providing shade to the young seedlings.



3.13 MODEL QUESTIONS

Q.1. What are the different types planting materials recommended for commercial planting? Describe each type in brief giving suitable examples.

Q.2. What is a biclonal seed variety? How the seed is produced? Describe the establishment of seed barie.

Q.3. What are the criteria of choosing planting materials for planting?

Q.4. Describe the differences between a clone and clonal seed variety.What are the different methods of propagation of tea?

Q.5. What are the sources of tea seeds for purchasing?

Q.6. How to test the tea seeds for viability?

Q.7. How to take cuttings from mother bushes and prepare cuttings?

Q.8. What should be the ideal site for tea nursery?

Q.9. Describe the method of seed propagation.

*** ***** ***

UNIT 4: LAND PREPARATION AND PLANTING

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Land Preparation

- 4.3.1 Land Preparation in Virgin Land
- 4.3.2 Land Preparation in Uprooted and Marginal Land

4.4 Planting

- 4.4.1 Age and Size of Plant
- 4.42 Stacking
- 4.4.3 Spacing
- 4.4.4 Digging of Pits or Trenches
- 4.4.5 Planting Time
- 4.4.6 Planting Out

4.5 Aftercare

4.6 Infilling

4.7 Planting of Tea in Undulating Hilly Areas

- 4.7.1 Catchment Planning
- 4.7.2 Identification of Catchment
- 4.7.3 Man Made Catchment
- 4.7.4 Contour Planting

4.8 Let Us Sum Up

4.9 Further reading

4.10 Answers to Check Your Progress

4.11 Model Questions

4.1 LEARNING OBJECTIVES

After going through this unit you will be able to:

- name the different types of land for tea cultivation.
- describe the procedure of land preparation in virgin land.
- describe the land preparation in uprooted and marginal land.

- explain the need for soil rehabilitation.
- describe the method of planting.
- select the planting materials for planting in different situations.
- describe the practices adopted following planting.

4.2 INTRODUCTION

Land preparation before planting tea is an important operation. Proper care should be taken at the time of land clearing and preparation. At this stage, there is every chance of land erosion and destruction of soil structure, particularly in virgin land in sloppy terrain if the land is exposed to sun and rain. Planting is also a simple process, but if not properly done, it can cause serious setback to the establishment, growth and development of young tea. Any error at the time of planting may persist for long years after planting. It is, therefore, essential to take adequate care at the time of planting. After planting, the plants are trained to develop a frame by adopting different practices.

In this unit, we shall discuss land preparation and planting of tea and its aftercare.

4.3 LAND PREPARATION

The land available for planting tea is of three types *viz.,* virgin land, uprooted land and marginal land. Virgin land is one which has never been used for any cultivation but has been under forest or grassland. This type of land is very suitable for tea cultivation. Such soils are very fertile and have very good physical character.

When virgin land is not available for cultivation of tea, then land under old tea or other crops is replanted after uprooting the old tea bushes or the other crops. In Assam, tea is planted in many small holdings which were earlier under other crops like arecanut, sugarcane, orange or other crops. The physical properties of such old tea areas or land under some other crops are substandard from the point of view of tea planting and, therefore, can be replanted only after adequate rehabilitation.

Marginal land is that land which was not deemed fit for planting tea earlier and was left as such but due to non-availability of good land it has now been considered for tea cultivation, only after adequate rehabilitation.

4.3.1 Land preparation in Virgin Land

Virgin land is very suitable for tea cultivation. Generally such soils are very fertile and have good physical condition. However, the soils physical conditions and fertility can be destroyed within a short time by adopting faulty land preparation techniques.

Virgin land suitable for tea cultivation is becoming scarce. Most of such land now available in the North eastern states is located in hilly terrain, occasionally on steep hill slopes. It is, therefore, very important to take utmost care so that the soil is not destroyed by way of erosion and destruction of its structure. Because when land is cleared for planting tea, the cover of vegetation which acts as a barrier to movement of water along the surface is destroyed, making it easier for the rain to wash the loose soil down the slope.

The soil of the proposed area should be tested at least one year ahead of planting to determine its suitability for tea cultivation.

In areas, with more than 2 per cent gradient of slope, layout of field drains, roads etc. should be strictly according to the topography of the land. In such areas, topographical survey by competent surveyor is necessary to survey the area to identify the catchments and identify the topographical features like main and subsidiary water channels and ridges.

In such sloppy areas, clearing should be done catchment-wise. If the entire catchment cannot be cleared or if it is not required to clear at a time, the clearing should be taken in stages staring from the top. Clearing of the area should be done from the top to the lower portion of the catchment. The details of planting tea in undulating areas are discussed later in this unit.

Catchment

A catchment is a self contained unit so far as water collection and disposal is concerned. A catchment is bounded by ridges or high land and usually contains a main outlet for flow of water. The catchment in an area can be identified from the knowledge of the topography of the area which can be identified from the contour map prepared by a surveyor.

The big trees of the area should be killed one season ahead by adopting “Ring barking” method. The dead trees after felling should be uprooted completely removing their stump and the entire root system.

The under growth can be cleared by cutting down or uprooting leaving the litters *in situ.* Burning of the jungles should be avoided.

The pits formed due to uprooting of stumps should be filled up with the excavated soil.

If there are any ant hills, these should be removed completely and the pit so formed should be filled up with top soil.

The land should be leveled with minimum soil disturbances. No ploughing is needed in virgin soil. Soil disturbances should be kept to the minimum, particularly in sloping terrain.

Ring Barking

Ring barking is a method of killing big tree in which the entire root system dies and while removing the stump and roots, no fresh root is left behind in the soil. Fresh vegetative materials left in soil may harbour soil pathogens, hence killing of tree is recommended instead felling. In rink barking, the bark of the trunk is removed upto cambium making a ring of 30 cm thick at a height of about 1.0 -1.5 m from the ground. Burnt mobile along with 2, 4-D or 2, 4-T may be applied to the cut portion. This checks the translocation of photosynthates from the leaves and gradually the tree starts dying.

After leveling, drains should be dug and the excavated soil should be thinly spread over the ground, or if possible, the soil should be removed from the site. Generally, the field drains are dug making only 30 cm deep at the time of land preparation and these are deepened only after planting tea.

In undulating land, contour drains are marked and dug along the contour maintaining suitable gradient. The tea rows are staked and if possible green crops like *Crotolaria angyroides* should be grown in between tea rows. In sloping land, staking should be done in between two contour, drains following 'Master Row' system.

Land preparation should be completed before the onset of monsoon and planting should be completed before heavy rains. There should be minimum interval between clearing of the site and planting of tea.

4.3.2 Land Preparation in Uprooted and Marginal land

The continuous mono cropping of tea for many years may destroy the physical condition of soil and make the soil compact. The unsatisfactory growth of plants in such area is due to the lack of aeration and sheer physical obstruction in the growth of roots. In case of the land under other crops like sugarcane, orange or other crops also, the soil structure may be destroyed by rain beating on soil and breaking down of the soil aggregates, burning up of organic matter by the sun in exposed soil. All these factors lead not only to deterioration of soils physical condition but also its fertility status. While the fertility status may be easily rectified by addition of nutrients, the improvement of the physical condition of the soil is a long term process.

Soil Rehabilitation : Before planting tea in such area, the area needs to be rehabilitated for the proper growth and development of tea plants and the sustained productivity of the area. Soil rehabilitation is needed in areas where the soil structure is destroyed

due to burning of the organic matter and soil being compact. The objectives of soil rehabilitation are to increase soil aeration, improve soils physical condition and to increase the organic matter content.

The land after the uprooting of the old tea bushes, or any other such areas where soil's physical condition is poor, is required to be rehabilitated before planting tea.

Normally, soil rehabilitation is done by growing grasses for a period ranging from 18 to 24 months. Some other crops like twining creepers, green manuring crops may also be used. However, grasses are the most suitable crops for soil rehabilitation.

In case of replanting of tea in the uprooted tea areas, first step of rehabilitation programme is to plough the land properly and, if required, sub soiling should be done. Sub soiling is needed in case of heavy soils by means of which the compact sub soil is broken without inverting the soil with a narrow cultivator shovel or chisel. The next phase is the incorporation of organic matter into the soil. The status of the organic matter in the soil is improved by addition of lopping of rehabilitation crops.

Soil Rehabilitation Crops : The rehabilitation crop selected for the purpose should be easy to grow in the particular locality and should produce luxuriant growth to provide a large amount of organic matter. Further, the species grown should be amenable to repeated lopping. The species should preferably possess a robust and deep root system which can penetrate to the lower depth of the soil.

Guatemala grass (*Tripsacum laxum*) is the most suitable and extensively used soil rehabilitation crop. Pusa Giant Napier (*Pennisetum purpureum*), citronella grass (*Cymbogan wintarianus*) may also be used as rehabilitation crops.

The rehabilitation crops should be planted in future tea rows after properly ploughing the land. At the time of planting of the rehabilitation crops, 15 – 20 tones of cattle manure per hectare should be applied as basal dressing, if possible. If not, N; P; K 60:30: 60 kg per ha as 10:5:10 YTD mixture may be applied. The

crop can be lopped three times a year at 8-10 weeks intervals and the lopping should be placed *in situ.* If the soil is very acidic (pH less than 4.5), 2-3 tons of powdered slacked lime per hectare is suggested at the time of soil preparation.

The land can be considered properly rehabilitated only when there is satisfactory growth of the rehabilitation crop itself. On satisfactory completion of rehabilitation, the crop is cut at ground level and the litters are kept in situ as mulch.



CHECK YOUR PROGRESS

Q.1. How to clear the virgin land for planting tea?

.....

.....

.....

Q.2. What types of land need soil rehabilitation before planting?

.....

.....

.....

Q.3. How is soil rehabilitation done?

.....

.....

.....

.....

.....

Q.4. State true or false :

a) The big trees of the area should be killed one season ahead by adopting “Ring barking” method for planting tea (True/False)

b) The area for planting can be cleared easily by burning the vegetation (True/False)

c) Grasses are most suitable crops for soil rehabilitation (True/False)

d) Normally, soil rehabilitation is done by growing grasses

for a period ranging from one year to two years. (True/ False)

e) Land preparation should be completed before the onset of monsoon and planting should be completed before heavy rains. (True/False)

Q.5. Name three soil rehabilitation crops.

.....

.....

Q.6. What are the benefits of soil rehabilitation?

.....

.....

4.4 PLANTING

4.4.1 Age and Size of Plant

Healthy and vigorous nursery plants should be selected for field planting. Plants with at least 12-15 leaves or 45-60 cm in height having a stem thickness of 0.5 to 0.8 cm (pencil thickness) are ideal. Sub-standard plants and those with damaged branches or leaves should not be used. Usually, between 10 -20 months from sowing seeds or planting cuttings, the nursery plants become ready for field planting. Plants of uniform height should be used for planting in the same field as far as practicable.

4.4.2 Choice of Planting Materials

It is very important to select the right types of planting materials suitable for the particular region or area. While using clones, one should be very careful in choosing the clones. It is advisable to choose those clones only which are performing well in the particular area. However, seed varieties may be selected for planting without much consideration.

The planting materials recommended for planting in Assam are given in Table 5.1.

Table 5.1 : Planting materials recommended for Assam

TV Clones	TRA/Garden series and Industry clone	Biclonal seed
TV 1, TV 9, TV 14, TV 16, TV 17, TV 18, TV 19, TV 20, TV 21,TV 22, TV, 23, TV 24, TV 25, TV 26, TV 27,TV 28, TV 29,TV 30	Longai17, Hauplongcherra, Kaliapani 25, Baghmari 35, Nagrijuli 6/24, Teen ali 17/1/54, Panitola 126,Barmajan 2, S3/A3, Gohpur33, Barmajan 5, Heelehkah 22/14, Kolony 26, Dhulapadung 36, Arajuli 37, Mornoi 30, T S3/A1	TS 449,TS 450, TS 462,TS 463, TS 464,TS 491, TS 520,TS 589, TS 506

The following planting materials may be chosen under adverse situations and other purposes :

Growing situation	Recommended planting materials
Marginal land	TS 462, TS 463,TS464, TS 491, TS520,TS 506
Drought prone area and poor drainage	TV 9,TV 18,TV 20, TV 22,TV 23, TV 25, TV 26, TV 27, TV 28, TV 29, TV 30,TS 491,TS 589
For infilling	TV 9,TV 18,TV 20, TV 22,TV 23, TV 25, TV 26, Tin Ali 17/1/54, TS 462,TS,4643,TS 464,TS,491, TS 506,TS 520.

4.4.3 Spacing

The recent trend in planting is to accommodate as many plants as possible per unit area of land. However, it is considered that plant population higher than 20,000 plants per ha is not beneficial. Usually, 14,000 to 18,000 plants per ha is considered to be desirable

plant population for a high early yield and quick ground coverage.

In selecting spacing, the minimum spacing between plants in a row and between rows should be 60 cm and 105 cm respectively. The spacing between rows should not be less than 105, if the spacing is less than that it will hinder plucking and other intercultural operations. However, it should not be more than 120 cm.

The spacing should be chosen considering the growth habit (whether spreading or compact) of the clones or seed varieties selected for planting. Closer spacing should be used for clones or seed varieties having compact frames e.g. clones like TV1, TV 17, TV 27, TV 28, Tin Ali 17/1/54 and seed varieties like TS 449,TS520. On the other hand, wider spacing should be adopted for spreading types of planting materials like TV 14, TV 19, TV 20, TV 23, TV 26, TV 29, S_3A_3, TS 462,TS 463, TS 464.

Planting may be done in two different patterns *viz.*, single hedge and double hedge. However, now- a-days, only single hedge planting is preferred. The plant population under different spacing is shown in Table 5.1.

Table 5.1 : Plant population in different spacing

Spacing	Calculated plant population per ha
105 cm x 60 cm	15,680
105 cm x 70 cm	13,605
105 cm x 75 cm	12,550
120 cm x 60 cm	13,700

As mentioned earlier, the spacing should be selected based on the planting material chosen for planting.

4.4.4 Staking

Prior to digging out the pits for planting tea, bamboo pegs are normally used in the field to mark the position of the plants in order so that the alignment of the bushes are in straight line. This procedure is called staking. Stakes are made of 45-50 cm long split

bamboo pegs. Staking may be done in two ways. The stakes may be put between the pre determined positions of the plants so that the stakes will remain in its own position while pits are being dug according to spacing. Again, the stakes may be put in the pre-determined position of the plant as per spacing and pit is dug by removing the alternate stake.

4.4.5 Digging of Pits or Trenches

Two methods of planting may be followed *viz.,* pit planting and trenching planting. Pit planting is followed when the spacing between plants is sufficiently large enough to allow large pits to be dug without difficulties. Pit should be 45 cm wide 45 cm deep circular and straight walled. In heavy soils, the bottom soil may be forked to a further depth of 15 cm. If the spacing is closer, pits can be dug alternatively to avoid difficulties. After that the rest are dug. Pits should be dug only at the time of planting. In the rainy season, it is not desirable to dig pits in advance and leave them as such. On heavy rainy days also, pits should not be dug. Pebbles, wood, root or leaves should be removed from the pits.

Trench planting may be adopted for closer spacing and heavy soils. Trenches of 30 cm wide and 45 cm deep are dug along the rows. Normally pit planting is preferred to trench planting.

4.4.6 Planting Time

In general, a cool, humid climate and soil that is moist but not wet favour transplanting. However, a favourable soil climatic condition following transplanting is more important to encourage the growth of the young plants till they are firmly established in the field.

In areas like Upper Assam where thick mist in the cool hours of night and morning occurs during the period from November to January coupled with a few light showers, planting is possible in this part during late autumn and early winter (October-November).In

other areas where the winter is dry and monsoon arrives only in March, even later, planting is safe only during spring and early summer (April-May) after a few showers when the soil is sufficiently moist. However, planting in heavy rainy days should be avoided.

4.4.7 Manuring at the Time of Planting

At the time of planting adequate manuring with phosphatic fertilizer and organic manure is essential for better tilth of the soil in the pit and root growth of the young plants. Four to five kg well decomposed cattle manure; 30 gm rock phospahate and 30 gm single superphosphate are applied per pit at the time of planting. Vermicompost may also be applied in place of cattle manure.

Rock phosphate and cattle manure or vermicompost are mixed with the excavated soil thoroughly and filled in the pit. Single super phosphate is applied around the *bheti* of the plant about 5 cm below the ground level.

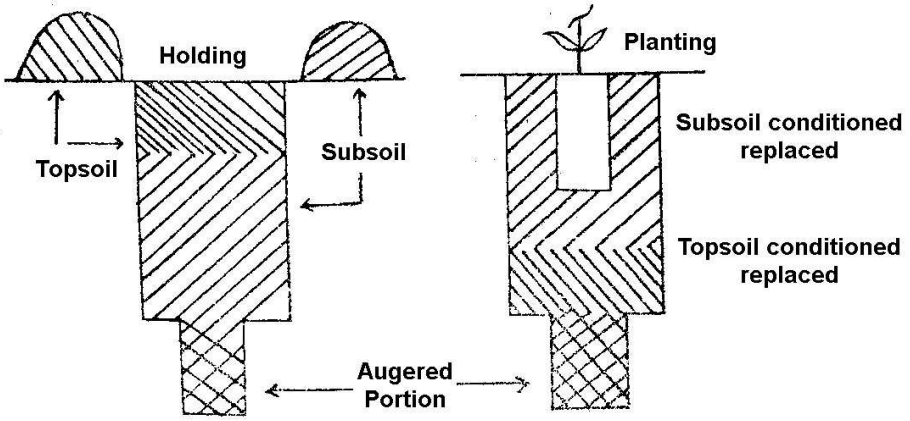


Fig. 5.1 : Planting technique

To protect the young plants from nematodes, Thimet or Furadon @ 2.5 gm per pit may be applied at the time of planting. It should be mixed with a portion of excavated soil and applied to the upper half of the pit. If the area is prone to cockchafer grub, 500 ml of Thiodan solution (diluting to 1:500) may be applied to the pit when the pit is filled up upto 2/3 rd of its depth.

4.4.8 Planting

While filling the soil, proper ramming should be done. Poor ramming may create depression in the collar region and result in localized water logging, anaerobic condition thus created, and result in high mortality after planting. On the other hand, ramming the soil too hard is harmful and may cause soil compaction which is detrimental to plant growth.

While planting seedling plants, the top of the sleeve or *bheti* should remain just above (1.2 cm) the ground level. In case of clonal plants, the tip of the cutting should remain slightly above the ground. Planting deeper i.e. burying the stem in the soil results in poor growth and finally in the death of the plant.

The following precaution should be taken in planting

- The polythene sleeves should be carefully removed
- While ramming, the *bheti* should not be damaged
- If the sleeve gets damaged during transportation and/or planting exposing the root system, care should be taken to place the root system vertically in the pit without twisting. Roots fail to grow and develop properly if they remain twisted at the time of planting.
- In case where the roots overgrow the size of the sleeve, the roots of the bottom of the sleeve should be cut with a sharp knife to avoid twisting.



CHECK YOUR PROGRESS

Q.7. What should be the size of nursery plant for field planting?

.....

.....

Q.8. What should be the minimum spacing between the plants in a row?

.....

Q.9. Name four planting materials which are recommended in drought prone area.

.....

.....

Q.10. What should be the size of planting pit?

.....

.....

Q.11. What chemical fertilizer is applied at the time of planting?

.....

Q.12. State true or false

a) In general, a cool, humid climate and soil moist but not wet favour transplanting (True / False)

b) In Upper Assam, spring planting is preferred to autumn planting (True / False)

c) Normally pit planting is preferred to trench planting.

4.5 AFTERCARE

4.5.1 Leveling

As soon as planting is completed, the whole field should be leveled by cheeling. During planting the surface becomes undulating and localized stagnation of water may occur.

4.5.2 Deepening of Field Drains

If the field drains were dug shallow before planting tea, the drains are deepened and the excavated soils are uniformly spread. The excavated soil should not be heaped in one place which hinders the water movement causing localized water logging.

4.5.3 Mulching

After leveling, the field should be mulched heavily with any green leafy materials. Mulching simply means covering the surface

of the soil with any available plant material *viz.*, straw, cut grass, tree leaves, ferns, water hyacinth, rice hulls, leaves from green-manure crops etc. Whatever plant material is used should be harvested before it has produced seeds. If the mulch contains seeds, they may sprout after the mulch is placed in the tea field, producing weeds that will have to be controlled. Mulching is very essential in droughty areas. Mulching with materials like Guatemala grass or water hyacinth at a thickness of about 6 inches is most suitable. Mulching should be done by the middle of November when the soil is moist.

The benefits of mulching are: It

- Reduces soil erosion (by protecting the soil from the impact of raindrops)
- Increases soil moisture (by protecting the soil from sun and wind, and therefore reducing evaporation from the soil).
- Can increase problems with root diseases (especially if the mulch is leaves from green-manure plants or other leaves rich in nitrogen)
- Helps in controlling the weeds
- Improves soil structure and fertility (by adding organic matter to the soil). If mulch leaves are collected from forests, it can damage forests and natural areas.
- May help control some diseases of tea leaves (by preventing soil from splashing onto leaves during rains).
- Increases absorption of phosphorous fertilizer by tea plants (probably because mulching increases the production of feeder roots in the surface layer of the soil).
- It is easy and cheap.
- It adds organic matter to the soil
- It proliferates the feeder root growth

Approximately 20-40 tons of mulching materials are needed for mulching an area of one ha. If the grower does not have enough mulch to cover the entire surface of the soil, mulching can be done

in strips. The mulch should not touch the stems of the tea bushes, because the mulch gets hot and can kill the tender stem tissues. The mulching materials should be placed in between rows of tea keeping a gap of 10 cm from the collar of the plants.

In fields where soil insects are a problem, the mulch should be kept even farther away from the tea plant, leaving a ring of bare soil 15-20 cm diameter. In dry weather, mulch is a fire risk. To reduce the risk of fire, strips of land in both directions (side to side) should be kept bare of mulch.

If green materials are not available, straw may also be used for mulching. But while such materials with high C: N ratio is used, it is advised to apply 20 kg Urea per ha or any nitrogenous fertilizer to avoid temporary nitrogen starvation of the plants.

If mulching cannot be done, the ground should be spread with a cocktail mixture of 1:400 solution of an acaricide, an insecticide and a fungicide with a hand-operated sprayer.

4.6 INFILLING

Some plants may die in the field for a variety of reasons such as poor drainage, pests and diseases, debility, lightning etc. Infilling is the replacement of dead plants by new ones. Vacancies encourage growth of weeds and reduce the production. Infilling of vacancies is better done in the first two years when the young plants have not spread much so that the infill can grow freely and have better chance for survival. After planting of infill, the ground should be mulched with any suitable vegetable materials in order to reduce the loss of soil moisture and add organic matter to the soil.

Strong plants with good root system of appropriate clones or clonal varieties should be used for infilling in order to compete against the established plants around. It is not necessary only to use the material that is already planted in the field. While infilling, a large pit should be dug to ensure the presence of no live roots of established tea close to the new plant. Preferably, two plants per vacancy in a large pit should be planted.

The side branches of the neighboring plants may be trimmed and the infill should be tipped a little higher in the first two years or so. Pegs can be put around the infill which would protect plants from trampling.



CHECK YOUR PROGRESS

Q.13. What type of planting materials should be used in infilling?

.....

.....

Q.14. Why is mulching beneficial in young tea areas?

.....

.....

4.7 PLANTING OF TEA IN UNDULATING HILLY AREAS

4.7.1 Catchment Planning

Most of the land area selected for growing tea in the hilly states of North East India except the plains of Assam is located on hill slopes or on undulating topography, though occasionally there may be some areas having very steep slope. In those areas, all the soils are not equally deep and stable. Heavy rainfall at least during a part of the year, is a characteristic feature of most of the areas of this region. A combination of these factors is likely to lead to erosion of soil, when the land will be cleared for planting tea. In the slopping terrain where the soil is not sufficiently deep, heavy and continuous rain can cause land slide which is experienced in the existing tea plantations of Darjeeling.

Thus, safe disposal of water from such areas is a perquisite for soil conservation in tea plantation. Flat and gently sloping land may also pose serious problems of the disposal of surplus water under the conditions of heavy rain. During the rainy months, water logging, high water table and occasional flooding in most of the tea

areas of Assam pose some serious problems.

One of the most important factors responsible for soil erosion, land slide, poor drainage in different regions of North East India's tea growing areas is the lack of catchment planning. In other words, planting of tea, construction of roads, and layout of drains in old tea plantations are not according to topography.

As topography dictates water movement over the soil and to a certain extent below the soil surface, conservation of soil and water, safe disposal of excess water ,and good access can only be achieved correctly when the layout of a tea plantation is based on the topography. It is, therefore, emphasized that planting of tea in any new areas should be based on catchment planning for maximum sustained production which in turn is dependent on the best possible use of all assets.

A catchment is a self contained unit so far as water collection and disposal is concerned. A catchment is bounded by ridges or high land and usually it contains a main outlet for out flow of water. The first requisite of catchment planning is to divide the proposed area into major natural catchments followed by further sub-division into minor natural catchments. Subsequently, these minor catchments are sub-divided by man-made constructions such as roads, paths and graded contour drains so that each unit becomes a catchment.

The catchment can be identified from the knowledge of the topography of the area. A complete level survey, designed to pick out all the topographical features is necessary for catchment planning. The survey and preparation of survey map must be done by some competent surveyor. It is suggested that the scale used should in no case be less than 25 cm to a kilometer. For flat land and for areas of less than 240 ha, the scale should be 50 cm to a kilometer. It is because the larger the scale the clearer is the topography.

The topography of an area becomes obvious from the

contour lines drawn on the map. A contour line is a line drawn on a map connecting all those points on the ground which are at the same distance above (or below) a specific datum, usually, mean sea level. These lines are numbered, and therefore, show the degree and extent of rise and fall of the land surveyed.

4.7.2 Identification of Catchments

Division of catchments is based on the very simple principle that water always flows down hill at right angles to the contours. On the survey map, it is seen that in some areas contour lines are convex while in some other areas are concave to the fall. Where the contour lines are convex to the fall, then the movement of water over such are will be away from the apex of the curve; on the other hand, where the lines are concave to the fall then water will collect in the apex of the curve and flows downhill in a line connecting each apex. Similarly, a line connecting the apices of the convex curves is a crest or ridge. The area between two ridges, therefore, forms a catchment because water will tend to flow inwards away from the two ridges until it meets at the apices of the concave curve of the contours. Thus, a line drawn connecting the apices of the concave curves is the natural water channel for the area between two ridges and forms the main drainage channel for this catchment.

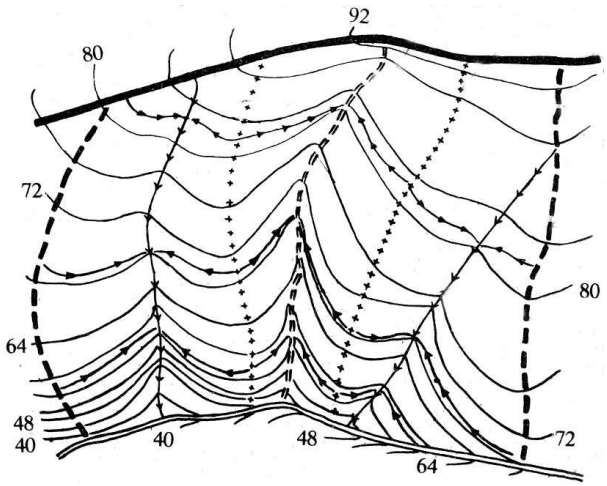


Fig. 5.2 : Identifiocation of catchment

Based on this principle, major and minor natural catchments within the boundaries of the proposed tea plantation can be identified.

After getting the survey map, planning on a catchment basis can be commenced. It is advisable to avoid drawing on the contour map and, therefore, it is suggested that the plan be made on the tracing paper which is fixed on the contour map.

First, the permanent features of the area, boundaries, building, public road, river etc. should be traced. Thereafter, the major and minor catchments should be identified marking the crest and natural water courses using the contour lines as the guide. In topographical planning the first factor to consider is access or road. The roads should follow the ridges/crests because if roads are constructed along the ridges, they have easy and direct access and pose no problem for water disposal.

After preparing the plan it should be examined carefully to see if complete road access has been achieved. If more roads are considered necessary then these should be aligned from the main ridges to main water disposal channels at right angles to the contours.

For plucking access, paths will have to be made that run down the slope across the contour planted tea and drains. These paths could become uncontrolled water channels, which though undesirable, are necessary. In order to reduce leaf damage in plucking baskets/bags, it is essential that the leaves should be emptied into large baskets. When planning, it is therefore, necessary to provide such plucking paths after every 75-110 meter or hedge.

On flat land, the topographical features of minor crests and water channels are either not obvious or non existent. In such cases, whenever roads are considered necessary these are marked from the main ridge to water channel at right angle to the contours and in between each pair a water channel at right angle to contours should be marked.

With the completion of these exercises, a plan showing

topographical access and the complete break down into catchment has to be made, and this becomes the Master Plan for all future development.

4.7.3 Man made Catchments

Planning work for planting tea like land cleaning planting and digging of drains etc. should be done catchment-wise. A minor natural catchment is then sub-divided into man made catchment by constructing graded contour drains from ridges to water courses at intervals down the slope.

For making the graded contour drains on the tracing paper, first the vertical interval (V.I) should be calculated. The vertical interval between the contour drains is dependent on three factors, *viz.,* the percentage slope, soil type and rainfall in that area

The following formula can be used to calculate the vertical interval between graded contour drains:

a) Rainfall below 2500 mm (100″)

$$\text{V. I. in feet} = \frac{\text{Percentage slope}}{4} + 3$$

b) Rainfall below 2500 mm – 4375 mm (100-175″)

$$\text{V. I. in feet} = \frac{\text{Percentage slope}}{4} + 2$$

c) Rainfall above 4375 mm (above 175″)

$$\text{V. I. in feet} = \frac{\text{Pecentage slope}}{4} + 1.75$$

To convert the result to metric units, the calculated V.I. in feet should be multiplied by 0.305 to get in meters.

These formulae apply to medium textured soils under the different rainfall conditions. As run off will be more in fine textured soils and less in coarse textured soils, adjustments should be made

for soil type. Adjustments to the calculated vertical intervals for soil type should be made as follows:

Soil type	Adjustment
Coarse textured soil(Sand and loamy sands)	+ 12 to + 20%
Moderately course(Sandy loam)	+ 4 to + 12%
Medium texture(Loam and silt loam)	+ 4 to – 4%
Moderately fine texture(Clay loam, silty clayloam)	-4 to – 12%
Fine texture(Silty clay and clays)	12 to – 12%

After calculating the V.I. for different situations, the graded contour drains are marked on the plan. The positions of the drains which are always graded from ridge to water course are marked and the direction of flow is also indicated. The gradient of 1:500 is maintained to the drains when they are marked on the ground.

4.7.4 Laying out Catchments in the Field

So far all the work in connection with catchments planning has been done in the office and the time has now come to inspect the ground to explore the conversion of the estate into topographical units according to the Master Plan, and identifying on the ground the catchments.

The various stages for laying out man made catchments are detailed below:

- **Preparation of sketch :** Prepare a sketch of the catchment to be laid out on a scale of not less than 64 inches to one mile (approximately 1m to one kilometer). The sketch should show the catchment boundary, percentage slope, plucking paths, collector and contour drains.
- **Checking the plan against topography**: Walk over the catchment with the sketch to see if the plan you have made will fit in conveniently with the lie of the land. Some alternations may be necessary and where they are required they should be made and recorded on the sketch.

- **Marking of plucking paths and collector drains** :With the aid of the sketch, measuring tape and stakes, mark on the ground with the stakes the plucking paths and the collector drains in such a manner that it is possible to distinguish between them.
- **Marking of starting point of each contour drain**: For the sketch it will be possible to determine the distance between each of the graded contour drains and their starting points. These should be carefully measured and marked on the ground. To avoid wastage of space, the distance between drain should be adjusted so that the total distance is divisible by the space that is going to be left between tea rows e.g. presuming a planting distance of 120 cm between rows then the distance between the contour drains should be exactly divided by 120 cm.
- **Marking the contour drain on the ground:** A constant fall of 1:500 from the ridge to the collector drain should be the gradient given to the contour drains. To mark the position of the drains on the ground a Dumpy Level is essential.

The method of marking the position of graded contour drains on the ground is to stake points 20 ft (for any distance) apart along the line of the drain so that the fall between stakes 1 in 500 which is a fall of 0.04 between stakes. This is done by setting up the dumpy level in a suitable position and after selecting a convenient temporary bench mark (TBM) and recording the level reading on the TBM, the level staff is held at the starting point of the topmost contour drains in the catchment and level is recorded. The staff man then moves 20 feet along contour towards the collector drain, a reading is then taken through the dumpy level and the man holding the staff is made to adjust until staff reading of 0.04 feet more than the previous reading is seen. When correct reading is obtained, the position of the staff is marked by a stake. The process is repeated until the complete length of the first contour drain has been traversed. All

contour drains are marked on the ground in the same manner. After completing the staking, the drain lines are smoothened out.

4.7.5 Contour Planting

After marking the drain lines in a catchment, the planting should be started from the upper part .A Master Row is first marked on the ground in between two graded contour drains and, subsequently, the other rows are marked for planting. The Master Row is marked based on the nature of the two drains (Fig.5.2).

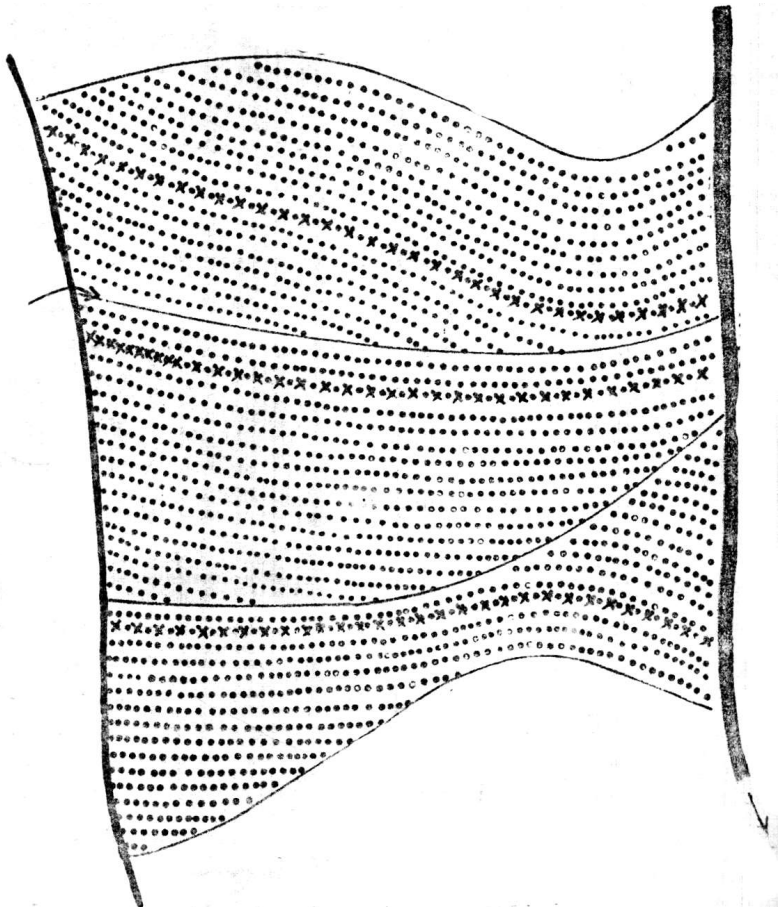


Fig. 5.3 : 'Master Row' planting in sloppy areas



CHECK YOUR PROGRESS

Q.15. What is the need for catchment planning?

.....

.....

Q.16. What is a contour line?

.....

.....

Q.17. What is Vertical Interval?

.....

Q.18. State true of false :

a) The first requisite of catchment planning is to divide the proposed area into the major natural catchments which is followed by further sub-division into minor natural catchments. (True/False)

b) Planning work for planting tea like land cleaning planting and digging of drains etc. need not be done catchment-wise. (True/False)

c) The planting of tea should be started from the upper part of a catchment. (True/False)



4.8 LET US SUM UP

- Land available for planting tea is of three types *viz.,* virgin land, uprooted land and marginal land.
- The soil of the proposed area should be tested at least one year ahead of planting for its suitability for tea cultivation.
- In areas, with more than 2 per cent gradient of slope, layout of field drains, roads etc. should be made strictly according to topography of the land. In such areas, topographical survey by a competent surveyor is necessary to survey the area and to identify the catchments and the topographical features like main and subsidiary

water channels and ridges.

- In virgin area, the big trees should be killed one season ahead by adopting “Ring barking” method. The dead trees after felling should be uprooted completely removing their stump and the entire root system. The undergrowth can be cleared by cutting down or uprooting, but leaving the litters *in situ.*
- The land should be leveled with minimum soil disturbances. Soil disturbances should be kept to the minimum particularly in sloping terrain.
- Land preparation should be completed before the onset of monsoon and planting should be completed before the heavy rains. There should be a minimum interval between the clearing of the site and planting of tea.
- In uprooted or marginal land, soil rehabilitation is needed before planting tea.
- The objectives of soil rehabilitation are to increase soil aeration, improve soil physical condition and increase the organic matter content.
- Soil rehabilitation is done by growing grasses for a period ranging from 18 to 24 months. Some other crops like twining creepers, green manuring crops may also be used; however, grasses are the most suitable crops for soil rehabilitation. Guatemala grass (*Ttripsacum laxum*) is the most common rehabilitation crop used in tea.
- Plants with at least 12-15 leaves or 45-60 cm in height having a stem thickness of 0.5 to 0.8 cm (pencil thickness) are ideal for field planting.
- In areas like Upper Assam where thick mist in the cool hours of night and morning occurs during November to January coupled with a few light showers, planting can be done during October-November. In other areas where the winter is dry and monsoon arrives only in March planting can be done during April-May after a few showers when the soil is sufficiently moist.
- In selecting spacing, the minimum spacing between plants in a row

and between rows should be 60 cm and 105 cm respectively.

- Pits are dug just before planting. Pit should be 45 cm wide 45 cm deep circular and straight walled. In heavy soils, the bottom soil may be forked to a further depth of 15 cm.
- Four to five kg well decomposed cattle manure, 30 gm rock phospahate and 30 gm single super phosphate is applied per pit at the time of planting. Vermicompost may also be applied in place of cattle manure.
- As soon as planting is completed, the whole field should be leveled by cheeling, mulched with vegetative materials and field drains are deepened.
- The vacancies created due to death of plants should be infilled with stout plants of suitable clones or seed varieties preferably during the first two years of planting.
- In hilly undulating areas, catchment planning is necessary. By surveying the area, the major and minor catchments can be identified from the contour map. Based on the map, the natural waterlines and ridges can be identified.
- First the contour drains are marked and the vertical interval between two contour drains is determined depending of the soil type, rainfall and slope of the area. Planting of tea is done between two drains following Master Row principle.



4.9 FURTHER READINGS

- *Tea Cultivation- Comprehensive Treatise* by N.Ghosh Hajra. International Book Distributing Co., Lucknow
- *Baigyanik Vittit Chahkheti* (in Assamese) by Dr. G.K.Saikia and Dr.M.Taparia, Published by B.Saikia, North Lakhimpur, 2009.
- *Field Management of Tea*, Tocklai Experimental Station, Tea Research Association, Jorhat.

4.10 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : While clearing the virgin land for planting tea, the big trees are killed by Ring barking one year ahead of planting. The trees should not be felled. The undergrowth should be cut and allowed to decompose *in situ.*

Ans. to Q. No. 2 : Land which was under plantations of tea or other crops where the soil has become compact, the structure is poor; organic matter is lost and it becomes unfertile needs rehabilitation before planting tea.

Ans. to Q. No. 3 : Soil can be rehabilitated by growing grasses or some other green manuring crops. However, grasses are the most suitable crops for soil rehabilitation. The fibrous roots of the grasses can penetrate deep into the soil and after decay of the roots following lopping of the top at intervals are added to the soil. Thus, the organic matter content in the soil increases. The roots of the grasses being fibrous do not harbour any soil pathogen. The grasses are grown for 18 to 24 months.

Ans. to Q. No. 4 : a) True, b) False, c) True, d) False, e) True

Ans. to Q. No. 5 : a) Guatemala grass (*Tripsacum laxum*)
b) Pusa Giant Napier (*Pennisetum purpureum*) and
c) Citronella grass (*Cymbogan wintarianus*)

Ans. to Q. No. 6 : The objectives of soil rehabilitation are to increase soil aeration, improve soil physical condition and increase the organic matter content.

Ans. to Q. No. 7 : Plants with at least 12-15 leaves or 45-60 cm in height having a stem thickness of 0.5 to 0.8 cm (pencil thickness) are ideal.

Ans. to Q. No. 8 : 60 cm.

Ans. to Q. No. 9 : TV 9,TV 18,TV 20, TV 22,TV 23, TV 25, TV 26, TV 27, TV 28, TV 29,TV 30,TS 491,TS 589

Ans. to Q. No. 10 : Pit should be 45 cm wide 45 cm deep circular and straight walled. In heavy soils, the bottom soil may be forked to a further depth of 15 cm.

Ans. to Q. No. 11 : Single super-phosphate

Ans. to Q. No. 12 : a) True, b) False, c) True

Ans. to Q. No. 13 : Strong plants with good root system of appropriate clones or clonal varieties should be used for infilling in order to compete against the established plants around.

Ans. to Q. No. 14 : Mulching conserves soil moisture, checks weed growth, adds organic matter to the soil and proliferates the feeder root growth of tea plants.

Ans. to Q. No. 15 : Catchment planning is needed for scientific layout of drains, roads, plucking paths in a plantation for safe disposal of water and to conserve the soil from erosion.

Ans. to Q. No. 16 : A contour line is an imaginary line on the ground which connects all the points situated at the same elevation.

Ans. to Q. No. 17 : Spacing between two contour drains.

Ans. to Q. No. 18 : a) True, b) false, c) True.



4.11 MODEL QUESTIONS

Q.1. Describe how to clear the virgin land for planting tea. What precautions should be taken during land clearing to conserve the soil?

Q.2. Why is soil rehabilitation necessary in uprooted and marginal land for planting tea? What are the objectives of soil rehabilitation?

Q.3. How is soil rehabilitation done? Why grasses are preferred to other green manuring plant? How long the soil should be under

rehabilitation crops?

Q.4. Describe the method of planting in respect of (a) Season (b) Spacing (c) Size of nursery plants (d) Manuring at the time of planting.

Q.5. What do you mean by catchment planning? Describe the importance of catchment planning for planting tea.

Q.6. Write notes on :

a) Natural catchment and man made catchment.

b) Graded contour drains

c) Vertical Interval.

*** ***** ***

UNIT 5: YOUNG TEA MANAGEMENT

UNIT STRUCTURE

5.1 Learning Objectives

5.2 Introduction

5.3 Objectives of Training

5.4 Frame Formation

6.4.1 Operations

5.5 Methods of Bringing Up

6.5.1 Method Adopted for Plains of N. E. India

6.5.2 Method Adopted for Hilly Areas of N. E. India

5.6 Cultural Practices Adopted in Young Tea Management

5.7 Let Us Sum Up

5.8 Answers to Check Your Progress

5.9 Further Reading

5.10 Model Questions

5.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- State the objectives of training the young tea.
- Describe the different operations adopted in training the young tea.
- Describe the methods adopted in bringing up the young tea into bearing.
- Explain the importance of different cultural practices adopted in young tea management.

5.2 INTRODUCTION

In the previous unit, we have discussed land preparation and planting of tea. In this unit, we shall discuss the different methods that are adopted to train the young plants to form a low spreading bush with a well developed frame and branch system.

The initial 4 to 5 year period after planting is crucial because during this formative period if a good frame can not be developed, the plantation can not sustain high yield. The formation of a bush frame is, therefore, one of the main objectives of young tea management. However, the maintenance of the health and vigour of the plant by proper nutrition, protection from pests and diseases, conservation of soil and water during this period are equally important for the development of a good frame.

5.3 OBJECTIVES OF TRAINING AND YOUNG TEA MANAGEMENT

The tea plant by nature is a small tree or shrub. However, when it is cultivated, the plant is trained to form a low spreading bush so that maximum vegetative growth (shoots) can be harvested at a convenient height. The objectives of training or bringing up of young tea are:

i) To develop a low spreading frame for quick ground coverage
ii) To form a plucking table at convenient height for plucking
iii) To develop a sturdy bush frame (permanent frame) during these formative years for sustained luxuriant growth in future years and
iv) To harvest maximum crop even in the early years to recover in the shortest possible time the capital invested in planting.

Recent methods of young tea management emphasize on the harvesting of good crops as well as building up of a healthy permanent frame to support high yields in years to come. However, health and vigour of the plants are not sacrificed at the cost of higher yields during the formative period. A good management should strike a balance between these two factors and such tea bushes should yield anything in between 1000-4000 kg of made tea per hectare, after fourth or fifth year of planting.

Good management practices consist of adoption of suitable post-planting operations so as to encourage early and vigorous growth. It consists of the following:

- Adoption of suitable measures to increase the root volume to sustain the growth of heavy foliages.

- Adoption of suitable measures to increase the density and area of the bush frame to facilitate harvesting of higher amount of shoots for longer periods.
- Adoption of efficient and timely plant protection measures to relieve the young plants from unnecessary external stress, thereby allowing the plants to grow with their full potential
- Judicious harvesting of shoots without affecting the health and vigour of the plants.
- Application of manures and fertilizers commiserating with the growth requirement of the plants.
- Adoption of suitable cultural operation like drainage, shade, irrigation etc. to provide a healthy environment for the luxuriant growth of plants.

5.4 FRAME FORMATION

One of the basic aims of training of young tea plants is to develop a good permanent frame during the formative years for sustained high yield. The frame developed during this stage is called permanent frame as the frame is not disturbed during the entire life span of the bush, unless it is damaged by diseases or other causes requiring rejuvenating by removing the diseased or damaged portions.

An ideal bush frame should be wide and compact, with adequate number of uniformly thick and distributed branches. The different methods adopted for frame formation consist of various operations, which are carried out during the initial 4-5 years after planting. Before describing the methods, let us describe the operations that are adopted for training the plants.

5.4.1 Operations

Decentering : This is the operation in which the main stem is removed at a height of about 20 cm from the ground level. The operation is done when the plant makes one flush of growth following transplanting in the field and whilst they are *banjhi.* Decentering is

done by leaving at least 2-3 laterals below the decentering cut. The cut should be clean and slope towards the centre. Laterals are then cut at 35 cm above the ground level. Removal of the main stem and excision of the laterals promote more laterals from lower portion of the stem, thus increasing the number of branches.

The decentering operation should be done when the reserve (starch) in the roots is sufficient for recovery and to minimize mortality after decentering.

If the plant does not have any lateral i.e. single stemmer, then lung pruning or thumb breaking is done.



Fig. 6.1 : Decentering

Thumb breaking or Lung pruning : In this operation, the young plant is held between the thumb and index finger at a height of about 20 cm from the ground and the stem is broken in such a way that the tissues (bark) on one side of the stem are left intact for movement of water and nutrients. The broken portion of the stem should be bent towards the ground facing either south or west depending upon the row direction. It encourages development of laterals below the broken height. This is called thumb breaking. The broken portion of the stem should be removed when the laterals developed below produce a flush of growth and become *banjhi.* Care should be taken so that the broken portion of the stem remains

facing towards the ground, otherwise laterals will develop above the broken height.

If the stem is thick enough and thumb breaking cannot be done, a small pruning knife can be used to break the stem cutting one side of it. This is called lung pruning. Lung pruning or thumb breaking can be done even if starch content in roots is not at its optimum.

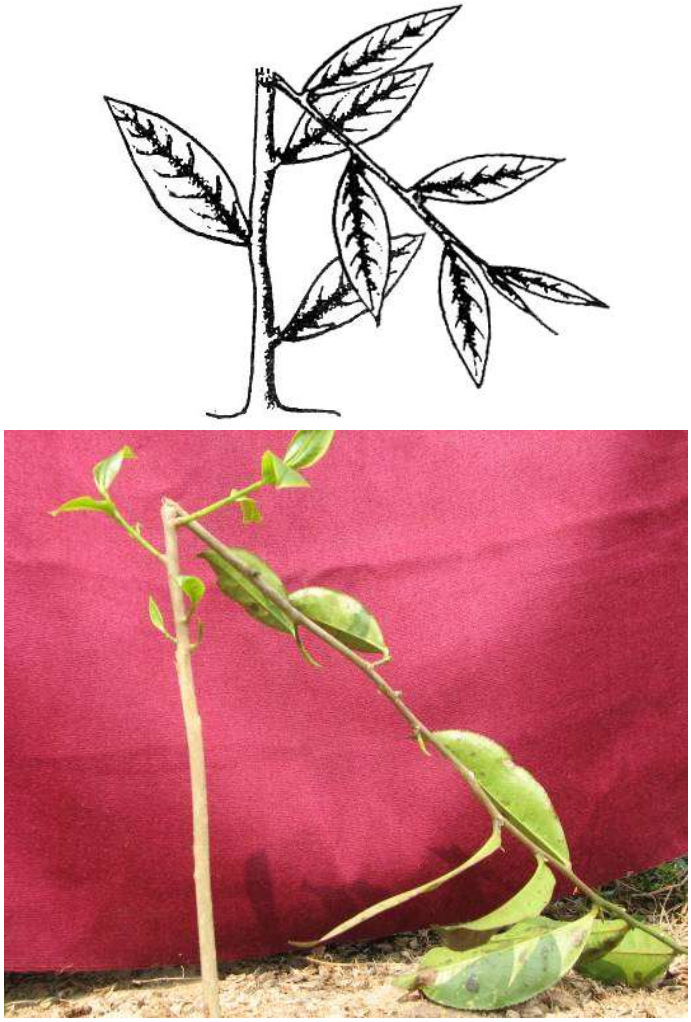
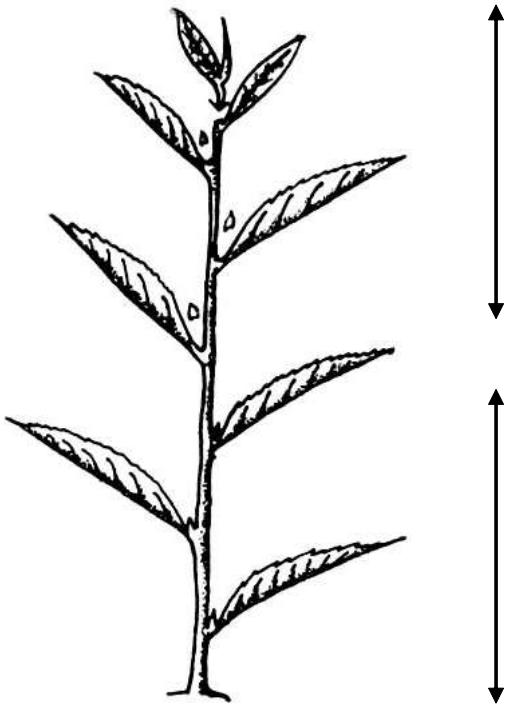


Fig. 6.2 : Lung pruning

Pegging or Bending : It is the operation by means of which the main stem and subsequently the laterals are bent with the help of pegs to encourage lateral development. The bending is done at an angle of 60 to 70 degrees from vertical. Normally, this is not practised nowadays.

Debudding : In this operation buds from the leaf axils are removed from the upper portion of the plants leaving the lower 20 cm untouched. This is done with the help of a small hack-saw blade or using finger. The top two leaves and the bud should be tipped off from the plants before debudding. This stimulates the buds below to swell and the removal of the buds becomes easy. Debudding can be done in the nursery 4-5 days before planting. Debudding at the nursery is economical and convenient. After about four weeks of planting in the field, removal of bud if any left out in the first operation should be done. When debudding is done, buds remaining below the height of 20 cm from the ground grow and form healthy laterals. The main stem should be removed by giving a clean cut at 20 cm.

The main objectives of the above operations are to suppress central dominance (apical dominance) and apical growth, distribute vigour for even radial spread so that there are uniformity in distribution and thickness of branches at the final height of the permanent frame.



Apical dominance : A growth correlation in plants. Complete or almost complete inhibition of growth in axillary buds by the presence of apical bud. The principle of training is to eliminate the apical dominance by adopting different operations.

Fig. 6.3 : Debudding

Frame forming prune : By adopting different operations described above, the plants are made to develop new branches of first tier in the frame. After about 20 -26 months from planting, a prune called the first formative prune is given at a height 5 cm below the pre-determined height of the permanent frame. Normally, in the plain areas of N.E. India, the height of the permanent frame is maintained at 40 to 45 cm and in hilly areas at 35 to 40 cm. However, the bushes should be pruned (cut across) only when the branches are 1 cm thick at the pruning height. Thicker branches are head back on merit and any congestion at the centre is removed.

After pruning, new shoots develop from the pruned branches which form the second tier of the frame. Finally after about 2 years, the final frame formation prune is given 5 cm above the first prune. At the time of final frame formation prune, the bushes are completely cleaned out removing the crossing, diseased and weak branches and snags. After this prune, the bushes are considered to be mature ones and thereafter the tea is brought under normal pruning cycle.



Fig. 6.4 : Frame forming prune

Procedure of Starch Test in roots : It is essential to test the starch reserve in roots before decentering. The procedure is as follows:

i) Select at random 10-12 plants per bigha for starch test in roots

ii) Collect roots of about 0.5 cm thick (pencil thickness) from the selected plants by digging a hole 10 cm away from the collar of the plants up to 10-15 cm depth

iii) Give a sharp cut on one end of the root and put one to two drops of Iodine solution on the cut end and wait for 5 minutes

iv) The Iodine solution is prepared by dissolving properly I g Iodine and I g Potassium iodide in 4-5 ml of distilled water in a glass beaker. Make up the volume to 100 ml by adding distilled water and preserve the solution in a coloured bottle wrapping with carbon paper.

v) After about 5 minutes of putting the solution to the cut end of the root, deep blue colour develops, if there is sufficient starch. No change in colour occurs if the reserve is low.



CHECK YOUR PROGRESS

Q.1. What do you mean by a permanent frame?

.....

.....

.....

.....

Q.2. Name three operations adopted for training tea to form a bush?

.....

.....

Q.3. Why starch test is done before decentering?

.....

.....

.....

Q.4. State true or false :

a) After decentering, the lateral branches left below should be allowed to grow freely.(True/False)

b) Debudding is done in the nursery 4-5 days before planting.(True/False)

c) After thumb breaking, the broken portion of the stem should be bent towards the ground (True/False)

d) Decentering should be done when the plants are actively growing (True/False)

Q.5. Answer the following :

a) At what height from the ground, should the plants be decentered?

.....

b) Do you suggest to decenter the single stemmers?

.....

55 METHODS OF BRINGING UP OF YOUNG TEA

Illustrations of the methods of bringing up of young tea into bearing adopted for different situations are described below. A combination of suitable frame forming prunes and plucking system contribute greatly towards the formation of a healthy good frame and proper field management practices like manuring, weed control, pest and disease control, drainage, shade, water conservation etc. help the plants to grow very vigorously.

5.5.1 Method Adopted for Plains of N. E. India

In the previous unit, you have come to know that tea is planted either in autumn or in spring. Depending upon the time of planting, the method will vary as described below.

For plains of N. E. India, tea planted in Autumn (October-December)

Plant age	Month	Operation
0 year	October to December	Planting is done and the plants are allowed to grow
	Late February to Mid April	Plants are decentered at 20 cm height from the ground level and plants are tipped at 65 cm above the ground
+1 year	June-July	If the central branches are strong, these are pruned down or head back. The crossing branches, if any, should be removed
	End October	The height of the plant is raised (step up) by a leaf
+2 year	Whole year	Plucking is carried out throughout the year. Plucking is done upto *janam*
+3 year	End January to Early February	First frame forming prune is given at 35 -40 cm above the ground level. Tipping is done at 65 -70cm above the ground.
	End October	Step up by one leaf, if required, is done
+ 4 year	Whole year	Plucking is continued throughout the year
+5 year	End January to early February	Final frame forming prune is given at 40 -45 cm above the ground. Thick central branches, if any, are headed back. The bushes are tipped at 70cm above the ground and plucking is continued.

For plains of N. E. India, tea planted in spring (April-May)

Plant age	Month	Operation
0 year	April-June July-August	Planting is done and plants are allowed to grow. When the plants establish well, thumb breaking/lung pruning or decentering is done at 20 cm from the ground level. The plants are tipped at 60-65 cm above the ground. However, if the pants are weak or planting was done late, the operation is deferred to early February to mid April of the next year.
+1 year	Whole year	Plucking is continued. The plants are kept unprune.
+2 year	End January to Early February End October	First Frame forming prune at 35-40cm above the ground is done. Tipping is done at 65-70 cm above the ground. If required, step up the bush by 1 leaf.
+3 year	Whole year	Plucking is continued, bushes are kept unprune.
+4 year	End January–early February	Final frame forming prune is done at 40-45 cm above the ground. Tipping is done at 65-70 cm. Thick branches at the central portion are headed back.

5.5.2 Method Adopted for Hilly Areas of N. E. India

For low elevation hilly areas

Plant age	Month	Operation
0 year	June-July	Planting is done and plants are allowed to grow.

+1 year	January-February	Decentering is done at 15-30 cm and tipping is done at 55-60 cm above the ground. Strong central branches and cross branches, if any, are removed.
+2 year	Whole year	Plants are kept unprune and plucking to janam is continued.
+3 year	January-February July-August	First frame forming prune is done at 30-35 cm and plants are tipped at 55-60 cm above the ground done. The plucking table is stepped up by one leaf, if required.
+4 year	Whole year	Bushes are kept unprune and plucking is continued.
+5 year	January	Final frame forming prune is done at 35-40 cm and tipping is done at 60-65cm above the ground. Thick central branches, if any, are removed

For high elevation hilly areas

Plant age	**Month**	**Operation**
0 year	June-July	Planting is done and plants are allowed to grow.
+1 year	January-February Early September	Decentering is done at 15-20 cm and tipping is done at 50-55 cm above the ground. Thick central branches are removed. Step up one leaf, if required.
+2 year	Whole year	Plants are kept unprune and plucking is continued
+3 year	January-February Early September	First frame forming prune is done at 30-35 cm and tipping at 50-55 cm above the ground. Step up I leaf, if required, is done.

+4 year +5 year	Both years	Bushes are kept unprune. Plucking is continued. Step up by one leaf is done, if required.
+6 year	January-March	Final frame forming prune at 35-40 cm is done. Tipping is done at 55-60 cm above the ground. Any strong branch at the central portion is removed.

After giving the final frame forming prune, the bushes are treated as mature tea. Thereafter, the bushes are brought under regular pruning.

5.6 CULTURAL PRACTICES ADOPTED IN YOUNG TEA MANAGEMENT

5.6.1 Weed Control

This is an important practice in young tea management. The young tea plants are extremely susceptible to weed competition. Weed growth is very prominent in the first and second year of planting before the plants cover the ground. During March to October, weed growth is most vigorous in young tea areas; therefore, utmost care should be taken to control the weed growth during this period. Weeds may be controlled both by manual or mechanical and chemical methods. The details will be discussed latter. Mulching is one of the most effective measures to control weed growth in young tea areas.

5.6.2 Shade Planting and Regulation

Planting of temporary shade tree species in young tea areas is important to provide shade to the young plants Though permanent shade tree species are planted at the time of planting tea, these species being slow growing can not provide shade to the young

tea plants. Generally quick growing species like *Indigofera teysmanii, Gliricidia sepium* etc should be planted at closer spacing which are later thinned out and finally removed completely when the permanent shade trees take over. These temporary shade trees are kept in the young tea areas for initial 5-6 years. Regular lopping of branches may be done if the shade becomes dense. We shall discuss shade management in tea plantations in Unit 7.

5.6.3 Manuring

Application of fertilizers in young tea plays a significant role in the establishment of frame and yield during the formative period. Nitrogen , phosphorous and potash are applied to the young plants in the form of YTD (NPK mixture) at frequent intervals .We shall discuss in detail about the preparation of YTD doses and the method of application later in Unit 8.

5.6.4 Green Cropping

Green crops are useful in young tea. The trees and shrubs used for perennial manures are known as green manure crops. They are initially used as cover crops and later they or their lopping are either hoed into the soil or mulched to enrich the soil. *Crotalaria anagyroides* is the most useful among the green manuring crops. It grows rapidly and resists the drought well. It is better to grow a mixture of species of green crops, which are known to grow quickly and make bulky crops in that area in order to provide large amount of organic matter, fix atmospheric nitrogen and add in appreciable quantities.

The green manuring crops or ground cover crops like *Crtalaria angyroides, Priotropie cytissoides, Desmodium gyroides, Calopogonium muscoides, Stylosanthes guyanensis, Centrosoma pubescence, Pureria phasioloides, Tephrosia candida* may be used alone or in mixture.

The green crops and the cover crops should be ploughed under during August-September, a month or so before planting or replanting. The green crop should be sown between the rows of young tea.

5.6.5 Pest and Sisease Management

The young tea areas should be kept free from the pests or diseases. Poor drainage, heavy or poor shade, weed infestation are some of the factors for the incidence of pests and diseases in tea. The details of pest and disease management will be discussed later.

5.6.6 Drainage and Irrigation

The drainage in the young tea areas should be proper. The field drains should be deepened to keep the root zone free from water logging. Keeping the drains free from weeds and maintenance of the drains by removing the silt and soil due to bank slip are important. Watering may also be needed in the event of drought due to delay in arrival of the monsoon in some years. In drought prone areas, mulching is most important for the conservation of soil moisture.



CHECK YOUR PROGRESS

Q.6. What are the recommended heights of the permanent frame of the tea bush in plain and hilly areas of N.E.India?

.....

.....

Q.7. How many prunes are given during the formative period for developing the bush frame?

.....

.....

Q.8. Name three most important cultural practices adopted in young tea management.

.....

Q.9. What fertilizers are applied in young tea and in what form?

.....

Q.10. Name one important temporary shade tree species.

.....



6.7 LET US SUM UP

- Initial 4-5 years after planting tea is the crucial period of tea cultivation because during this formative period the tea plants are trained to form a low, spreading bush.
- The objectives of training are to develop a low spreading frame for quick ground coverage, to develop a sturdy bush frame for sustained luxuriant vegetative growth in future years, to facilitate easy plucking at a convenient bush height and to harvest maximum possible crops during the early years
- The frame developed during this stage is called permanent frame as the frame is not disturbed during the entire life span of the bush, unless it is damaged by diseases or other causes requiring to rejuvenate by removing the diseased or damaged portions.
- For developing the bush frame, different operations are adopted. These are decentering, lung pruning or thumb breaking, pegging or bending, debudding .The main objectives of these operations are to suppress the central dominance and apical growth, distribute vigour for even radial spread so that there are uniformity in distribution and thickness of the branches in the bush frame.
- By adopting these operations, plants are encouraged to develop branches from the lower 20 cm height to form the first tier of branching system.
- Decentering can be done, in case the plants have at least 2-3 branches at 20 cm height. Starch test in roots is necessary before

decentering. Decentering should be carried out when the plants establish well in the field and go *banjhi.*

- In case of single stemmer plants, thumb breaking or lung pruning is done. Care should be taken after breaking/pruning the single stemmer plants so that the broken portion is bent towards the ground.
- Debudding is the removal of the buds in the leaf axils above the 20 cm height of the plants .It is normally carried out in the nursery.
- Different method are adopted to bring up the young plants into bearing by decentering /lung pruning or thumb breaking /debudding, frame formation pruning, tipping and plucking for different situations.
- The final height of the permanent frame is maintained at 40-45 cm in plain areas and at 30-40 cm in hilly areas of N.E.India.
- Weed control, temporary shade tree planting, pest and disease control, manuring, drainage and irrigation play important role in young tea management.



5.8 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : The bush frame that is developed during the formative period i.e. during the initial 4-5 years after planting by adopting different methods is called permanent frame. It is called permanent because the frame is not disturbed in the entire life span of the bush, unless it is damaged by diseases or other causes and in cases requires to be rejuvenated by removing the diseased or damaged portions.

Ans. to Q. No. 2 : Decentering, Thumb breaking or lung pruning and Debudding

Ans. to Q. No. 3 : Decentering is a drastic operation and the removal of the main stem gives shock to the plant. For recovery, there should be sufficient reserve (starch) in the roots. Hence, starch test is necessary before decentering.

Ans. to Q. No. 4 : a) False, b) True, c) True, d) False**.**

Ans. to Q. No. 5 : a) 20 cm.

b) No. For decentering the plant should have at least 2-3 branches below the cut. Single stemmers can not be decentered.

Ans. to Q. No. 6 : 40-45 cm in plains and 35-40 cm in hills. The height of permanent frame is dependent on topography and spacing.

Ans. to Q. No. 7 : Two- the first frame forming prune and the final frame forming prune. The first is given 5 cm below the pre-determined height of the permanent frame.

Ans. to Q. No. 8 : Weed control, manuring and planting of temporary shade

Ans. to Q. No. 9 : N, P and K fertilizers in the form of YTD

Ans. to Q. No. 10 : *Indigofera teysmanii.*



5.9 FURTHER READINGS

- *Field Management in Tea*. Tocklai Experimental Station, Tea Research Association, Jorhat.
- *Tea*. By A.Deka, P. C.Deka and T. K. Mandal, in Plantation Crops. VolumeI. Naya Udyog, Kolkata.



5. 10 MODEL QUESTIONS

Q.1. What are the objectives of training of young tea? What is a ‘permanent frame’?

Q.2. What are the different operations adopted for frame formation? Describe in brief.

Q3. How to bring up the young tea into bearing in non droughty plain areas of Assam? Describe the sequence of operations.

*** ***** ***

UNIT 6: SHADE AND SHADE MANAGEMENT

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Introduction

6.3 Need of Shade in Tea

6.4 Benefits and Disadvantages of Shade Trees

6.5 Choice of Shade Trees

6.6 Planting of Shade Tree

6.7 Shade Management

6.8 Let Us Sum Up

6.9 Answers to Check Your Progress

6.10 Model Questions

6.1 LEARNING OBJECTIVES

After going through this unit you will be able to:

- explain the need for growing shade trees in tea plantations.
- discuss the benefits of shade trees.
- describe the characteristics of an ideal shade tree species.
- list out the species of shade trees used as temporary and permanent shade trees.
- describe the procedure of planting.
- describe the management of shade trees.

6.2 INTRODUCTION

As plant, tea was discovered under the great canopy of forest as an under storied plant species and was believed that it would thrive well under shade. From the beginning of the tea cultivation in Assam Sau tree (*Albizzia chinensis*) was grown in tea plantations and considered as tea fertilizing tree. However, it was later realized that shade trees not only provide nutrients to the soil, but shade trees have many beneficial effects for the

tea plants. Shade in tea is, thus, an integral part of tea plantation particularly in those areas where the leaf temperature rises to affect the photosynthesis and cause damage to leaves by scorching. In Assam, tea is grown under shade trees.

In this unit, discussion will be made on the need of shade, its benefits, different shade tree species used in tea etc.

6.3 NEED FOR SHADE

Air temperatures above 30^0 C and below 13 ^{0}C are harmful for growth of tea plant. However, in the plains of north east India including Assam, the air temperature remains above 30^0C for a greater part of the harvesting period and hence shade trees are interplanted in tea gardens to keep the temperature below a level where it cannot affect the photosynthesis adversely.

Wind velocity is useful in reducing high leaf temperature. However, the velocity of wind in the Brahmaputra valley in Assam is low due to the shelter effect of the hills on either side of the valley and for that shade is needed in a tea plantation to keep the leaf temperature down. However, in those areas where air temperature is high but the wind velocity is also high, shade is not needed. In Darjeeling where the ambient temperature is cool shade is not required.

6.4 BENEFITS AND DISADVANTAGES OF SHADE

The benefits of shade trees are:

i) Shade trees keep down the leaf temperature to a beneficial range for maximum photosynthesis.
ii) They protect the tea plants from sun burning.
iii) Shade trees reduce the quantum of harmful portion of sunlight to fall on the crop canopy.
iv) Shade trees conserve soil moisture; protect the soil surface from impact of rain drops.
v) Leguminous shade tree species fix atmospheric nitrogen besides

adding a large amount of organic matter in the forms of leaf litters.

vi) Shade trees turn over nutrients from lower soil layers and enrich the top soil.

vii) Shade trees favour partitioning of growth without affecting the quality of the crop.

viii) Attack of mites is less under shade.

ix) Shade trees minimize the hail damage.

x) In many occasions, shade trees act as a wind breaker.

xi) Shade trees create such a micro climate inside the tea plantation that enhances the growth of tea plants and thereby the yield, which cannot be achieved by artificial shading.

xii) Over and above, shade trees provide comfort to the workers while performing different operations in the field.

However, there are some disadvantages of shade trees in side the tea plantations. These are:

i) Shade trees may compete for moisture and nutrients with young tea during the years of establishment

ii) Many shade trees act as alternative hosts for some pests and diseases

iii) Shade trees hamper the mechanization inside the tea plantation.

iv) Falling of branches or uprooting due to storm causes damage to the tea plants.



Fig. 7.1 :Shade tree in tea garden

6.5 CHOICE OF SHADE TREES

6..5.1 Ideal Shade Tree Species

The species used as shade trees should have a canopy which allows sufficient light to pass through to fall on the bush surface and do not compete with the tea for moisture and nutrients .So in selecting the species the following criteria should get due consideration.

a) Suitability to the soil and climate of the area
b) Economic life, i.e. the life span should be long
c) Size and shape of the canopy- it should be spreading but not dense
d) Leaflet size and duration of leafless period-Leaflet size should be small and short leafless period
e) Root depth, deep rooted species is ideal
f) The species should be resistant to pests and diseases
g) Species should be resistant to storm damage.

6.5.2 Shade Tree Species

The trees which are used as shade trees in tea plantations

are of two types viz., temporary and permanent shade trees.

Temporary shade tree : Temporary shade trees are fast growing and are kept in the plantation for the initial 5-6 years.The following species can be used as temporary shade trees (Table 7.1):

Table 6.1 : Temporary shade tree species and their local names

Species	Assamese name
Indigofera teysmanii	Nil gas
Albizzia moluccana	–
Albizzia procera	–
Dalbergia sisso	–
Melia azadarach	Ghora neem
Leucaena lecucephala	Subabul
Gliricidea maculeata	Medura

The temporary shade trees are initially planted at a closer spacing and later thinned out and then removed completely when the permanent shade trees take over. Initially these are planted at a spacing of 2 m x 2 m and later on thinned out to 4.5 m x 4.5 m. Some of the temporary shade tree species like *Indigofera* can be vegetatively propagated. One year old stump of 1.5 m length can directly be planted in the field.

As the temporary shade trees are fast growing, thinning out of the branches and selected loppings are necessary.

Permanent Shade tree : The species used as permanent shade trees are generally slow growing. They are with longer life and taller canopy and can be kept in the plantation for 30 to 40 years.

The recommended shade tree species along with their leafless periods and local names are given in Table 7.2

Table 6.2 : Recommended permanent shade tree species

Species	Local name	Leafless period
Albizzia odoratissima	Sil Koroi or Sam koroi	End December to end February
Albizzia chinensis	Sau koroi	February-April
Albizzia lebbek	Kathia koroi	January-April
Derris robusta	Mouchita	Mid December-February
Acacia lenticularis	Kaitia Koroi	December-march
Adenanthera pavonina	Ronga chandan	January-March
Dalbergia sericea	–	December-March

In the vicinity of elephant infested areas, shade trees like *Acasia lenticularis, Derris robusta and Melia azadarach* should be preferred.



CHECK YOUR PROGRESS

Q.1. Is shade necessary in all tea growing areas?

.....

Q.2. Why is shade trees necessary in Assam?

.....

.....

.....

.....

.....

Q.3. Name three important benefits of shade trees.

.....

.....

.....

.....

.....

.....

Q.4. Why is temporary shade trees planted?

.....

.....

.....

.....

Q.5. Name four permanent shade tree species.

.....

.....

Q.6. State true or false :

a) In areas where air temperature is high and the wind velocity is also high, shade is not needed.(True/False)

b) Attack of mites is less under shade (True/False)

c) Temporary shade trees are fast growing and hence they are kept in the plantation for a longer period. (True/False)

d) *Acasia lenticularisis* preferred in areas which are prone to elephant damage. (True/False)

6.6 PROPAGATION OF SHADE TREES

6.6.1 Propagation of Shade Trees

Shade trees are propagated by seed. It is always advisable to obtain genuine shade tree seeds from own sources. For this purpose, the mother trees that possess all the desirable characters of an ideal shade tree are selected in the tea estate from which seeds are collected. In leguminous trees, the seeds are enclosed inside pods. As soon as the pods turn brown, they should be collected from the selected mother plants during January-February.

After the pods are dried thoroughly under the sun, the seeds are extracted by hand pounding. The seeds should be stored in wooden bins or gunny bags in well- ventilated, cool, dry room.

6.6.2 Nursery Techniques

The shade tree nursery should be on deep well drained high sandy loam soils rich in organic matter. The site should be near a

perennial source of water. The best time for land preparation for shade nursery is between November-December when the soil is neither too wet nor too dry. It is very important to prepare the soil into a good tilth by deep cross ploughing, harrowing and leveling. Dry well decomposed cattle manure or organic manure @ 25 tons per ha and dolomite @ 2 tons per ha used during land preparation will improve the soil condition.

The size of the nursery bed should be 1.50 m wide and of convenient length. It is advisable to complete the preparation of nursery beds in January. While preparing the beds, for a good growth of the tap root, the soil in the beds should be loosened to a depth of 60 cm. SSP should be applied @ 125 g/m2 of bed area. Each bed should be separated by 60 cm deep and 30 cm wide drain which should be connected to 120 cm deep and 45 cm wide perimeter drain.

The best time of sowing of seeds is between February-April. Before sowing, the seeds are soaked overnight in water. The dormancy of seeds with hard seed coats can be broken by immersing the seeds in water which is heated up to 80°C (without boiling) and allowing cooling in that water overnight. The seeds are sown in the following morning on moist beds at 0.5-1 cm depth and 20 cm apart in rows spaced at 30 cm distance. The seeds are covered with a thin layer of soil. The beds may be watered initially using a hand operated sprayer frequently so that beds do not go dry.

Nursery in Polythene Sleeves : Shade tree seedlings can also be raised in polythene sleeves of 60cm length, 30cm wide (lay flat) and 150 gauze thickness. For filling the sleeves, sandy loam virgin soil rich in organic matter is preferable. In absence of this, the available soil should be improved by mixing friable soil (4 parts) and dry well decomposed cattle manure (1 part) with 1 kg of SSP and 500 g of dolomite per cubic meter of soil. The above ingredients are thoroughly mixed, moistened lightly and are allowed to incubate for 7-10 days under shade before filling up the polythene sleeves.

The size of nursery beds, drainage etc is as mentioned under bed nursery. The sleeves are watered 24 hours before sowing. Two to three seeds are drilled to a depth of 0.5-1.0 cm per sleeve and covered with a layer of soil.

It is observed that during the initial period under low overhead shade, shade nursery raised in polythene sleeves does well. Low overhead shades made of any vegetative matter/Netlon can be used. The sleeves are watered lightly using Bakpak fitted with a Fan/ Cone jet nozzle. As the seedlings grow, the quantum of water will have to be increased depending upon the weather.

Pests, diseases and weeds in the nursery : Sucking pests like Psyllids and leaf defoliators do considerable damage to the germinating seedlings in their early stage. Red rust is the most serious disease of shade nurseries and is the principal cause of failure in many instances. Therefore, from the beginning care must be taken to keep the nurseries free of pests by taking timely action. In addition, proper weed control and drainage should be given attention.

Thinning : In the 7th or 8th month, it will be necessary to remove the congestion in the nursery. All the laggards, weak and stunted seedlings should be thinned out to provide more room for growth and development of the promising ones.

6.7 PLANTING OF SHADE TREES

6.7.1 Pre-planting Treatment

Well grown, healthy saplings which have attained a minimum stem diameter of 2.5 cm at a height of 1.35 m from the ground should be selected for planting in the field. About 7-10 days before transplanting, the top of the selected saplings should be cut at a height of 1.50 m - 1.80 m and the cut ends are sealed by a lump of raw cow dung and wet soil. Simultaneously, the foliage is removed

by cutting the compound leaves flushed to the stem. This is required to reduce transpiration loss from the sapling at the time of planting in the field. As soon as the axillary buds on the stems swell the saplings will be ready for planting in the field.

6.7.2 Transplanting Time

March to June is the ideal time for transplanting shade tree saplings in the field.

6.7.3 Method of Planting

***Bheti* Planting :** The shade tree saplings should be lifted from the nursery beds with a block of earth *(bheti*) which is 60 cm long and 30 cm in diameter for planting in the field in already prepared pits. The *"bhetis"* should be carried to the field very carefully so that the earth is not disintegrated. While lifting the "*bhetis"* or sleeve grown plants, the extra length of the tap root which is below 60 cm should be cut flushed to the ground.

Stump planting : The stumps should be given the pre-planting treatment as described above. The stumps should be lifted without block of earth with a 60 cm long tap root. Additional length should be trimmed or cut below 60 cm and planted in already prepared planting pits. The time gap between lifting of stumps and planting them in the field should be minimum. While carrying the stumps from the nursery to field, they should be wrapped in a moist hessian cloth so that they do not dry out.

Planting pit : The size of the planting pit is 90 cm deep and 60 cm wide. The excavated soil is mixed with 10 kg dry well decomposed cattle manure, 0.5 kg SSP, 0.5 kg wood ash and 1 kg dolomite. At the time of planting hard ramming should be ensured and the collar areas should made elevated to avoid localized water logging.

Spacing : The spacing used for planting the permanent shade trees is 10.86 -12.6 m. While planting the seedlings, the positions of the

shade trees should be in the rows of tea and for that one tea plant has to be sacrificed.

Shade mixture : To avoid the damage of epidemic pests and diseases, it is necessary to plant a mixture of different species of shade trees. The ideal mixture, called intimate mixture is one where no two trees of a single species are adjacent to each other. To get an intimate mixture a minimum of four species are required as shown in Fig 6.2.

A	B	C	D
B	C	D	A
C	D	A	B
D	A	B	C

A, B, C and D are the different species of shade trees.

Fig. 6.2 : Intimate mixture of shade trees

When species are not available to get an intimate mixture, dispersion with less than four species can be achieved by interplanting temporary shade trees. Such mixture is called non intimate mixture.

A		**B**		**A**		**B**
	X		**X**		**X**	
B		**A**		**B**		**A**
	X		**X**		**X**	
A		**B**		**A**		**B**
	X		**X**		**X**	
B		**A**		**B**		**A**

A and **B** are permanent species and **X** is the temporary species.

Fig. 6.3 : Non intimate mixture of shade tree

6.7 SHADE MANAGEMENT

Rotation of shade trees : Shade trees should be managed on a shorter rotation of 20-25 years. This is required to avoid shade trees with large trunk diameter as such trees when they fall because of storm, normally

damage 25 -30 bushes. Incidence of pests and diseases is also drastically minimized when shade trees are renewed on a shorter rotation. Therefore, interplanting of permanent shade trees should be done in the tea section where the older shade trees will have reached their rotational age in about 6-8 years.

Maintenance of young shade trees : The young shade trees in the field need constant attention for their growth and development. Sucking and leaf eating caterpillars are the main pests of shade trees. Timely control measures against these pests should be taken for a successful raising of the shade trees.

From the third year of establishment, the lower branches of the young shade trees should be trimmed selectively for obtaining a clean bole and a single leaf canopy. After trimming or cutting the branches, the cut ends should immediately be painted with indopaste.



CHECK YOUR PROGRESS

Q.7. How the shade trees are propagated?

.....

.....

.....

Q.8. What should be the dimension of the polythene sleeves used for raising shade tree saplings?

.....

.....

Q.9. What is the spacing of planting the permanent shade trees?

.....

Q.10. What is an intimate mixture?

.....

.....

Q.11. What is the ideal time of planting shade trees in the field?

.....

.....

Q.12. Answer why :

a) Shade trees should be planted in a mixture.

.....

.....

b) Temporary shade trees are grown in young tea.

.....

.....

c) Shade is not required in Darjeeling.

.....

.....

d) Shade tree species should be deep rooted.

.....

.....



6.8 LET US SUM UP

- Growing of shade trees is an integral part of tea plantation particularly in those areas where the leaf temperature rises to affect the photosynthesis and causes damage to leaves by scorching. In Assam, tea is grown under shade trees.
- Air temperatures above 30^0 C and below 13 ^{0}C are harmful for the growth of a tea plant. However, in the plains of the North east India including Assam, the air temperature remains above 30^0C for the greater part of the harvesting period and hence shade trees are interplanted in tea garden to keep the temperature below a level where it cannot affect the photosynthesis adversely.
- Shade trees have many other beneficial effects. Shade trees add organic matter to the soil, conserve soil moisture, reduce mite attack, protect the tea bushes from hail damage, and provide comfort to the workers. Leguminous species of shade trees fix atmospheric N.
- Temporary shade trees are grown for initial 5-6 years to provide shade to the young plants before the permanent shade trees come

up. Quick growing species are selected as temporary shade tree and are initially grown at closer spacing and subsequently thinned up and ultimately completely removed when the permanent shad trees take over.

- Permanent shade tree species are slow growing and they are kept in tea plantation for 20-25 years.
- Permanent shade trees species should be suitable to the area, deep rooted with minimum leafless period and resistant to pests and diseases and storm damage.
- Shade trees are propagated from seeds. Seedling may be raised both in beds or polythene sleeves. Well grown healthy saplings which have attained a minimum stem diameter of 2.5 cm at a height of 1.35 m from the ground should be selected for planting in the field. March to June is the ideal time for transplanting shade tree saplings in the field.
- Shade trees should be planted in mixture to avoid the damage of epidemic pests and diseases. Ideally, a minimum of four species should be planted to get an intimate mixture where no two trees of the same species are adjacent to each other. In absence of suitable species, along with the permanent shade tree species temporary trees may be grown to get a mixture of shade trees.
- Shade tree should be managed on a shorter rotation of 20-25 years. This is required to avoid shade trees with large trunk diameter. Therefore, new trees are planted before the old trees become 20-25 years old.
- From the third year of establishment, the lower branches of the young shade trees should be trimmed selectively for obtaining a clean bole and a single leaf canopy.



6.9 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Shade is not required in all areas.

Ans. to Q. No. 2 : In Assam, the air temperature remains above 30^0C for

a greater part of the harvesting period and the wind velocity is low. As a result, in hot sunny days, the leaf temperature rises .Hence shade trees are inter planted in tea gardens to keep the temperature below a level where it can not affect the photosynthesis adversely.

Ans. to Q. No. 3 : i) Shade trees keep down the leaf temperature to a beneficial range for maximum photosynthesis.

ii) Shade trees reduce the quantum of harmful portion of sunlight to fall on the crop canopy.

iii) Shade trees conserve soil moisture and protect the soil surface from impact of rain drops.

Ans. to Q. No. 4 : Temporary shade trees are grown in a tea plantation for the initial 5-6 years to provide shade to the young tea plants. Because during this period, the permanent shade trees do not attain the growth for providing shade to the tea plants.

Ans. to Q. No. 5 : *Albizzia odoratissima, Albizzia chinensis, Albizzia lebbek, Acacia lenticularis, Derris robusta.*

Ans. to Q. No. 6 : a) True, b) True, c) False, d) True.

Ans. to Q. No. 7 : Permanent shade trees are generally propagated by seeds. However, some species of temporary shade tees like *Indigofera teysmanii* can be propagated vegetatively.

Ans. to Q. No. 8 : The polythene sleeves for raising seedlings of shade trees should be 60cm long, 30cm wide (lay flat) and 150 gauze thickness.

Ans. to Q. No. 9 : 10.86 m x 10.86 m, 12.6 m x 12.6m

Ans. to Q. No. 10 : The intimate mixture is one where no two trees of a single species are adjacent to each other.

Ans. to Q. No. 11 : March to June is the ideal time for transplanting shade tree saplings in the field.

Ans. to Q. No. 12 : a) Shade trees should be planted in mixture to avoid the damage of epidemic pests and diseases.

b) To provide shade to young tea as the permanent

species can not provide shade during this period.

c) Due to high elevation, the ambient temperature is low and also the wind velocity is high in Darjeeling tea areas. So shade is not needed.

e) The species with shallow root system compete with tea plants for both moisture and nutrients.



6.10 FURTHER READINGS

- *Science and Practices in Tea Culture*. By D.N. Barua. Tocklai Experimental Station, TRA, Jorhat.
- *Tea Cultivation-Comprehensive Treatise*. By N.Ghosh Hajra. International Book Distributing Co., Lucknow.
- *Field Management in Tea* .Tocklai Experimental Station, TRA, Jorhat.



6.11 MODEL QUESTIONS

Q.1. Why shade is grown in tea plantation? What are the advantages and disadvantages of growing shade trees in tea?

Q.2. What are the criteria of an ideal shade tree species? Name a few shade tree species recommended for an area which is prone to elephant damage.

Q.3. How is seedling of shade trees raised? Describe the method of planting of shade trees in the main field.

Q.4. Write short notes on : a) Intimate mixture**,**

b) Temporary shade tree,

c) Rotation of shade trees

*** ***** ***

UNIT 7 : MINERAL NUTRITION AND FERTILIZER APPLICATION

UNIT STRUCTURE

7.1 Learning Objectives

7.2 Introduction

7.3 Mineral Nutrition

7.4 Forms of Fertilizers

- 7.4.1 Nitrogeneous Fertilizers
- 7.4.2 Phosphatic Fertilizers
- 7.4.3 Potassic Fertilizers

7.5 Fertilizer Application at the Time of Planting

7.6 Fertilizer Application of Young Tea

- 8.6.1 Objectives
- 8.6.2 Application of Fertilizers

7.7 Fertilizer Application in Mature Tea

- 7.7.1 Rate of Application
- 7.7.2 Method of Application
- 7.7.3 Application of Secondary Nutrients
- 7.7.4 Application of Micronutrients
- 7.7.5 Foliar Nutrition
- 7.7.6 Application of Soil Amendments

7.8 Nutrient Deficiency Symptoms

7.9 Organic Fertilizers

7.10 Let Us Sum Up

7.11 Answers to Check Your Progress

7.12 Further Readings

7.13 Model Questions

7.1 LEARNING OBJECTIVES

After going through the unit, you will be able to:

- Explain the need for fertilizer application in tea.

- Name the different forms of fertilizers and their nutrient content.
- Describe the fertilizer application at the time of planting.
- Explain the principle of fertilizer application in young tea.
- Describe the method fertilizer application in young tea.
- Describe the method fertilizer application in mature tea.
- Discuss the deficiency symptoms of the nutrients.
- Describe the role of organic fertilizers in improving soil conditions.

7.2 INTRODUCTION

Tea is normally grown as a long term mono culture. For proper maintenance of the health of the bushes and to obtain high yield, a well balanced fertilization and manuring is necessary at certain levels. Judicious use of fertilizers in association with other appropriate cultural practices is essential for sustained production of tea over a long period. Fertilizers are applied at the time of planting for the proper establishment and growth of the plants, for development of the bush frame during the formative period and for maintaining the health and vigour of the bushes and harvesting good yield during the entire life span of the plantation.

In this unit, we shall discuss the mineral nutrition of tea and fertilizers application in tea plantation.

7.3 MINERAL NUTRITION

Plants obtain a wide variety of inorganic elements from the soil. All green plants, on the other hand, manufacture their food (carbohydrates) from CO_2 and H_2O in presence of light. The inorganic elements which are essential for the growth and development of plants are called mineral nutrients or mineral elements.

The thirteen nutrient elements are recognized as essential for plants. Out of these, nitrogen (N), phosphorus (P) and potash (K), sulphur (S), calcium (Ca) and magnesium (Mg) are called macro nutrients and the rest *viz.*, zinc (Zn), iron (Fe), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo) and chlorine (Cl) are called micronutrient. Aluminium

(Al) and silicon (Si) are considered as beneficial elements for some crops. Aluminium (Al) is considered to be beneficial for tea.

The required mineral nutrients of plants are obtained largely from the soils. However, under continuous cropping, these nutrients get depleted in the soil due to crop removal and other causes and may become deficient. Therefore, for the proper growth and development of plants, these nutrients need to be replenished and the nutrition of mineral elements is called mineral nutrition.

In tea field, nutrients are removed in various ways .The nutrients are continuously removed at each plucking round and thus in a year considerable amount is removed from the soil. Some amount of nutrients is also removed in pruning litters, if these are taken away from the field.

In tea, all macro nutrients viz., N, P, K and S are supplied to the soil every year in the form of chemical fertilizers. In some areas, some of the micro nutrients also need to be applied. Zinc deficiency is widespread in many tea areas and it is applied as foliar spray.

The doses of fertilizer application for the mature tea are mostly determined on the results of long or short term field experiments. The levels of fertilizer application are determined on the basis of yield potential of the area.

7.4 FORMS OF FERTILIZERS

Knowledge on common fertilizers used in tea is useful in order to apply them judiciously. The nutrient content of some common fertilizers is presented in Table 8.1.

Table 8.1 : Important commercial fertilizers and their nutrient contents

Fertilizers	Nutrient content (%)
Ammonium sulphate	N-20.6 and S -24
Urea	N -46
Ammonium sulphate nitrate	N -26 and S-15
Calcium ammonium nitrate (CAN)	N-25 and Ca-8
Single super phosphate	P_2O_5 -16 ,S-12, Ca -21

Triple super phosphate	P_2O_5 -43 , Ca - 1
Rock phosphate (Mussorie, India)	P_2O_5 20-24, S -2.3
Diammonium phosphate (DAP)	N-18, P_2O_5 -46
Rock phosphate (Udaypur, India)	P_2O_5 30-40
Muriate of potash (Potassium chloride)	K_2O -40-60, Cl- 47
Potassium sulphate	K_2O – 50, S-16 -22
Zinc sulphate	Zn-23-35, S-11-18,
Zinc chelate	Zn -9-14
Magnesium sulphate	Mg -9.88, S-13
Dolomite (Magnesium limestone)	CaO-34, MgO-18-21
Iron Pyrites	S- 22-24 ,Fe-20-22

7.4.1 Nitrogenous Fertilizers

Ammonium sulphate : This has been the traditional nitrogenous fertilizer in tea. It is a white crystalline salt and non-hygroscopic in nature. It is easy to handle and can be stored well under dry conditions. It is relatively slow acting as the ammonium has to be converted to nitrate before absorption by the tea plant.

Ammonium sulphate is recommended for application (a) during pre monsoon or hot weather when soil moisture is not optimum, (b) when soil pH is high, (c) in fertilizer mixture and (d) once in three years to combat possible sulphur deficiency. The unit cost of nitrogen in ammonium sulphate is the highest compared to other nitrogenous fertilizers.

Urea : Urea is white granular with very hygroscope in nature. It is difficult to store. However, the unit cost of nitrogen is the cheapest. Urea should be applied when the soil is sufficiently moist. However, if application is followed by dry spell then there will be a volatilization loss. Urea being highly soluble in water, leaching loss is high if applied on rainy days. Urea contains a chemical called biuret which is supposed to produce toxic effects on tea, if its content in urea exceeds 1.5 to 2.0 percent.

Calcium ammonium nitrate (CAN) : It is a fine free-flowing granular fertilizer, grey or light brown in colour and hygroscopic in nature. Keeping quality under storage is poor. The unit cost of nitrogen is in between ammonium sulphate and urea.

Since nitrate form is liable for leaching, its application during monsoon is not advisable. It is almost neutral and can be applied even to acidic soils.

7.4.2 Phosphatic Fertilizers

Rock Phosphate : It occurs as natural deposit of rock. It is a brown powder, non-hygroscopic in nature and insoluble in water but soluble in acidic soil solution. In general, no rock phosphate, as such, is used as fertilizer.

Superphosphate : It is the most widely used phosphatic fertilizer which is manufactured by treating rock phosphate with sulphuric acid or phosphoric acid or both. It is acidic in nature. The fertilizer is manufactured in three grades: single superphosphate, dicalcium phosphate and triple superphosphate. Phosphatic fertilizer is applied as basal dose to young tea as well as while planting. In acidic soil having pH less than 5.5, liming is needed before application of single superphosphate to increase efficiency.

Diammonium phosphate (DAP) : It contains both nitrogen and phosphate. DAP contains 18 % N and 46 % $P_2 O_5$.

7.4.3 Potassic Fertilizers

Muriate of potash : It is a grey crystalline material and is highly soluble in water. The unit cost of potassium in muriate of potash is cheaper than potassium sulphate.

Potassium sulphate : It is crystalline and white in colour and soluble in water. It is costly fertilizer as it is imported.

7.5 FERTILIZER APPLICATION AT THE TIME OF PLANTING

No inorganic fertilizer except phosphate is recommended at the time of planting in the pit. About 3 to 5 kg of well decomposed organic manure should be used per pit. In the absence of sufficient quantity of bulky organic manure, concentrated organic manure like oil cake at the rate of 150 to 200 g per pit can also be used as a substitute. Concentrated organic manure should be thoroughly mixed with the excavated soil. A fresh stock of oil cake should be fermented by exposing to the atmosphere with adequate watering to avoid injury to the root system.

The present recommendation of phosphatic fertilizer for planting pit is 60 g per pit. A mixture of water soluble (e.g. single super phosphate) and citrate soluble (e.g. Rock phosphate) at equal rate (i.e.30 g each) is preferable for sustained availability of phosphorous. Half of the phosphatic fertilizer mixture should be evenly mixed with the loosened bottom soil and the rest half of the fertilizer mixture should be place around the *bheti* at about 5 cm below the ground surface.

7.6 FERTILIZER APPLICATION IN YOUNG TEA

8.6.1 Objectives

Recent methods of young tea management emphasize on harvesting of good crops as well as building up of a healthy permanent frame to support high yields in years to come. However, health and vigour of the plants are not sacrificed at the cost of higher yields during the formative period. A good management should strike a balance between these two factors and such tea bushes should yield anything in between 1000-4000 kg of made tea per hectare, after fourth or fifth year of planting. So the fertilizer policy for young tea should be different from that of mature tea. The principle of fertilizer application in young tea is to develop a strong bush frame and root system which can only support vigorous cropping at maturity.

Application of fertilizers in young tea plays a significant role in the establishment of frame and the yield during the formative period. It is different from that of mature tea considering the requirement at the formative period of young plants. In mature tea, the usual policy is to harvest maximum shoots without affecting the health and vigour of the plants, while in young tea equal emphasis is given to the following counts:

i) Quick development of roots to keep pace with the supply requirements of nutrients to the top.

ii) Development of healthy permanent frame and top hamper so as to allow harvesting of shoots in higher quantity for a longer period.

iii) Quick multiplication of foliage growth to facilitate harvesting of more crops during the formative period.

In young tea, a balanced fertilizer mixture containing N, P and K is applied at frequent intervals. The nitrogen helps in foliage growth, the phosphorous in root growth and the potash in building up of healthy permanent frame. Since building up of healthy frame is of prime requirement, adequate amount of potassic fertilizers need to be applied. However, the role of organic manuring cannot be undermined. Generous application of organic manuring at the time of preparation of field and at the time of planting in pits is reflected in vigorous growth of the plants. Usually organic manures help in creating a good soil condition in the immediate vicinity of the young plants. At the first place, it improves the physical condition of the soil, wherein the plants get an easy and quick root development by way of free access and proper respiration. However, judicious and generous application of fertilizers can never be a substitute for sound field work. Unless the plant is developing freely, well rooted in conditioned soil with protected soil surface it cannot benefit from fertilizers and all applications are wasted.

7.6.2 Application of Fertilizers

Based on the requirement of young tea during the formative period, fertilizers are applied in the form of YTD (NPK) mixture which is recommended for application in frequent intervals. The YTD may be prepared as 10:5:10 NPK mixture or 10:5:15 NKP mixture. For the soil deficient in potash, YTD mixture of 10:5:15 NPK is preferred.

Preparation of YTD mixture : YTD mixture 10:5:10 denotes 10 kg N, 5 kg P_2O_5 and 10 kg K_2O per 100 kg of mixture while 10:5:15 indicates 10 kg N, 5 kg P_2O_5 and 15 kg K_2O per 100 kg of mixture. The three basic ingredients i.e. N P K can be derived from various inorganic fertilizers. Nitrogen can be derived from Ammonium sulphate (20% N) or Urea (46% N). The phosphorus can be derived from single super phosphate (16% P_2O_5) and DAP (46% P_2O_5, 18% N). The potash is available from Muriate of Potash (60% K_2O).

The YTD should be prepared just before application. Only the required amount should be prepared as it can not be stored. While mixing the fertilizers, SSP should be mixed at the last.

Composition of different YTD mixtures :

i) YTD : 10 : 5 : 10 NPK (Fertilizers-Ammonium sulphate, SSP and MOP)

Fertilizer	Quantity (kg)	N (kg)	P (kg)	K (kg)
Ammonium Sulphate	48.54	10	–	–
MOP	16.66	–	–	10
Filler (Dolomite or Dry sand	3.55			
Total	100	10	5	10

ii) YTD : 10 : 5 : 15 NPK mixture (Fertilizer used : Urea, SSP, MOP)

Fertilizer	Quantity (kg)	N (kg)	P (kg)	K (kg)
Urea	21.70	10.0	–	–
SSP	31.25	–	5.0	–
MOP	25.00	–	–	15.0
Filler (Dolomite or Dry sand	22.00	–	–	–
Total	100.00	10	5.0	15.0

iii) YTD : 10 : 5 : 10 NPK mixture **(**Fertilizers used : Urea, DAP, MOP)

Fertilizer	Quantity (kg)	N (kg)	P (kg)	K (kg)
Urea	17.50	8.05	–	–
DAP	10.85	1.95	5.00	–
MOP	16.65	–	–	10.00
Filler	55.00	–	–	–
Total	100.00	10.00	5.00	10.00

Sulphate of ammonia based YTD mixture is preferable to Urea based mixture. Phosphate should be applied as freshly prepared mixture of rock phosphate (24% P_2O_5) and single super phosphate (16% P_2O_5) in 50:50 ratios for longer availability to the plants.

Rate of application : Since young plants have feeble volume of root system, it is advisable to apply fertilizers in splits. Usually, 3-4 split application at 6-8 weeks interval are recommended. The doses of application of YTD mixture varies as per age of the plants. The rate of application is as follows:

Year of planting	N kg/ha	YTD kg/ha	Method of application
0 year	20-40	200-400	Ring in 2-3 splits
+1 year	80-100	800-1000	Ring in 4 splits
+2 year	100-120	1000-1200	Ring in 4 splits
+3 year	120-140	1200-1400	Ring in 4 splits
+4 year	140-150	1400-1500	Strip in 2 splits
+5 year	140-150	1400-1500	Strip in 2 splits

If the soil potash level is below 100ppm, then 10:5:15 YTD mixture should be applied.

Time of Application : Usually, manuring should be started from the month of March/April when the soil is sufficiently moist after the onset of the pre monsoon rain. For the application of subsequent splits, it should be avoided on the heavy rainy days.

Method of Application : The YTD mixture should be applied in ring method around the collar region of the plants. The ring or circles to be fertilized depends on the growth of the top hamper. The collar portion is left unmannered, as the fertilizer may cause injury to the bark of the collar of the plants, resulting in the mortality of the plants. The usual procedure followed is to keep the 1/3rd area in the center of the ring (near collar region of plants) unmanured and the rest 2/3rd area of the periphery of ring is manured. The ring is extended further in relation to the area left in the center.

Before applying the YTD mixture, the soil near the collar of the plant is cleaned by scrapping the weeds, debris etc. The area is forked and the required amount of YTD mixture is applied and stirred in the soil after application and again covered with weed scrapings keeping the collar region free.

While applying YTD, care should be taken so that the fertilizers do not come in contact with the collar of the plant. Fertilizers may cause damage to the bark, if it comes in contact, and plants may die.



CHECK YOUR PROGRESS

Q.1. What fertilizers are applied at the time of planting?

.....

Q.2. In what form NPK fertilizes are applied in young tea?

.....

Q.3. What are the quantities of N, P and K in 100 kg YTD 10:5:15 NPK mixture?

.....

Q.4. Why is YTD applied in young tea in frequent intervals?

.....

.....

Q.5. How many split applications of YTD are recommended during 2nd and 3rd year after planting?

.....

Q.6. State true or false :

a) The principle of fertilizer application in young tea is to develop a strong bush frame and root system which can only support vigorous cropping at maturity. (True/False)

b) About 1 kg of well decomposed organic manure should be used per pit at the time of planting. (True/False)

c) Fertilizers should be applied starting from the month of March/April when the soil is sufficiently moist after onset of pre monsoon rain. (True/False)

d) Fertilizers can be applied on heavy rainy days. (True/False)

7.7 FERTILIZER APPLICATION IN MATURE TEA

Till early eighties of the 19th century, nitrogen alone had received the major emphasis in mature tea manuring, with very little concern for balanced nutrition, especially with P and K. Consequently, the N response has been limited between 90 to 135 kg N/ha with deleterious effects showing up whenever the level was raised above 150 kg N/h.

7.7.1 Rate of Application

The current recommendation of fertilizer application in mature tea is given in Table 8.1.Periodic application of sulphate of ammonia as the nitrogen source, preferably in the pruned year is beneficial. Phosphate can be applied as rock phosphate and potash as MOP. If no extra gain is obtained after increasing the NPK dose in a pruning cycle, the other limiting factors should be looked into.

Table 7.2 : Recommendation of NPK fertilizers in mature tea for plain districts of North East India

Yield range in KMTH (cycle average)	N Kg/ ha	P_2O_5 Kg/ha	K_2O kg/ha Soil available Potash status		
			Low[1]	Medium[2]	High[3]
Up to 1500	Up to 90	20	Up to 90	Up to 70	Up to 50
1500-2000	90 – 110	20 – 30	90 – 110	70 – 80	50 – 70
2000-2500	110 – 140	30 – 50	110 - 140	80 – 120	70 – 100
2500-3000	140 – 165	50	140 – 165	120 – 140	100 – 120

1. Less than 60 ppm, 2. 60 – 100 ppm, 3. Higher than 100 ppm

The agro-climatic conditions of the hilly areas like Darjeeling estates are different from those of plains estates. With a comparative low yield potential but with a quality product and slow decomposition process of organic matter, the highest level of N should not exceed 110 – 120 kg N/ ha. The recommendation for NPK nutrition of mature tea for the hilly areas (Darjeeling region) is given in Table 8.2.The recommendation of fertilizer application for other hilly states of N.E.India like Arunachal Pradesh, Mizoram, Meghalaya and Manipur may be applicable as no trial has been conducted in those non-traditional tracts. However, elevation of the location, planting materials used and the yielding potential of the plantation should receive due consideration while applying fertilizers.



Cycle average yield : The average of the yields obtained in different years in a pruning cycle. For example, if the length of the pruning cycle is three years i.e. 3-year pruning cycle, theaverage of the yields of the three years is the cycle average yield.

Table 7.3 : Recommendation of NPK fertilizers in mature tea in Darjeeling region

Yield range in KMTH (cycle average)	N Kg/ ha	P_2O_5 Kg/ha	K_2O kg/ha Soil available Potash status		
			Low[1]	Medium[2]	High[3]
Up to 1500	Up to 60	20	Up to 60	Up to 50	Up to 35
600 – 1000	60 – 90	20	60 – 90	50 – 70	35 – 50
1000 – 1400	90 – 120	20	90 – 120	70 – 100	50 – 70

1. Less than 60 ppm, 2. 60 – 100 ppm, 3. Higher than 100 ppm

7.7.2 Method of Application

With low fertilizer use efficiency, uniformity of application is vitally important for optimum results. For application of small quantities of fertilizers as done in Darjeeling as well as in young tea, ring application is expected to ensure greater uniformity, compared to broadcasting method of application.

Nitrogen availability starts after two weeks of fertilizer application. Peak uptake of nitrates (NO_3) is within 5 – 16 weeks of fertilizer application but its absorption by the plant continues for about four to five months. So splitting of nitrogen into two or three doses at an interval of 3 – 4 months in 60:40 or 40:30:30 ratios will improve fertilizer use efficiency. Leaching loss is also reduced by split application. Split application of potash is of special importance where the soil is coarse textured and has low retention capacity for the nutrients.

7.7.3Application of Secondary Nutrients

Calcium and magnesium requirements are fulfilled to a great extent by maintaining the soil pH between 4.5 and 5.5. With large scale introduction of high yielding Cambod clones, magnesium nutrient has assumed greater significance. Foliar spraying of magnesium sulphate at 1 to 2% (w/v) concentration between autumn and spring (October to March) help to prevent manifestation of deficiency symptoms.

Sulphur is also gaining importance as secondary nutritional element. Elemental sulphur @ 20 to 40 kg/ha increased yield significantly during three years of experimentation. After three years of application, sulphur content increases from 55 ppm to 161 ppm at 60 kg S/ha.

7.7.4 Application of micronutrients

Among the various micronutrients tried, only Zinc has shown consistent response and is recommended to be applied as regular practice in North East India, particularly in unprunned or skiffed teas. However, the deficiency of the nutrients is more physiological than its actual deficiency in the soil and only foliar application of Zinc sulphate at 1 to 2% (w/v) is suggested. Addition of urea at equivalent concentration has been observed to improve response to Zinc especially during early season.

The present recommendation for Zinc sulphate application is 12.5 kg/ha for plain's estates, 25 kg/ha for Golaghat area and 50 kg/ha for estates of Darjeeling. Foliar application of Zinc sulphate at 1 to 2% concentration (equivalent to 8 and 16 kg/ha) is also found to enhance nitrate reductase activity, nitrogen uptake and protein content in the shoot without any adverse effect on quality of C.T.C. tea.

Zinc, however, is a heavy metal and several consuming countries have imposed restrictions on its content in made tea. Germany has fixed the limit of maximum 50 ppm. Considering these market restrictions and also from the information generated on enzyme activity, the dose of Zinc sulphate applied annually is suggested to be restricted to 12.5 kg/ha in all the areas.

So far chelated source of Zinc has failed to show any significant response in terms of yield as compared to Zinc sulphate, although Zinc uptake from chelated source was found to be 8 to 10 times higher than Zinc sulphate at equivalent rate of application in young tea.

The ideal time of Zinc application are beginning of first flush, end of first flush and beginning of autumn flush for unpruned/lighter skiffed teas and beginning of autumn flush in pruned/deep skiffed tea. Zinc application should be avoided during second flush as well as main cropping period.

Folia applications of Manganese, Boron and Molybdenum have shown varied response and are not recommended as regular practice. However, foliar application of Manganese sulphate at 1 to 2% (w/v) substantially increases nitrate reductase activity and protein content in tea shoot.

7.7.5 Foliar Nutrition

Under normal situation ground application should have preference as the plants obtain all the nutrients from the soil in balanced proportion. Foliar nutrition is normally considered as complimentary to soil fertilization for promoting growth. Foliar nutrition is beneficial under stress condition (water logging or drought) or coinciding with physiological changes in the bush. Foliar spraying of Potash @ 2% MOP (w/v) during the period of moisture stress can enhance water use efficiency.

To support shoot growth during waterlogging period, foliar application of NPK mixture prepared by mixing Urea (4.0kg), DAP (2.5kg) and MOP (3.5kg) in 400 litres of water per hectare should be undertaken at fortnightly interval.

MOP (1%) + $MgSO_4$ (1%) is suggested to be sprayed in combination from January to March to ameliorate the ill effect of moisture stress in unpruned teas.

7.7.6 Application of Soil Amendments

Tea soils exhibit wide variation in pH and it ranges from as low as 3.5 to as high as 6.0 and above. Soil having pH more than 5.5 needs to be corrected by application of pyrites/aluminium sulphate.

On the other hand, it is also essential to maintain a soil pH between 4.5 and 5.5 so that the increasing availability of nutrients is sustained for better nutrition of a tea bush. If the pH is below 4.5, it can be increased by either lime or dolomite application.

The rate of liming depends mainly on the initial pH of soil, soil buffering capacity, rainfall, soil texture and the liming material

used. Liming also increases the structural stability and infiltration capacity of soil.

Table 7.4 : Recommendation on Dolomite Application.

pH range	Dose of dolomite		Mesh size	Time of application	Method of application	Next application
	Coarse textured soil	Fine textured soil				
Below 4.50	@ 2 t/ha	@ 3 t/ha	80-100	Nov/Dec	Uniform broadcasting & 25 mm deep forking	At least 8 weeks after application following good shower of rain
4.50–4.65	@ 1 t/ha	@ 1.5 t/ha	80-100	Nov/Dec		



CHECK YOUR PROGRESS

Q.7. On what basis is the rate of potash application fixed?

.....

Q.8. Why is spilt application of nitrogenous fertilizers recommended?

.....

Q.9. Name two secondary nutrients gaining importance in tea nutrition.

.....

Q.10. What is the rate and method of zinc application in tea?

.....

Q.11. State true or false :

a) Split application of nitrogen into two or three doses has no added benefit. (True/False)

b) Foliar spraying of Potash @ 2% MOP during the period of moisture stress can enhance water use efficiency. (True/False)

c) Soil having pH more than 5.5 needs to be corrected by

application of pyrites/aluminium sulphate. (True/False)

d) Periodic application of sulphate of ammonia as the nitrogen source, preferably in the pruned year is beneficial. (True/False)

7.8 NUTRIENT DEFICIENCY SYMPTOMS

The deficiency symptoms of some of the nutrients are described below.

Nitrogen : When the supply of Nitrogen in soil solution becomes limiting, tea plant shows stunted growth. A few shoots are produced with short internodes. The colour of the new shoots and young leaves become lighter, sometime turns to whitish, growth slows down. Older leaves loose colour and turn brown and eventually fall off. Symptoms are more prominent under full sunlight.

Phosphorous : Deficient leave become dull and matt, glossiness of leave vanishes and a blue tint develops. Tip of leaf turns yellow. Die back of stem takes place from pruning cut ends.

Potassium : Typical marginal scorching with red bronze colouration develops in older leaves Twiggy branches with silvery white colour thin stem, folded small leaves are formed. Older leaves remain attached loosely with the bush but fall off with slight shaking. Defoliation moves upward through the maintenance foliage eventually maintenance level becomes thin and shallow. Growth slows down with scanty shoots and increase numbers of banjies. Recovery from pruning affected and bush become cylindrical in shape.

Magnesium : Deficient leaves develop a characteristic marginal yellowing which leave a dark green V-shaped area. Widest at the base of the base of the leaf.The V-shape may extend along individual veins. Older leaves are affected first. Symptoms are more prominent when soil pH falls below 4 and in droughty condition.

Sulphur : While veins remain green the leaves become bright yellow specially the young ones. New leaves become slender with shorter internodes. Scorching (chloratic) takes place and leaves fall off. Die back of stem becomes prominent from the tip. This condition is known as “Tea yellows”.

Calcium : When the soil pH falls below 4 in calcium deficient soil,

mature leaves curls downward followed by marginal scorching from leaf tip. Apical activities reduced. In excess of calcium when soil pH is high the young shoot and leaves are affected first. The stem shortens and the leaf does not grow to normal size. Leaves become distorted in size and cracked, then fall off.

Zinc : Small buds in rosette form a single axil. Elongation of leaves takes place as well as twisting to a sickle shape with wavy margin; leaves become very small with shorter internodes. The leaf margin often goes yellow.

Copper : Plants deficient in copper have slightly darker leaves; the difference is difficult to judge in the field. The main effect of copper deficiency is to inhibit fermentation in the factory. Fermentation takes longer than usual and the leaf becomes dark brown rather than bright orange.

Manganese : This deficiency is very rare, occurring occasionally on soil of very high pH. Leaves turn pale yellow on the edges and develop a mottling of red brown spots.

Boron : This is also very rare. The apical bud fails to grow and cork develops on the upper side of the leaf petiole.

7.9 ORGANIC FERTILIZERS

Organic fertilizers or manures have significance for improving the soil fertility and productivity. The also have corrective effect on adverse soil conditions caused by continuous and excessive use of inorganic fertilizers. Organic fertilizers promote soil aggregation leading to better water holding capacity in coarse textured soils and drainage in heavy soils, because favorable changes in soil reaction enrich the nutrient status of the soil. The fixation of soil phosphorus and leaching losses of secondary and micronutrients are reduced by organic manures.

Green manure is a cheap alternative to the use of fertilizer nitrogen. Green manuring is a low cost and effective technology in minimizing investment cost of fertilizers. Trees, shrubs, cover crops, legumes, grasses, weeds, ferns etc provide green manure. The weeds of tea field may be used for preparing vermicompost, which is important enriched manure and

can be applied in tea fields for overall improvement of physical and chemical conditions of soil.



7.10 LET US SUM UP

- The requirement of mineral nutrients of plants is obtained largely from the soils. However, under continuous cropping, these nutrients get depleted in the soil due to crop removal and other causes and may become deficient. Therefore, these nutrients need to be replenished and the nutrition of mineral elements is called mineral nutrition.
- In tea, all macro nutrients viz., N, P, K and S are supplied to the soil every year in the form of chemical fertilizers. In some areas, some of the micro nutrients also need to be applied.
- Ammonium sulphate, Urea, Calcium ammonium nitrate (CAN) are the nitrogenous fertilizers, single superphosphate and triple superphosphate are the phosphatic fertilizers and muriate of potash is the potassic fertilizer commonly used in tea.
- The doses of fertilizer application for the mature tea are mostly determined on the results of long or short term field experiments.
- No inorganic fertilizer except phosphate is recommended at the time of planting. Application of fertilizers in young tea plays a significant role in establishment of frame and yield during the formative period. NPK fertilizers are applied to young tea in the form of YTD.
- YTD 10 : 5 : 10 or YTD 10 : 5 : 15 is the NPK mixture containing 10 kg N, 5 kg P_2O_5 and 10 or 15 kg K_2O per 100 kg of fertilizer mixture which are applied to young tea in splits at frequent intervals.
- The doses of application of YTD is fixed per plant basis and applied in ring method upto 3rd year after planting and when the ground cover is achieved YTD is broadcasted per ha basis.
- The recommendation of fertilizers application in mature tea is done based the yield potential of the field/crop. Potassic fertilizer is

recommended based on the available potash in the soil. Phosphate can be applied as rock phosphate and potash as MOP. If no extra gain is obtained after increasing the NPK dose in a pruning cycle, the other limiting factors should be looked into.

- Split applications of nitrogen into two or three doses at an interval of 3 – 4 months in 60 : 40 or 40 : 30 : 30 ratios improve fertilizer use efficiency and reduce leasing loss. Split application of potash is of special importance where the soil is coarse textured and has low retention capacity for the nutrients.
- Folia applications of Manganese, Boron and Molybdenum have shown varied response and are not recommended as regular practice. However, Zinc has shown consistent response and is recommended to be applied as regular practice in North East India, particularly in unprunned or skiffed teas.
- Foliar nutrition is beneficial under stress condition (water logging or drought) or coinciding with physiological changes in the bush. Foliar spraying of Potash @ 2% MOP (w/v) during the period of moisture stress can enhance water use efficiency.
- If the soil pH is below 4.5, it can be increased by either lime or dolomite application. The rate of liming depends mainly on the initial pH of soil, soil buffering capacity, rainfall, soil texture and the liming material used. Liming also increases the structural stability and infiltration capacity of soil.
- All the deficient nutrients show characteristic deficiency symptoms.
- Organic fertilizers promote soil aggregation leading to better water holding capacity in coarse textured soils and drainage in heavy soils, cause favourable changes in soil reaction, enrich nutrient status in the soil.



7.11 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Rock phosphate and Single superphosphate

Ans. to Q. No. 2 : YTD

Ans. to Q. No. 3 : 10 kg N, 5 kg P_2O_5 and 15 kg K_2O per 100 kg YTD.

Ans. to Q. No. 4 : In young tea the root growth is not well developed to absorb all the nutrients applied.

Ans. to Q. No. 5 : 4-6 splits

Ans. to Q. No. 6 : a) True, b) False, c) True, d) False

Ans. to Q. No. 7 : Available soil K-status.

Ans. to Q. No. 8 : For increasing fertilizer use efficiency and reduce leaching loss

Ans. to Q. No. 9 : Sulphur and magnesium

Ans. to Q. No. 10 : 1-2 % (12.5 kg per ha) as foliar spray

Ans. to Q. No. 11 : a) False, b) True, c) True, d) True



7.12 FURTHER READING

- *Tea Cultivation-Comprehensive Treatise*. By N.Ghosh Hajra. International Book Distributing Co., Lucknow.
- *Field Management in Tea*. Tocklai Experimental Station, TRA, Jorhat.



7.13 MODEL QUESTIONS

Q.1. What are the common fertilizers used in tea? Describe how the nutrients deplete in the soil.

Q.2. What are the objectives of fertilizer application in young tea? Give the recommended rates of fertilizer application in young tea.

Q.3. What are the recommended rates of fertilizer application in plain areas of N. E. India? Describe the methods and time of application.

Q.4. Under what situations, foliar application of nutrients is recommended? What is the rate of zinc application in tea?

Q.5. Give the characteristic deficiency symptoms of potash, nitrogen and magnesium.

*** ***** ***

UNIT 8 : Plant Protection in Tea

UNIT STRUCTURE

8.1 Learning Objectives

8.2 Introduction

8.3 Tea Diseases and their Management

8.4 Tea Pests and their Management

8.5 Integrated Pest Management

8.6 Let Us Sum Up

8.7 Answers to Check Your Progress

8.8 Further Readings

8.9 Model Questions

8.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Name the different tea diseases and pests attacking the tea bushes.
- Describe the nature of their infestation.
- Describe the nature and the extent of damages caused by different diseases and pests to the tea bushes.
- Explain the importance of cultural measures in controlling them
- Identify the appropriate pesticides for controlling the pests.
- Explain the importance of integrated pest management.

8.2. INTRODUCTION

Occurance of Disease and pests are vay common problem in Tea Plantation. Disease and pests can attack tea plants starting from the nursery to the main field. Therefore proper care should be taken during proper time. Tea plant is an evergreen perennial and is cultivated mostly as a monoculture. Tea plantation thus provides a suitable condition for the pests to feed on and breed. It supplies plenty of food for the pests throughout the year and there is no problem of suitable host for them for breeding.

The loss of crop due to pest damage is considerably high. It has been estimated that 7-10 percent of the total crop is lost annually from the ravages of the pests and in case of severe outbreak of some pests the loss may be as high as 15-25 percent.

Management of diseases and pests is one of the most important practices in tea cultivation. In this unit, we shall deal with the important diseases and pests of tea, their nature of damage and the measures for control.

8.3.TEA PESTS AND THEIR MANAGEMENT

Different pests infest every part of the tea plant, the leaves, stem, root, flowers, but the maximum number of pests occurs on the foliage. The important pests of tea which attack different parts of the plant and thereby cause economic loss will be discussed hereunder. The pests may be sucking pest, chewing or leaf eating in nature.

8.3.1 Leaf and Shootpests

The pests which infest the leaf and shoot are as follows:

a) Mites, b) Tea Mosquito bug, c) Caterpillars, d) Thrips, e) Aphid, f) Jassids, g) Flush worm, h) Scale insects and mealy bugs and h) Weevils and beetles.

Mites : Various species of mites infest the tea. Mites are sucking pest. Among them, Red spider mite (*Olygonychus coffeae*), Scarletmite (*Brevipalpus phonicis*), Pink or Orange mite (*Acaphylla theae*)

and Purple mite (*Calacarus carinatus)*are economically important pests of tea.

Red Spider Mite : It occurs almost throughout the year. The peak period of infestation of red spider mite is March to May or June. During July, their population is greatly reduced due to heavy shower which washes away the mites. In winter also, the population is reduced.

Red spider mite normally attacks the upper surface of the mature leaves.Infestation starts along the midrib and veins and gradually spreads to the entire leaf surface. In severe attack, young leaves are also equally infested and they spread to the under surface of the leaves. They often form a web of silken threads and remain protected against adverse weather conditions.Red spider mite is a sucking pest. The larvae, nymph and the adult suck cell sap of the mature leaves. Reddish or coppery spots develop on the sucking sites which subsequently unite to form large brown patches and defoliation may occur leading to huge crop loss.

The following factors favour the occurrence of red spider

- Prolong drought favours the incidence,
- Light rains with intermittent sunny days increase the mite,
- Unshaded or poorly shaded areas suffer most,
- Roadside bushes covered with dust favours the incidence,
- Waterlogged areas are prone to red spider mite,

- Unpruned or light skiffed tea bushes are more prone,
- Weed infested areas suffer more.

Scarlet Milte : Scarlet mite mostly feeds on the under surface of the leaf particularly around the petiole and sometimes prevents the flow of nutrients to the leaf lamina. Its sucking leads to yellowing of leaves and brownish discoloration of the mid rib. The bark of the affected stem may split. Severe infestation results in premature defoliation.

Purple Mite : Purple mite mostly occurs on the upper surface of mature leaves. The affected leaves turn purplish brown particularly at the margin, dry up and fall off.

Pink Mite : It attacks both surfaces of mature and young tender leaves. Petiole and tender stem may also be infested. Affected leaves turn pale yellow, leathery and curl upwards.

CONTROL MEASURES OF MITE PESTS :

Cultural Practices : The following measures may be undertaken for controlling the mite pests.

- Shade trees should be planted, if the shade status in the area is poor
- The area should be kept free from weeds
- The drainage should be improved
- Adequate fertilization should be done for the health and vigour of the bushes
- Bushes should be knife cleaned to improve bush sanitation
- Cattle trespass should be checked
- The foliage of the bushes on the road side fields should be protected from dust by growing hedges of *titaphool (Phlogacanthus trysiflorus).*

Chemical Control : Agro-chemicals used to manage mites are known as acaricides. Propargite, Fenpyroximate, Fenazaquin, Spiromecifen, Profanofos, Neem and micronized sulphur formulations, etc can control the mites.

Tea Mosquito Bug : The tea mosquito bug (*Helopeltis theivora*) is one of the major pests which causes extensive damage in tea. It is present almost throughout the year, but the peak period of infestation is from June to September. During winter, its population comes down and reappears in February-March. The adult *helopeltis* is a tiny insect with along antenna. The normal distance of flight is very less; it is only from one bush to another. However, high wind can carry the insect over long distances causing a sudden spread of attack. The females lay eggs in the tissue of tender stem, mid rib and the petiole of leaves.

The nymphs and adults of *helopeltis* are the active suckers of sap from buds, young leaves, tender stems and shoots. They feed at early morning, late evening and at night hours. On a sunny and warm day, they take shelter in the lower layer of the bush canopy.

While sucking the sap, they inject toxic saliva which causes necrosis of the tissues surrounding the puncture .A circular spot is formed around the sucking point which turns brown first, then black and subsequently dries up. The badly affected leaves become deformed and even curl up. In severe attack, the bushes cease to form shoots and the affected areas may not flush for along period. The tender stems near the apex turn dark brown due to oviposition and the shoots die back. Cracking of the tender stem may also occur at the site of oviposition which results in callus growth underneath and the shoot dries up. Infestation of helopeltis may become destructive during the cropping season.

Control Measures : Helopeltis is becoming a problematic pest in tea in the recent time. An integrated approach is necessary to control the pest which often causes havoc in tea.

Cultural practices :

- The plantation should be kept free from weeds.
- The heavily infested areas in the previous years should be pruned or deep skiffed.
- If the infestation is severe, the area should be skiffed followed by removal of left over infested leaves below the plucking table by hand before undertaking chemical spraying.
- All the drains should be kept functional to avoid waterlogging during the monsoon. Shallow relief drains from localized depressions on the ground should be provided.
- The shade should be regulated in densely shaded areas by lopping of the lower branches of shade trees.
- If closely planted the side branches of tea bushes in each row should be removed to improve ventilation.
- As for pruning or skiffing, pruning should be started from the periphery toward the centre and a few bushes should be kept untouched for a day or two in the centre. These bushes should be pruned or skiffed after through spraying with Quinalphos or diflubenzuron.
- In heavily infested fields, black plucking should be followed.
- All the infested shoots should be removed and destroyed.

Chemical Control : Thiomethoxam 25 WG, Quinalphos 25 EC, Diflubenzuron 25WP etc. can control the pest. For an effective control, first the contact insecticide should be sprayed followed by the systemic and then again the contact insecticide. The powerful contact insecticide is used to knock down the mobile fraction of the population at the shortest possible time and the systemic one is to take on the emerging populations within the bush and the unfolding leaves.

Points to remember : The following points should be remembered for effective control of tea mosquito bug

- Spraying should be done in the early morning or late evening when the bugs are active.

Thorough drenching of top, middle and bottom hamper of the bush with spray fluid is a must for killing the residual population of the pest.

- Synthetic pyrethroids should not be mixed with neem formulations.
- Mixing of insecticides with foliar nutrients, acaricides and others should be avoided for retaining the toxicity of the pesticides and for a better control of helopeltis.
- Timely application, interval between the rounds of spraying, technique of spraying and selection of pesticides are important.

In the helopeltis prone areas, care should be taken by taking prophylactic measures. In such areas, one round of spray should be done during January- February in unpruned sections ,late February–early March in pruned sections and immediately after the bud breaks in the skiffed sections.

In case of the extensive damage to the stem, bushes should be given sufficient rest at the end of the season and should be pruned down to the healthy stem. The bushes which have recovered after chemical spray should be plucked leaving an extra leaf.

Caterpillars : Common Lopper Caterpillar (*Biston suppressaria),* Bunch Caterpillar *(Andraca bipuncata)* and Red Slug caterpillar *(Eterusia magniica)* are well known caterpillar pests of tea in this region.

Looper Caterpillar : The young looper is dark brown with pale greenish white lines on the back and side and has a brownish head. The body colour gradually changes to green to brownish grey or dark brown. The life cycle is completed in about 60-72 days.

Young caterpillars first eat out the young leaves making very small holes along the margin and then bite off small pieces at the margin of the leaf. The young early instars feed on the tender leaves while the late instars prefer older leaves. In severe cases of attack caterpillars can completely strip a bush of its leaves and infestation becomes devastating within a short period. Young larva of looper is highly mobile and can, therefore, be carried to a long distance.

CONTROL MEASURES :

Cultural practices :

- The caterpillars may be collected and destroyed.
- During December to February, the caterpillars may be collected and destroyed by light forking the collar of the tea bushes in affected sections.
- The moths may be killed by light trapping during February-March and August-October.
- *Dalbergia assamica* (Bormedelua) shade tree should be avoided in looper infested areas.
- An extra dose of nitrogen @ 20 kg N per ha should be applied after a sever attack. Sufficient rest period should be given before pruning the infested areas.

Chemical control : Endosulfan 35 EC, Quinalphos 25 EC or any other insecticides recommended by Tocklai Experimental station may be used to control Helopeltis. In case of severe infestation, synthetic pyrethroids may be applied. During the plucking season, it is advisable to spray the neem extracts like Bioneem, Fortunia or Azdirachtin etc.

- Close monitoring is required for early detection of the pest incidence. The very young caterpillars could be controlled by spraying Quinalphos 25EC @ 250 ml in 100 litres of water using a hand sprayer or Diflubenzuron 25WP @ 500ml in 100 litres of water using a power sprayer.

- One round of synthetic pyrethroid @ 50 ml in 100 litres of water using a power sprayer should be sprayed for control of late instar and mixed brood.
- Spraying should also be taken up on the shade trees to a manageable height to kill the eggs.

Chemical control : Endosulfan 35 EC, Quinalphos 25 EC or any other insecticides recommended by Tocklai Experimental station may be used to control Helopeltis. In case of severe infestation, synthetic pyrethroids may be applied. During the plucking season, it is advisable to spray the neem extracts like Bioneem, Fortunia or Azdirachtin etc.

- Close monitoring is required for early detection of the pest incidence. The very young caterpillars could be controlled by spraying Quinalphos 25EC @ 250 ml in 100 litres of water using a hand sprayer or Diflubenzuron 25WP @ 500ml in 100 litres of water using a power sprayer.
- One round of synthetic pyrethroid @ 50 ml in 100 litres of water using a power sprayer should be sprayed for control of late instar and mixed brood.
- Spraying should also be taken up on the shade trees to a manageable height to kill the eggs.

Bunch Caterpillar : Full grown Bunch caterpillar is about 65 mm in length with a brownish black head and the body is densely covered with fine hairs. It is tawny yellow with a reddish tinge and broad brown transverse bands running on each body segment crossed by a number of yellowish longitudinal lines.

Females lay in cluster on the under surface of leaves and occasionally on the stems and each cluster consists of a series of eggs arranged in rows. The life cycle is completed in 55-65 days in March –June passing through 5 larval instars.

.

The young caterpillars remain in cluster on the undersurface of leaves during day hours and become active in the night and start feeding .The branches on which they form the clusters are completely stripped of the leaves; thereafter they migrate to the adjacent bushes

CONTROL MEASURES :

Cultural practices :

- Caterpillars may be collected by hand and destroyed.
- The moths may be light trapped during October-November and March-April.
- The chrysalides may be collected by stirring the soil during November–December.

Chemical Control :

- Quinalphos 25EC @ 250 ml in 100 litres of water using a hand sprayer targeted to maintenance foliage should be sprayed to control early instar caterpillars.
- In case the caterpillars were grown up, then one round with synthetic pyrethroid @ 50 ml in 100 litres of water using a power sprayer adopting barrier method of spraying should be sprayed. If necessary follow up with another round of Quinalphos 25EC @ 250 ml in 100litres of water in the next week with a hand sprayer.
- Early morning and late afternoon hours is considered to be the best time for spraying as caterpillars are usually active

Red Slug Caterpillar : It is another serious caterpillar pest in N. E. India. Early instars of the caterpillars first eat out the leaf, making hole, and bite the edges. When they grow in size the whole leaf is damaged. In severe infestation the bushes may be completely striped of their leaves.

Usually the caterpillar attacks the leaves but in severe outbreak, the bark is also eaten away resulting in die back of the branches.

The caterpillar becomes full grown in four to five weeks during May–June. They are active usually during theearly and later part of the day till night.

CONTROL MEASURES :

Cultural practices :

- The caterpillars can be collected and destroyed during November –January and February-April.
- The chrysalides should be collected during December-March.
- The moths can be light trapped during September-October and December–March.
- Caustic washing should be done in the bush frame.

Chemical control :

- Quinalphos 25EC @ 250 ml in 100 litres of water using a hand sprayer targeted to maintenance foliage should be sprayed to control early instar caterpillars.
- In case the caterpillars were grown up, then one round with synthetic pyrethroid @ 50 ml in 100 litres of water using a power sprayer adopting barrier method of spraying should be sprayed. If necessary follow up with another round of Quinalphos 25EC@ 250 ml in 100 litres of water using a hand sprayer in the next week.
- Early morning and late afternoon hours is considered to be the best time for spraying as caterpillars are usually active.
- While spraying, both surfaces of the leaves should be covered. Spraying should be done during early morning or late evening.
- The shade tree trunks should also be sprayed upto 2m height.

Two applications of pesticides like Quinalphos, Endosulfan or Chlorpyriphos should be applied at the application rate of 1:400 (250 ml in 100 litres of water) with high volume (HV) or hand operated sprayers or 1:200 (500 ml in 100 litres of water) with low volume (LV) or power sprayer at 15 days intervals.

Tea Aphids : The tea aphid (*Taxopetra aurantii*) is a common pest of tea. The adults and nymphs of tea aphids suck sap from tender stems, buds, petioles and lower surface of the leaves along the mid rib. As a result of the loss of sap the leaves crinkle and curl inwards resulting in marginal necrosis in later stage.

The pruned bushes suffer the most from the aphids attack from February onwards. The insect multiplies rapidly,resulting in a heavy build-up of colonies within a short time, but with the commencement of normal plucking the colonies are removed before significant damage can be done. It causes significant damage to the nursery plants.

Control measures :

- Hand picking and destruction of the affected leaves should be done.
- Pesticides like Endosulfan, Quinalphos or Chloropyriphos or any other insecticides recommended by the Tocklai Experimental Station may be applied @ 1:400 concentrations (250 ml in 100 litres of wayter) with high volume sprayer
- While spraying, care should be taken so that the lower surface of the leaves is thoroughly sprayed.

Tea Jassids : It is an insect pest of tea. It is commonly known as 'green flies'. The nymphs and the adults of the insect (*Empoasea flavescens*) suck the sap of the young leaves and occasionally the tender stems of the growing shoots. Normally they attack the under surface of the young leaves. The growth of the affected leaves become uneven and the leaves usually curl downwards and the margin becomes recurved. The characteristic symptom is known as the 'Rim Blight'.The growth of the infested shoot is arrested and

the leaves remain stunted, dry up and eventually fall off.

The newly hatched nymph is a colourless insect with pink eyes, but soon after feeding it becomes slightly yellowish green in colour.The adult is a small yellowish green insect about 2.50 mm (male) to 2.75 mm (female) in length. Tea Jassids occur throughout the year but they are more active during March to July.

Control measures :

- The area should be kept weed free to avoid the occurrence of the insect.
- For chemical control, Quinalphos/Endosulfan @ 1:400 (250 ml in 100 litres of water using the high volume sprayer or @ 1:200 (500 ml in 100 litres of water) using the low volume sprayer may be used. Two rounds of application should be done at 15 days interval.
- In case of unpruned tea where the incidence of greenfly is already started spraying should be done without delay.
- In case of pruned and skiffed teas, first round of spraying should be done in mid-February to early March depending on the new growth and population of the insect.
- Special care should be taken while spraying to cover the lower surface of the leaves as the population of the insect remains on the lower surface of young tender shoots at the top and middle hamper of the bush.

Flush Worm : Flush worm is a leaf tier pest of tea bush. The larva of the moth *Laspeyresia lencostoma* which attacks a few top leaves, tying them together, is commonly known as flush worm. The larva remains inside the fold of the bud or young leaf and feeds by scraping off the tissues of the upper surface, occasionally eating away the apical portion of the bud.

The affected leaf becomes rough, thick and somewhat brittle in texture, with a brownish discoloration of the damaged surface.

The affected shoots cannot reach full development and the internodes are greatly shortened and the tender stem bends over as a result of binding of two or more leaves together.

The pest appears from late February when new shoots start coming up. The peak of the attack is usually during March-April.

Control measures : The pest can be controlled by collecting the infested shoots and destroying them. Endosulfan, Quinalphos are effective against flush worm.

Scale Insects and Mealy Bugs : Scale insects and mealy bug (Coccoids) are sucking pests which attack the foliage, stems and roots of the tea bushes. Some species of scale insects are permanent major pest of tea. Scale insects excrete honey dew and are attended by ants. In a prolonged attack, the bark dies and irregular swellings are formed on the stem. In a persistent attack, the bushes become so debilitated that they produce little growth for some years, and then the branches die back.

Mealy bugs are a group of insects of the family *Pseudococcidae.* They are covered by a powdery coating or waxy filaments. The infested shoots become unproductive leading to the dying up and fall of the leaf

Control measures : Quinalphos, monocrptophos etc can effectively control these pests. In the plucking season two rounds of drenching spray with appropriate chemical at 15 days interval is generally sufficient. Addition of spreader/sticker is helpful in achieving better control.

8.3.2 Stem and Branch Pests

Common Red Stem Borer : The common Red Stem Borer is one serious pest of tea in Assam. The larva of the Borer *(Zeuzera coffeae)*bores into the tea stem, mostly one or two year's old wood. The leaves of the affected branch wither and eventually die. The larva usually tunnels downwards, eating away woody tissues. In due course it passes into the thicker stems, and in young tea plants the tunnel may extend down to the tap root. At various intervals during the course of tunneling circular holes are cut out through which excreta in the form of pinkish pellets is ejected and piles up on the ground underneath.

Control measures :

- The infested branch should be cut down to healthy wood and the larvae or pupae should be destroyed. The cut surface should be painted with Indopaste. Badly damaged young plants should be pulled out and the larvae destroyed.
- Strong solution of Endosulfan and Quinalphos or synthetic Pyrethroids may be poured inside the tunnel using ink filler. Afterwards the hole should be plugged. As a preventive measure, Endosulfan or Quinalphos @ 1:400 dilution may be applied during March-April and August-September when the emergence of moths takes place. The shade trees should also be sprayed upto about 2 m height.

- Spraying pesticides during hot mid day sun should be avoided.
    - A minimum of 8 -10 days gap between insecticide/acaricide application and plucking should be maintained.
    - Appropriate distance (30-45 cm) between nozzle and the target site should be maintained in case of high volume sprayers.
    - In case of low volume sprayer the delivery hose should be at the same level with plucking surface maintaining a distance of 30-45 cm.
    - Spraying during the windy weather should be avoided.
    - If it is unavoidable, then spraying should be done along the wind direction.
    - Adequate pump pressure (high volume) and engine revolution should be maintained for better spray.
    - Clean water should be used for spraying
    - Muddy water should never be used.
    - Pesticides should be mixed in the field ensuring proper dilution.
    - Liquid pesticide formulations should be added slowly to water in the mixing tank/drum.
    - The spray fluids in the mixing tank should frequently be agitated with bamboo or wooden stick.
    - The time of spraying should coincide with the period of peak activity of the pest.

8.5 INTEGRATED PEST MANAGEMENT

The use of conventional insecticides and acaricidesare the most common method known to bring about immediate reduction in pest populations, increased yield and reliable economic returns. However, control of pests with chemicals has some significant limitations. Therefore, the tea

growers should depend more on the integrated pest management rather than sole dependence on pesticides.

Integrated pest management is a system of pest management that utilizes all suitable techniques and methods in as compatible as possible to maintain the pest and disease incidence at level below those causing economic damage. It does not preclude the use of pesticides, but keeps it to a minimum level by judicious combination of other pest control methods like cultural, physical, mechanical, biological and hormonal control.

CHECK YOUR PROGRESS

Q.7. Fill in the blanks :

a) Two applications of pesticides like _____, _____ or _____ should be applied at the application rate of 1:400 (HV) or 1:200 (LV) at 15 days intervals for controlling tea thrips.

b) The adults and nymphs of tea Aphids suck sap from _____, _____, _____ and _____ surface of the leaves along the mid rib.

c) Scale insects and mealy bugs are _____ pest which attack the _____, stems and _____ of the tea bushes.

d) Brown cricket is one of the most destructive pests in _____.

e) The larva of _____ bores into the tea stem, mostly one or two year's old wood.

8.6. TEA DISEASES-CASUAL AGENCIES AND CLASSIFICATION

Casual Agencies

Diseases of tea bush are mainly caused by any of the following five agencies *viz.,*

a) Vegetable organisms like fungi, algae and bacteria
b) Animal parasites
c) Adverse conditions of soil and climate, leading to physiological disorder
d) Mechanical damage and
e) Virus

However, the bacterial and viral diseases and those caused by animal parasites are not so serious in tea crop and have no commercial importance. The physiological disorders and mechanical damage caused by some external agents will be discussed in Unit 6.

Classification of Tea Diseases

The diseases which commonly occur in tea can be classified into two broad groups, *viz.,*

a) Primary diseases and
b) Secondary diseases.

A disease which can cause death of the healthy tissues or the bushes even under the best growing conditions is called a primary disease. On the other hand, the secondary diseases are those which attack the bushes only after the health of the plants is impaired due to cultural and/or environmental stresses.

The primary and the secondary diseases can be further categorized into different groups on the basis of the site of first (major) infestation on the tea bushes as root diseases, stem

diseases and leaf diseases.

Common Diseases

The common diseases with their causal organisms are shown in Table 5.1.

The diseases which affect the above ground portion of the plant, i. e. stem or leaf may be recognized immediately after their occurrence by careful observation of the symptoms but those that affect the underground portion (be it primary or secondary) are difficult to identify. Often it becomes too late to identify the root diseases and to adopt proper management practices. However, certain external symptoms corroborate to their identification, which may subsequently be confirmed by digging out such bushes and looking at the roots.

Table : Common diseases of tea with their causal organisms and site of first infestation

Site of first infestation	Primary Disease		Secondary Disease	
	Name of disease	Name of causal organisms	Name of diseases	Name of causal organisms
Root	Brown root rot	*Fomes lamaoensis* = *Fomes noxius*	Violet root rot	*Sphaerostilbe repens*
	Charcoal stump rot	*Ustulina zonata* = *Ustulina deusta*	Diplodia	*Botryodiplodia theobromae*
	Red root rot	*Poria hypolateritia*	Rhizoctonia	*Rhizoctonia bataticola* = *Macrophomina phaseoli*
	Black root rot	*Rosellinia arcuata*		

Armillaria	*Armillaria mellea*			
Stem	Branch canker	*Poria hyppbrunnea*	Red rust	*Cephaleuros parasiticus*
	Die-back of primaries	*Fusarium solani*		
Leaf	Blister blight	*Exobasidium Vexans*	Brown blight	*Glomerella cingulat* = *Colletotrichum-camelliae*
	Black rot	*Carticium invisum* and*Corticium theae*	Grey blight	*Pestalozzia theae*

8.7 DESCRIPTION OF TEA DISEASES AND THEIR MANAGEMENT

Seedling Diseases

In the nursery from the time of emergence up to nine months of age, the tea plants are susceptible to fungal attack. In North East India two such important diseases are damping off and collar rot.

Collar Rot : The causal organism of the disease is a fungus, namely *Phomopsis* sp. It attacks young seedlings up to about nine months old from the time of emergence. At the collar region of the seedling a ring is formed encircling the main stem and it extends over a region of 2.5-5.0 cm above and about 1.25 cm below the soil level. Thus the affected portion of the stem becomes smaller in girth compared to adjoining unaffected portions on either side. A ring of callus growth is visible at the upper edge of the diseased area which pushes the bark up. Fructification of the fungus appears as minute, black dots scattered over the affected bark.

Damping Off : The causal organism of damping off diseases is *Pythium* sp, which is a soil borne fungus. During the first six months of the young seedlings the fungus attacks the main stem all round to about 2.5 cm above and the root to about 5.0 cm or more below the soil level. The bark of the affected region becomes very soft so that it crumbles away when rubbed with the fingers.

Management of seedling diseases : The management of seedling diseases of tea *viz.*, damping off and collar rot includes cultural treatment and chemical control.

Cultural treatment : This includes :

- Physical condition of sticky nature of soil should be improved by mixing soil, sand dry well rotten-sieved cattle manure or compost in adequate proportion.
- Nursery soil must not be allowed to remain unduly wet for a longer period by excess watering etc.
- Adequate shade should be provided to the nursery beds.
- Dirty water from shallow ponds or pools must not be used to water the nurseries.
- Rice-straw must not be used as a ground cover on nursery beds.

Chemical Control : Nothing can be done to save the diseased seedlings. Therefore, nurseries in heavy soils must receive prophylactic spraying of 0.25 % suspension of copper fungicide once after the heavy rains and again after about 3 weeks of the first application.

Nursery beds should be sprayed as soon as signs of damping off are noticed, followed by second application after 10 days. Before spraying, the crust formation on the surface of beds should be lightly forked and the soil adhering to the stem of the seedlings should be rubbed off with fingers for better results.

Primary Root Diseases

The primary root rots are the most dangerous diseases of tea plants. The root rot diseases are caused by some soil borne fungi. The pathogens are mostly present in the vegetative materials in the soil and they attack the tea bushes when they come in contact with the roots of the tea bushes.

The characteristic feature of the primary root rots is that they do not show any diseased symptoms and suddenly the bushes die. There is no control measure to save the diseased bushes but to uproot them.

The pathogens are normally present in those areas where the planting is done without proper soil rehabilitation. It is, therefore, stressed that big trees or the shade trees should be killed by 'Ring Barking' before uprooting and replanting tea instead of felling the trees so that no fresh vegetative materials remain in the soil.

During the two years rehabilitation period the pathogens would die due to shortage of food. Grasses are used to rehabilitate the soil as the fibrous roots of the grasses cannot harbor any soil pathogen.

A few important primary root rot diseases are described below:

Brown Root Rot : Brown root rot is caused by the fungus, *Fomes noxius.* Roots of affected bushes are encrusted with soil, sand and stone particles, firmly held by a brown mycelium. The mycelium also grows upto main stem along with thin white film. Irregular rings or reticulations are formed by hard brown lines in light yellow coloured lines. In the advanced stages of the disease the brown ring decays forming a honey comb-like structure.

Charcoal Root Rot : The disease causing fungus, *Ustilina zonata* spreads through root contact with the diseased woody material present in the soil and through wind borne spores. There are no visible symptoms on the surface of the affected root but if the bark is removed characteristic delicate fan-shaped patches of dull white, silky mycelium may be seen spreading over the diseased wood.

Sometimes it is seen that part of the mature bush affected by this disease dies while the other side remains apparently healthy and functional.

Red Root Rot : Red root rot is caused by the fungus, *Poria hypolateritia*. The disease is found on mature tea bushes in a lightning affected areas as found in charcoal stump rot.

Reddish rhizomorphs appear on the root surface and the roots present a reddish or reddish brown appearance. Underneath the rhizomorphs the root surface appears whitish. On washing with water, the rhizomorphs take brighter colour with the appearance of whitish patches of conidial conglomerations. When cut with a sharp knife, brownish dots appear on the wood. The cut surface of the old roots has water soaked appearance.

Black Root Rot : The fungus (*Rosellinia arcuata)* forms irregular black, cob-webby adherent cords of mycelium and small isolated black dots and dashes on root surface. Mycelium is woolly, purplish-grey to black in colour. Small white or black star-like markings with dashes and dots also develop on the wood. During fructification black spherical bodies like grains of shot grow side by side to form a crust. Spreading source is similar as in charcoal stump rot.

Management of primary root diseases : The primary root rots spread fast and kill the plant outright. The infected plant does not show any apparent distress or symptoms. Mortality of the affected bushes is sudden and without any warning. It is also seen that a part of the plant suddenly dies while the other half is still living.

The most widely adopted conventional method of management of the primary root rot diseases is described below:

- Isolation drain of 1.0 m deep and 0.3 m wide should be dug up immediately surrounding the affected bushes as an interim measure.
- During the winter the affected bushes along with a ring of the unaffected healthy bushes should be uprooted.

All possible woody materials must be removed by digging

- The soil should be put under rehabilitation for two years growing green crop such as *Crotalaria anagyroides* or soil rehabilitation crop like Guatemala (*Tripsicam laxum*).
- Periodical watering should be done with some systemic fungicides for a period of one year after replanting tea.

Chemical control : The primary root diseases may also be managed by soil fumigation with the following advantages:

- Only the affected plants are to be uprooted and not the unaffected healthy ones
- Replanting can be done during or after 12th week as against 24 months of rehabilitation in the conventional method
- Soil fumigation is less expensive.

Central Insecticide Board of India has approved Durofume, consisting of equal parts of methyl bromide and ethylene dibromide in the ratio of 1:1 as one soil fumigant. The fumigant is injected into the soil after properly clearing the affected area.

Biological control : Application of beneficial microorganisms has been attempted in the control of primary root diseases *viz.,* charcoal stump rot and brown root rot of tea. At the time of replanting or infilling the planting pit and the excavated soil should be treated with Trichoderma bio- agent having 10% strength of the suspension @ 100 ml/pit or the compost/ any organic manure/ well decomposed cattle manure should be mixed thoroughly with the suspension and

Secondary Root Disease

Violet Root Rot : Violet root rot is caused by the fungus, *Sphaerostilbe repens*. Violet root rot attacks all tea plants above one year old in waterlogged areas. But the characteristic symptoms are produced on plants of about two years and above.

Affected roots are inky black or light violet in colour and freshly dug up ones often smell sour or vinegary. The surface of the wood is covered with thick, irregular white to orange flattened strands of mycelia that ultimately changes to purplish black. Fructifications may either look like small groups of pinkish or orange coloured pins (about 3mm long) with white heads on root surface or a cluster of minute red to black flower bud like bodies at collar region or little above. he excavated soil of the planting pit @ 200 g/pit.

Affected bushes bear leathery and yellowish leaves and carry few plucking points, become unproductive and finally die.

Management :

- Improved aeration by providing adequate drains and improved physical condition of soil by growing green manuring crops, deep rooted shade tree etc. help in controlling the violet root rot disease.
- Soil should not be cheeled away nor should sub-soil be piled up thickly at the collar region of the tea plants.
- Chemical manure should not be applied in low lying areas in wet weather.
- In case of death of the tea bush due to secondary root disease, only the dead bush should be removed. It is neither necessary nor advisable to uproot a ring of unaffected healthy bushes as would be done in case of primary root diseases.

Diplodia : The disease caused by the fungus, *Botryodiplodia theobromae* may attack any part of the tea plant, young or old, only when the plant is debilitated by other causes. When the root is attacked, no characteristic symptom develops initially. However, in advanced stages small isolated or groups of grayish black to coal black hairy cushions develop, giving a shooty appearance which may extend upto collar. The wood when sliced, exhibit even bluish black discoloration.

Infection is believed to take place through air borne spores.

Management : The main predisposing cause of Diplodia disease is general debility of the plant chiefly due to lack of root starch reserve. Therefore, improving the general health and vigor of the plants through judicious cultural and manurial practices the incidence of the disease can be reduced.

Rhizoctonia : The fungus *Rhizoctonia bataticola* or *Macrophomina phaseoli* attacks all tea plants, young and old, when they are debilitated by other causes as does *Diplodia.* Very often Rhizoctonia by the same conditions.

No outward symptom in the affected roots is visible. On the surface of the wood beneath the bark and also in the wood number of minute, irregular black dots (sclerotia) are noticeable, Rhizoctonia infested roots are very light in weight and completely devoid of reserve.

Management : The main cause of Rhizoctonia disease being similar to that of Diplodia judicious cultural and manurial treatments is to be followed for management of the disease.

CHECK YOUR PROGRESS

Q.8. What is the main agent that causes all common diseases in tea?

.....

.....

Q.9. What is a primary disease?

.....

.....

Q.10 Name four primary root rot diseases of the tea bushes.

.....

Q.12.Can we control primary root rot diseases by using chemicals? Name one such chemical method.

.....

.....

Q.13. What are the predisposing factors responsible for the violet root rot disease?

.....

Q.14. Name one bio agent used for preventing some primary root rot diseases.

Primary Stem Diseases

Branch Canker : It is a wound parasite prevalent in all tea areas. The fungus (*Poria hyppbrunnea* Petch) gains entry through the unprotected wounds especially on thicker branches, caused by various agencies such as heavy pruning cuts, sun scorched lesions, damages with ragged surfaces made by careless chopping or cutting off branches or falling of shade trees, wounds made by hail, cattle etc.

On weak bushes, even wounds on smaller branches may be affected by the disease. From the first site of infestation through stem the fungus gradually moves downwards killing the entire plant. It may take 8-15 years to kill a mature bush and 2-3 years a young plant.

The infested wood turns yellowish, soft and decays. Thin, irregular, light-brown lines are formed in the wood which are permeated with thin sheet of yellowish-brown mycelium. It produces yellowish (later dark grey) corky fructification on the underside of big branches at their base or collar region. Infection spreads through air borne spores.

Management : The dead bushes should only be removed. Vacancies may be infilled as soon as possible.

Cultural control :

- As a preventive measure all the dead wood should be carefully removed at each pruning. Medium pruned tea may be protected from sun-scorching by growing green crops.
- All cuts and wounds should be smoothed off with a sharp knife followed by application of bitumen paint or Indopaste on the exposed surface.
- Desnagging in the season following medium pruning, should be done carefully without breaking the dead and decaying branches, cutting out the dead portions to the clean healthywood.

Biological control : *Trichoderma viride* and *T. harzianum* show inhibitory activity against *Poria hypobrunnea.* Painting of large pruning cuts with 20% strength of *Trichoderma* biocide solution soon after medium pruning and the spraying the entire bush frame with 5% strength of the biocide soon after light pruning/ cut across pruning are recommended for management of Branch canker disease.

Die-Back of Primaries : The fungus (*Fusarium solanii)* causes blackening of the petioles of leaves which gradually extends to the nodes and internodes, followed by wilting of the primaries. White cottony growth of the fungus is visible on the dying tissues which changes to brown at maturity.

Management : Chemical control of *Fusarium solani* causing die-back of primaries has been found effective with Carbendazim @ 1:400 or Tridemorph @ 1:1000 dilution or combination of the both. Spraying of the chemical should be done immediately after tipping/ plucking followed by a second round 15 days after the first application.

Secondary Stem Disease

Red Rust : It is the only major algal disease of tea caused by the alga, *Cephaleuros parasiticus*. It causes severe damage to both old and young tea and is prevalent all over the tea areas. The alga causes branch die-back and hinders frame formation in affected young tea plants.

The affected patches become noticeable in 1, 2 or 3 year old branches during April to July which are brick red or orange coloured tiny hairs with minute knoblike heads (sporangia). From August onwards circular to oval purplish black coloured long cracks appear on the branches. Not only stems but the fruit coat (pericarp) and leaves are also infested by the alga. On lower surface of leafthe alga enters into the intercellular spaces through the stomata and isolated groups of cells forming a dead spot.

Management : Red rust being a secondary disease is associated with some predisposing factors. Hence it is imperative to identify these predisposing factors and necessary corrections should be made to these factors for management of the disease.

The important pre-disposing factors are:

i) Poor drainage,
ii) Lack of shade,
iii) Improper soil pH
iv) Lack of soil fertility,
v) Low potash content of the soil,
vi) Inadequate rehabilitation prior to replanting,
vii) Injudicious use of green crops and
viii) Use of susceptible clones in drought prone and water- logging area.

Chemical control : After correction of the predisposing factors, fungicidal spraying should be done as supplementary measures. The following may be followed:

- If rusty sporulations in the stem persist during July, spraying of Copper oxychloride formulation @ 1:400 (250 ml in 100 litres of water) with a hand sprayer at monthly interval should be continued.
- Urea and MOP (1% each) should be sprayed in the affected areas.
- Spray should be targeted to the foliage as well as the younger branches. Use of a sticker is essential.

Primary Leaf Diseases

Blister Blight : The fungus (*Exobasidium vexans*) causing blister blight is an obligate parasite with no known alternate or collateral host. It attacks the young succulent leaves and stems of tea under cool, misty weather with little or no sunshine.

Average weekly sunshine hours ranging from 2-10 hours, temperature from 10^0-23^0C, mean daily rainfall from 20-100mm and relative humidity from 60-100% favour the disease development.

A leaf wetness of 11 hours is optimum and 13 hours maximum for infection. The fungus reproduces through basidiospores, which are disseminated by wind. The wind borne spores on lodging on the surface of a susceptible host tissue germinate under favourable conditions and infect the host.

The pathogen requires only a short period to complete its life cycle. Depending on the ambient weather condition it may vary from 11 to 28 days. Hence many generations of the fungus can be completed during the disease season. Sporulation may start 10-12 days after infection and spore discharge continues upto 8 days.

The symptoms first appear on the young expanding leaves as pale yellow or pinkish translucent spots. The spots gradually enlarge to a circular lesion of 3.0 – 12.5 mm or more in diameter. As the lesion develops further, the upper side is depressed into a shallow cavity and correspondingly the lower side becomes convex forming the typical blisters from which the blight takes its name. The upper concave surface of the lesion is smooth and shiny, while the lower convex surface is dull at first and powdery as it sporulates.

The affected leaves often become folded or irregularly rolled up owing to the development of lesions. A mature blister lesion canproduce upto two million spores in 24 hours. Under severe infection, the affected leaves curl up and become distorted.

The fungus also infects young growing stems by producing slightly swollen velvety patches on the surface but never form blisters. When the tender stem is affected, the entire shoot withersand results in dieback.

Management : The management of Blister blight disease includes the following

Cultural or Field management :

a) Plucking
- Infected leaves and shoots should be pulled out and destroyed
- Black plucking should be done when disease appears in areas under plucking
- Pluckers engaged in the blister affected areas must not be allowed to pluck in the healthy areas unless the clothing is changed

b) Shade
- Thinning out of the overhead shade

c) Pruning

- In blister prone areas medium pruning should not be done earlier to November.

d) Autumn infection

- In widespread attack (November-December), the area due for pruning or skiffing should be pruned or skiffed as quickly as possible.

Chemical control :

This is the most effective method of getting immediate control of the disease and is achieved during active stage of external growth and reproduction of the pathogen. Application of 4-6 rounds of copper fungicide containing 50% metallic copper at 0.125% concentration (1:800) with a hand sprayer or @ 625g/ha in 100-150 litres of water with a motorized power sprayer are found to be effective. Repeated spraying of 4-6 rounds at 7-10 days interval may become necessary. Spraying is discontinued once the weather condition improves.

The following point should be considered.

- The nursery should be protected by spraying a suitable fungicide.
- Spraying at the top hamper in tea under plucking till the disease disappears.
- New growth (bud break) of cut across or medium pruned

tea should be protected by spraying initial two rounds of short duration and subsequent couple of rounds of long duration.

- If the attack is before the tipping starts, tipping should be done below the predetermined level and the tender shoots should be sprayed with fungicides.

Control by botanicals : Recently it has been shown that water and solvent extracts of three native plants namely, *Cassia tora, Lantana camera* and *Equisetum arvense* are effective in controlling blister blight in field condition in a range of 41-63%.

Black Rot : Black rot is caused by two species of the genus *Corticium* namely *invisum*and *theae* which occur at the same time. Heat combined with humidity is the favourable condition for the fungal development.Mature leaves are the spots of infection but the fungus is also seen on stems. The fungal mycelium enters leaf through undersurface of petiole and spread. While *Corticium theae* shows a cord of mycelium, white in colour, on the stem which changes to pink and finally to dark brown with age but no such symptom is exhibited by *Corticium invisum*.

Infestation starts in April and continues till September but remains as sclerotia in dormant stage, embedded in the cracks and crevices of the plant during winter to reinfect again in the next season.

Corticium theae on the contrary produce large patches of reddish brown colour on upper surface covering about half or more of leaf lamina while the under surface is light brown or grayish white, usually covered with a network of cream to brown mycelium.

Corticium invisum produces irregular patches with slightly raised wavy margin on the leaves, which are accompanied by many small greyish white circular spot. Larger patches exhibit a mixture of brown yellowish to chocolate brown and grey upper surface with evenly brown and grey under surface.

Corticium theae on the contrary produce large patches of reddish brown colour on upper surface covering about half or more of leaf lamina while the under surface is light brown or grayish white, usually covered with a network of cream to brown mycelium.

Diseased patches on leaves look black and slimy when wet. The disease gradually fills the leaves resulting in deterioration of health. Dead leaves often remain attached to other leaves or to the stem by small cushions of mycelium. Fructifications appear as powdery white patches on the undersurface of apparently healthy green leaves.

Management : The disease is persistent in nature. Therefore, if the control measure is not administered timely the disease continues to attack years after years. Management of the disease includes the following:

Cultural or Field management :

a) Plucking
- The pluckers must change apparel before going to pluck the healthy sections
- Infected leaves must be plucked and put under the tea bush.

pruning cycle should be followed in the disease prone areas.

b) Pruning

- Pruning physically removes most of the disease. Pruning litters should be allowed to decompose on the soil surface as the sclerotia (resting stage of the fungus) survive in lightly buried pruning litters.
- In heavily infected areas the bushes should be cleaned out following pruning. Unpruned and skiffed tea favour the disease. Shorter

c) Shade

- Shade should be corrected in the disease infected areas allowing proper air circulation.

Chemical control :

- The medium pruned bushes should be given a round of caustic lime wash before bud break.
- Spraying of copper fungicide @ 1:400 dilution should be done in general during April-May at fortnightly interval for two rounds wetting thoroughly the undersurface of the leaves and the stems.

Thereafter only the affected bushes are to be sprayed. A combination of Copper oxychloride with ergosterol biosynthesis inhibiting fungicides such as Hexaconazole group will enhance the level of control.

- To arrest the formation of sclerotia, specially of *C. invisum* during October when the night temperature falls below 20^0C spraying of a Carboxin formulation at 1:400 in the cracks and crevices of the infected stem should be commenced and the spraying may be continued for 2-3 rounds upto December at monthly interval.
- Application of copper fungicide during October-November for 2 rounds at monthly interval reduces the re-growth of both the species of *Corticium* in the following growing season.

Secondary Leaf Disease

Secondary leaf diseases are found mainly on old tea leaves when the plant is weakened by the attack of red spider mite, water logging, sun scorch etc.

Brown Blight : Brown blight, a secondary leaf disease, is caused by the fungus, *Glomerella cingulat*or *Colletotrichum camelliae* .Infestation starts at margin and spreads inwards, with the formation of patches, edges of the patches are sharply defined with a delicate concentric zone. Upper surface is yellowish to chocolate brown initially changing to grey from centre to outwards. Minute, black, scattered, dot-like fructification of the fungus appears a both surface of leaves.

Grey Blight : The casual fungus of this disease is *Pestalozzia theae*. Diseased patch may occur anywhere in the leaf lamina. Patches on the upper surface are brown coloured with a greyish centre, roughly circular to oval in shape. On young leaves the patches are usually dark brown to almost black.

Management : For management of Brown blight and Grey blight fungicidal treatment is not necessary. Instead the predisposing factors should be ascertained and the plants should be treated accordingly.

8.6 LET US SUM UP.

- Different pests infest every part of the tea plant, the leaves, stem, root, flowers, but the maximum numbers of pests occur on the foliage.
- The major pests which infest the leaf and the shoot are: Mites, Tea mosquito bugs or *Helopeltis*, Thrips, Jassids, Aphids, Flush worm, Caterpillars, Scale insects and mealy bugs.
- The different mites that attack the tea bushes are Red spider mite, Scarlet mite, Pink mite and Purple mite. The red spider mite is a serious pest of tea. All mites are sucking pests.
- The tea mosquito bug (*Helopeltis theivora*) is one of the major sucking pests which cause extensive damage in tea. The females lay eggs in the tissue of tender stem, mid rib and petiole of leaves. The nymphs and the adults of *helopeltis* are the active suckers of sap from the buds, young leaves, tender stems and shoots. Badly affected leaves become deformed and even curl up. Tender stems near the apex turn dark brown due to oviposition and the shoots die back.Infestation of *helopeltis* may become destructive during the cropping season.
- Among the caterpillars, Looper caterpillar, Bunch caterpillar and Red slug caterpillars are the most important tea pests. The young caterpillars eat away the leaves and in case of severe attack the entire tea bushes are completely defoliated. Hand collection of caterpillars and application of proper insecticides can control them. Light trapping of the moths at the time of their emergence helps in controlling the caterpillar pests.
- Other pests like Thrips, Jassids, Aphids, Flush worm, Scale insects and mealy bugs, Stem borer, etc can be controlled by application of proper insecticides along with other cultural measures.
- and they should be controlled before the damage becomes serious.

Pesticides recommended by Tocklai Experimental Station should be applied at proper doses only.

- Brown cricket, Cockchafer grubs, termites are other pests of tea bushes which cause considerable damage to the tea plants
- Spraying pesticides during the hot midday sun and windy weather should be avoided. A minimum of 8 -10 days gap between insecticide/acaricide application and plucking should be maintained. Appropriate distance between nozzle and the target site should be maintained.
- Integrated pest management is a system of pest management that utilizes all suitable techniques and methods in as compatible form as possible to maintain the pest and disease incidence at a level below those causing economic damage.
- pest control methods like cultural, physical, mechanical, biological and hormonal control.Diseases of the tea bush are mainly caused by any one of the five agencies *viz.,* vegetable
- organisms like fungi, algae and bacteria, animal parasites, adverse conditions of soil and climate leading to physiological disorder, mechanical damage and virus. However, the bacterial and viral diseases and those caused by animal parasites are not so serious in tea crop and have no commercial importance.
- Most of the serious diseases in tea are caused by fungi. Red rust is the only diseases caused by an alga.
- The diseases can be classified into two groups-primary diseases and secondary diseases.
- A primary disease can cause death of the healthy tissues or the ushes even under the best growing conditions. The secondary diseases attack the
- weak bushes when the health of the bushes is impaired due to cultural and/or environmental stresses.
- On the basis of the site of first (major) infestation on the tea bushes, diseases can further be classified as root diseases, stem diseases and leaf diseases.
- Soil fumigation may also be adopted against the pathogens.

8.7.ANSWER TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : (i) Mites–Red spider mite, Purple mite , Pink mite and Scarlet mite (ii) Tea Mosquito bug or *Helopeltis* (iii) Caterpillars-Looper ,Bunch and Red slug caterpillars (iv) Thrips (v) Aphid (vi) Jassids (vii) Flush worm (viii) Scale insects and mealy bugs and (ix) Weevils and beetles.

Ans. to Q. No. 2 : Red spider mite, Purple mite, Pink mite and Scarlet mite.

Ans. to Q. No. 3 : Looper caterpillar, Bunch caterpillar and Red slug caterpillars.

Ans. to Q. No. 4 : The nymphs and adults of *helopeltis* suck the sap from buds, young leaves, tender stems and shoots of the tea bush.

Ans. to Q. No. 5 : The three Synthetic pyrethroids are Deltamethrin, Cypermethrin, and Fenvalerate and the three Neem formulations are Fortunaza, Bioneem and Azadirachtin.

Ans.to Q. No. 6 : a) True, b) False, c) False, d) False, e) True, f) True, g) True

Ans. to Q. No. 7 : a) Quinalphos, Endosulfan or Chlorpyriphos

b) tender stems, buds, petioles and lower surface

c) Sucking, foliage, roots

d) nursery

e) Common stem red (*Zeuzera coffeae)*

f) Live wood eating termites (*Microcerotermes sp.*)

Ans. to Q. No. 8 : Fungi.

Ans. to Q. No. 9 : A disease which can cause death of the healthy tissues or the bushes even under the best growing conditions is called a primary disease.

Ans.to Q. No. 10: Black root rot, Charcoal stump rot, Red root rot and Brown root rot

Ans. to Q. No. 11 : a) True, b) False, c) True.

8.8.MODEL QUESTIONS

Q.1. What are the different insect pests of tea which attack the leaves and the shoots? Describe the nature of damage caused by each pest.

Q.2. What are the different mite pests of tea? Describe the nature of damage caused by the mites. How to control mite pest in tea fields?

Q.3. How does *Helopeltis* cause damage to the tea bushes? Describe the different measures adopted for controlling the pest. How to spray pesticides against *Helopeltis?*

Q.4. Describe the nature of the damage caused by Looper caterpillars. How can you control it? What insecticides are effective against Looper caterpillars?

Q.5. What are the different insecticides used in tea for controlling the insect pests? What types of sprayers should be used for pesticides application? Give the rate or dilution of pesticides for application by different types of sprayers.

Q.6. Prepare a table indicating the target site for application for different pests.

Q.7. What are the important considerations while spraying pesticides?

Q 8. What are the causal agencies that cause diseases in tea plant? Name the agencies.

Q.9 Distinguish between a primary and a secondary disease. Name a few common primary root rot diseases of tea. How can the primary root diseases be controlled?

Q.10 Under what condition does Blister blight occur? Describe the symptoms of the disease and its control measures.

Q.11. What is a red rust disease? Describe the pre disposing factors for red rust infection. How to control Red rust?

Q.12 What are the causes of Branch canker disease? How does it affect the tea bush? Describe the control measures against branch canker.

FURTHER READING

- *Tea Cultivation-Comprehensive Treatise*. By N.Ghosh Hajra.International Book Distributing Co., Lucknow.
- *Diseases of tea and associated crops in north east India*. By K. C.Sharma. Memorandum No.27. Tocklai Experimental Station, Jorhat, Tea Research Association.

UNIT 9 : PHYSIOLOGICAL DISORDERS IN TEA AND THE COLD WEATHER OPERATIONS

UNIT STRUCTURE

9.1 Learning Objectives

9.2 Introduction

9.3 Adverse Climatic and Soil Conditions

9.4 External Agencies

9.5 Cold Weather Management

6.6 Let us Sum Up

6.7 Answers to Check Your Progress

6.8 Model questions

9.1 LEARNING OBJECTIVES

After going through this unit, you will be able to :

- List the adverse soil and climatic conditions that may affect the tea bushes.
- Describe the physiological disorders due to such conditions.
- Discuss the effects of such disorder on bush health and productivity.
- Describe the ameliorative measures to rectify such effects.
- Identify the cold weather practices.

9.2 INTRODUCTION

In the previous Unit, we have discussed the different diseases of tea caused mainly by the fungi and algae. Adverse conditions of soil and climate also lead to some physiological disorder in the tea bush. Tea plants suffer from a series of physiological disorders due to a number of adverse soil and climate conditions. Mechanical damage caused by external agencies also sometimes cause disease condition.

In this unit, we shall deal with these conditions along with their effects on tea plants and the ameliorative measures necessary to rectify such effects. Further, some important operations should be undertaken during the cold weather (December –February) after the close of the plucking season. The cold weather management in a tea plantation influences theproductivity of tea in the next season. This aspect will also be discussed in this unit.

9.3 ADVERSE CLIMATIC AND SOIL CONDITIONS

Drought

In general, most tea areas of North India experience droughty situation between December and April/May period. During this period, there is virtually no rain in many areas and due to the water deficit, plants suffer from drought. Drought may be caused by environmental conditions like high ambient temperature due to direct solar radiation or high winds.

The following physiological disorders are encountered during drought.

i) Reduction in photosynthesis

ii) Closure of stomata

iii) Reduced cell expansion and leaf growth

Stomatal closure and restriction of CO_2 diffusion may account for the loss of photosynthesis activity. Decreased development of leaf area due to water deficit results in decreased photosynthesis. Decrease in leaf area is the earliest sign of water deficit. Leaf senescence is accelerated resulting in irreversible loss of photosynthesis surface. Loss in leaf area coupled with photosynthesis rate causes potential crop reduction. Water deficiencies, therefore, reduce the yield by decreasing the photosynthates accumulated during the season.

Rectification :

- If the drought is moderate, a plant with adequate maintenance leaves will tide over better as compared to a plant without leaves or with only tender immature leaves and growing shoots.
- If the drought is acute and shoots start dying, a skiffed may check the total collapse of the plant.
- In case of moderate drought in March to April or after the first flush, the growing shoots may be plucked over a leaf, adding up a layer of maintenance leaf at the same time reducing the water and respiratory losses through the tender leaf and shoot.
- In case of chronically drought prone areas pruning or skiffing might help.
- If the drought is for a short spell some remedial measures like good shade, mulching and wind breaks (shelterbelts) can reduce the impact.
- Drought can also be overcome by timely irrigation.
- Foliar application of potash during the dry months is recommended against drought.

Waterlogging

Waterlogging during the rainy season is a common feature in tea areas. At times plants are also submerged upto ground level for prolonged duration. The primary cause of suffering of plants due to waterlogging is due to lack of aeration. Impeded respiration due to paucity of oxygen will suffocate the roots and will retard the absorption of nutrients and synthesis of vital hormones like cytokinin and gibberallic acid. Prolonged waterlogging triggers the release of ethylene gas which suppresses the growth and accelerates leaf fall through abscission

In waterlogged condition, the leaves of the nursery plants become yellowish and flaccid and sometimes leaves are shed while still green. The most affected part of the plant under waterlogged condition is the root. The roots decay and cannot absorb the nutrients.

In waterlogged soil there is accumulation of hydrogen sulphide. The presence of even a trace of hydrogen sulphide is very toxic and can kill the plants.

Roots have the ability to extract nutrients when in contact with soil crumbs. Roots can also take up immobile nutrients such as phosphate by establishing direct contact. Under waterlogged condition, because of the collapse of soil crumbs and degeneration of root system, the roots not only fail to establish such direct contacts but also cannot take up the required amount of nutrients from the soil solution. The safety mechanism in mature leaves fails leading to the death of plants. As synthesis of new metabolites and hormones are impaired, the plants become weak.

Under waterlogged conditions, absorption, translocation and transpiration through leaves are impaired. In bright light and high ambient temperature, the leaf temperature shoots up causing serious scorching and leaf drop. This is mainly due to lack of transpirational cooling of leaves. Thus, chronic waterlogging leads to slow death of plants.

Rectification : Tea bushes in the plains of N.E. India are normally shallow rooting. There is an intimate relationship between the growth of the aerial part and the root of a tea plant and therefore without increasing the volume of roots, it is not possible to increase the top growth beyond a certain limit and hence the yield will be limited. Root growth can only be improved by improving soil aeration and preventing waterlogging.

To rectify the effects of waterlogging, the following practices are important to adopt.

- To improve aeration of the soil, the drainage should be proper. All the drains should be in working order.
- While deepening the drains, subsoil should not be piled up thickly round the collar of bushes.
- Good shade should be established by using shade tree species tolerant to wet soil conditions.
- Chemical manures should not be applied in low lying areas in wet weather.

Sun Scorch

Sun scorch is caused due to adverse weather conditions like strong solar radiation or a period of dull wet weather abruptly followed by one of the hot scorching sunshine. In the plains areas of N.E. India, sun scorch damage occurs not only on the leaves but also on the ticker branches and the main stem of mature tea bushes.

In case of mature tea, sometimes during the rains almost all the leaves in a section of tea suddenly turn chocolate red within a few days as if these are swept by fire. This usually happens when a period of dull wet weather is abruptly followed by hot scorching sunshine.

The affected leaves turn completely reddish brown, where a leaf is particularly shaded, by another immediately above it, a sharp and clear impression is left on the leaf below, showing the shaded area quite green and the rest completely reddish brown. The undersurface of the scorched leaves is usually coated in patches with a thin film of gummy, shining substance, as if lightly brushed with a varnish, which is not quite dry. The young buds, immature leaves and the old leaves lower down are usually unaffected. The damage is invariably followed by brown and grey blight diseases.

Young plants, planted out in unshaded or poorly areas, sometimes are affected by sun scorch when they are subjected to a period of strong sun immediately after transplanting. The leaves turn chocolate red, wither and exude a gummy substance on the undersurface.

Sun-scorched on branches : Healthy mature bushes, especially those with vigorous growth, when medium pruned or heavy pruned before November may be damaged by sun-scorch, in varying degrees.

When the hot sun ray falls directly on the upper surface of the thick, horizontal branches and on the southern and south western surfaces of the vertical and oblique ones, the bark may be killed either in isolated, longitudinal patches or in one single patch extending through the whole length. Sometimes sun-scorch occurs when a shower of rain is followed immediately by very hot sun shine.

Rectification :

- Establishment of adequate shade is the most effective precaution against sun scorch. When mature tea is severely affected by sun-scorch during the plucking season, the plucking table should be raised by leaving a leaf.
- Young tea should be provided with temporary green crop shade till permanent shade is established.
- Sun damage on nursery seedlings may be avoided by thinning out the shade gradually. This will help the leaves to adapt themselves to the increasing light and heat.
- Medium pruned tea can be protected from sun-scorch by inter sowing the areas in the early spring of the year of

pruning with *Crotalaria anagyroides* or other suitable green crops. These may be sown in alternate lines running North to South or North West to South-East direction.

- Painting of the branches, immediately following pruning, with a caustic wash mixed with lime will reduce the damage from sun scorch.
- Covering the top of the bushes by the pruning litters also reduces damage from sun-scorch but this must not be done in hot dry areas where there is risk of fire. If used the pruning litters should be removed before bud break takes place, in order to avoid damaging the new buds.

Lightning

Lightning neither scorches the leaves nor splits the stems but causes sudden death of bushes in groups of anything from about 15 to 70 or more. First the bushes at the center of the strike die and then this process continues for about 15-20 days. More often a shade tree is included in the affected patch but somehow it escapes damage in most cases.

The leaves of the bushes affected by lightning suddenly wither, turn reddish brown and remain attached to the branches for some time, giving the impression of being scorched by fire. The bark and the wood tissues of the above ground portion, and to some distance below the soil level, are severely plasmolysed. When sliced with a knife the wood is seen to be discoloured evenly dark brown.

The effect of lightning should not be confused with that of root diseases as in case of the latter the death is not that rapid, Due to lightning leaves become brown, more accurately bright reddish brown and may show in the under surface a film gummy in nature.

Rectification :

- Bushes affected by lightning should be dug up immediately since they are likely to be rapidly attacked by primary root diseases like charcoal stump rot and red root rot.

- The vacant area should be manured with a heavy dressing of well- rotten organic manure and put under a green crop such as *Crotalaria anagyroides* for at least a year and then replanted. If replanting is done without such treatment, it is more likely to end in failure sometimes even the grasses fail to grow in the affected areas for a long time.

Hail

In the plains estates of North East India, hail storms sometimes cause heavy damage to tea during March and May. There are certain belts where hail storm occurs almost every year.

A thick continuous fall of hail for about half minute may cause serious damage to the tea bushes. The damage is more when the hail is accompanied by high wind. Light pruned tea and young tea suffer the most, especially when they are poorly shaded or unshaded and not protected by any green crop.

The branches, light twigs and the flush all are affected. The branches are torn off by the force of the impact of large stones. In severe cases, bushes may be almost completely defoliated resulting in crop loss. The bark of the branches on the upper surface or on the side from which the hail comes is badly damaged. Damage to the branches is comparatively less on unpruned teas. Hail damage causes lesions through which *Poria, Agloaspora* and *Nectaria* attack the barked woody tissues.

Rectification :

- A suitable copper fungicide @ 2.5 kg/ha with a sticker should be sprayed as soon as possible within 24 hours starting with the badly affected areas, although this spray is beneficial to a lesser extent within 48 hours also.
- After the spray of copper fungicide within 48 hours of damage as protective measures against infections of fungal diseases, it is beneficial to spray 10 ppm (1 gm/100 1itre of water)

Naphthelene Acetic Acid or Kinetin within seven days of damage as ameliorative measures. This would help in healing the wounds early.

- Hard plucking is forbidden on teas affected by hail. Plucking table should be raised by a leaf. If the bushes remain weak in case of severe damage, the plucking table should be raised by another one leaf in the plucking season later also.
- Extreme damage requires the sections to be left unplucked and rested. Mature tea having severe damage may be applied with additional dose of 40 kg N/ha.

CHECK YOUR PROGRESS

Q.1. Name four adverse climatic conditions that may affect the tea bushes in a plantation.

.....

Q.2. What physiological disorders are brought about by drought?

.....

.....

Q.3. What are the reasons for sun scorch?

.....

.....

.....

.....

Q.4. What root disease is common in waterlogged soil?

.....

Q.5. State true or false :

a) In the plains areas of N. E. India sun scorch damage occurs only on the ticker branches. (True/False)

b) Foliar application of potash during the dry months is recommended against drought. (True/False)

c) Hail damage causes lesions through which *Poria, Agloaspora* and *Nectaria* attack the barked woody tissues. (True/False)

d) Lightning scorches the leaves and splits the stems and the bushes die gradually. (True/False)

9.4 EXTERNAL AGENCIES

Heat Damage

Tea bushes especially the young ones and the young shade tree plants growing on stony ridges, southern slopes of *teelas* and the exposed sandy soils which get baked in hot sun, are often damaged at the collar region by heat. The tissue of the main stem just near the soil surface is burnt on the southern and western side of the bigger bushes and practically on all sides of the smaller ones.

A ring of callus is usually formed at the upper edge of the damaged lesion but smaller plants, when completely girdled, often die.

The leaves of the severely affected plants wither, turn brown as in drought and curl inwards. The under surface is sometimes thinly smeared in patches with a shining varnish like substance. The main stem at the collar region when scrapped with a knife is found to be discoloured brown.

Heat injury may be avoided by providing adequate shade or ground cover as the situation demands. Damaged plants should be replaced.

Manure Injury

Young tea plants in the field are sometimes seriously injured by wrongful application of the chemical fertilizers. Chemical fertilizers, if applied in contact with the collar, especially during a dry period, absorb moisture from the plant tissues and causes

plasmolysis. Also, when the rain following the application washes down the fertilizers into depressions around the collar, thus bringing a concentrated solution in direct contact with the tissues, plasmolysis occurs.

Plants may be found at different stages of wilting according to the intensity of the damage. The severely affected ones die out completely. Some plants grow a ring of callus at the upper edge of the affected area which, when scrapped with a knife, is seen to be heavily discoloured brown.

Rectification : Chemical fertilizers should never be applied in direct contact with the collar of the plants. It is always risky to apply chemical manures to the plants situated in saucer like depressions formed while cheeling. Application of chemical fertilizers to dry soil following a prolonged dry period should be avoided. Dead and wilted plants should be replaced.

Callus Growth

Callus growth is a natural process which takes place as a result of a wound made on the living parts of a plant. It is an attempt on the part of the plant to repair the wound by growing new cells from the adjoining uninjured tissues. However, in many cases the process goes much beyond the desired limit. Callus formation is then considered abnormal. Thus occasionally some irregularly undulated surface or hard abnormal outgrowths are seen on the stem of the bushes. Such growths are believed to be the result of some irritation caused on the stem by insects or other agencies in the past.

Filling up of small cuts and bruises on the stems or covering up of pruning cuts of healthy tea bushes is necessary. With a reddish brown growth which takes place from the edge of the damaged area is a desirable healing process.

Debility or Lack of Reserves

Tea bushes, even vigorously growing ones, sometimes completely die out for no apparent reason, following a medium pruning or decentering in case of young tea. It is also a matter of common occurrence, especially with an older tea which is subject to adverse conditions, that the bushes gradually deteriorate in health and ultimately die, without the intervention of parasitic diseases. There may be a few exceptions but these are only coincidences. Careful examination of such bushes shows that their death is caused by complete absence of reserves.

Rectification : The following measures should be taken to provide safeguard against depletion of reserves:

- Care should be taken to maintain the bushes, both young and old in healthy state by preserving adequate maintenance leaves, especially during the growing season.
- Weak tea must not be medium pruned without resting for a maximum of 2 months prior to the operation. It should preferably be carried out towards the end of a dormant *(banjhi)* period. Nitrogen manuring before resting is found to be beneficial.
- Centering of young plants should be avoided during or immediately following a period of vigorous growth. It should be done towards the end of a dormant *(banjhi)* period.
- Over plucking and plucking too low a measure should be avoided.

9.5 COLD WEATHER MANAGEMENT

During the cold season after the close of the plucking season, there are certain important practices which are to be undertaken in each tea garden. These practices are necessary in order to maintain the health and vigour of the bushes and also to sustain the productivity in the next season. The practices are described below:

Management of the Pruned Bushes

- The pruning litters after the pruning or skiffing should not be removed from the field and be kept *in situ* for decomposition. It enriches the soil.
- The dried, diseased and very thin branches should be cut away before the bud break. In deep skiffed section also the very thin *banjh*i branches should be removed.
- After pruning, the cut ends of the branches thicker than 1 cm should be treated with Indopaste or Bordeaux paste (1 g Copper sulphate+100 g lime in 500ml water). Also 20 % Trichoderma solution may be used.
- The branches or the bush frame should be caustic washed if there is any fungal or lichen growth. The solution may be prepared by dissolving 2-3 kg quick lime and 6 kg washing soda in 100 liters of water.

Management for Pest Control

- Endosulfan 35 EC 500 ml and Dicofol 18.5 EC 500 ml mixing with 200 liters of water should be sprayed in all unprune, light skiffed and level-off-skiffed bushes towards the end of December and January for two times.
- The termite hills should be removed during the cold season. The termite mounds should be completely removed along with the termite queen and it should be flooded with Chloropyrifos mixing with a few buckets of water. 350 ml Chloropyrifos mixing with 100 liters of water should be applied at the collar of the termite affected bushes @ 60-250 ml per bush.
- During November-February, the pupae of the Looper and Bunch caterpillar should be removed and destroyed by stirring the base of the bushes in the caterpillar prone areas.

Management of Drains

- December to March is the best time for digging the drains.
- All the drains should be cleaned by removing the weeds, soil and silt deposited in the drain. The depth of the field drains should be maintained at 105 cm.

Foliar Nutrition

- During December-March, four rounds nutrient solution (1 kg M.O.P. and 1 kg Magnesium sulphate in 100 liters water) may be sprayed in all unpruned bushes as a safeguard against drought.
- Spraying of M.O.P. @ 2 kg in 100 liters of water helps to alleviate the drought effect.

Other Management Practices

- All the weeds like ferns and mikania should be uprooted along with the roots and destroyed.
- During January-February, the *banjhi* shoots should be removed in the unpruned sections and the plucking table should be leveled.
- The trunk of the shade trees should be white washed upto the height of about 1.5 m.
- Mulching should be done in all young tea areas
- This is the best time for collecting soil sample for testing.
- The tools and implements should be repaired, sharpened and the store should be organized.

CHECK YOUR PROGRESS

Q.6. What is the cause of callus growth?

.....

.....

Q.7. Sometimes tea bushes completely die out for no apparent reason, following a medium pruning. What is the reason for that?

.....

Q.8. What cold weather practices are important for controlling the caterpillar pests?

.....

.....

Q.9. How can the effects of drought be reduced by some cold weather operations?

.....

.....

.....

.....

9.6 LET US SUM UP

- Tea plants suffer from a series of physiological disorders due to a number of adverse soil and climate conditions. Mechanical damage caused by external agencies also sometimes cause disease condition.
- Drought, waterlogging, sun scorch, hail, lightning are the adverse climatic and soil conditions that cause physiological disorder in the tea bushes.
- Drought may be caused due to environmental conditions like high ambient temperature due to direct solar radiation or high winds which

bring some physiological disorders like reduction in photosynthesis, closure of stomata and reduced cell expansion and leaf growth.

- In case of a short spell drought, remedial measure like good shade, mulching and wind breaks (shelterbelts) can reduce the impact. Drought can also be overcome by timely irrigation. Foliar application of potash during the dry months is recommended against drought.
- The primary cause of suffering of plants due to waterlogging is due to the lack of aeration. The most affected part of the plant under waterlogged condition is the root. The roots decay and cannot absorb the nutrients .The bushes become weak and invariably the bushes are attacked by violet root rot. Chronic waterlogging leads to slow death of the plants.
- To improve aeration of the soil, the drainage should be proper. All the drains should be in working order. Good shade should be established by using shade tree species tolerant to wet soil conditions.
- Sun scorching may occur in tea bushes. Sometimes sun-scorch occurs when a shower of rain is followed immediately by very hot sun shine, so that the bark is 'steamed off.' Establishment of adequate shade is the most effective precaution against sun scorch.
- Lightning neither scorches the leaves nor splits the stems but causes sudden death of bushes in groups of anything from about 15 to 70 or more. Bushes affected by lightning should be dug up immediately since they are likely to be rapidly attacked by primary root diseases like charcoal stump rot and red root rot.
- Hail damage causes lesions through which *Poria, Agloaspora* and *Nectaria* attack the barked woody tissues. A suitable copper fungicide @ 2.5 kg/ha with a sticker should be sprayed as soon as possible within 24 hours starting with badly affected areas although this spray is beneficial to a lesser extent within 48 hours also.
- Heat damage and manure injury cause damage to tea bushes. Chemical fertilizers, if applied in contact with the collar, especially during a dry period, absorb moisture from the plant tissues and causes plasmolysis.

Tea bushes, even vigorously growing ones, sometimes completely die out for no apparent reason, following a medium pruning or decentering in case of young tea due to complete absence of reserves in the roots.

- Some practices during the cold weather are essential to maintain the health of the bushes and keep the garden free from pests, diseases and weeds.

9.7 ANSWERS TO CHECK YOUR PROGRESS

Ans.to Q. No. 1 : Drought, waterlogging, hail and lightning.

Ans. to Q. No. 2 : Drought brings some physiological disorder like reduction in photosynthesis, closure of stomata and reduced cell expansion and leaf growth.

Ans. to Q. No. 3 : When the hot sun ray falls directly on the upper surface of the thick, horizontal branches and on the southern and south western surfaces of the vertical and oblique ones, the bark may be killed by sun scorching either in isolated, longitudinal patches or in one single patch extending through the whole length. Sometimes sun-scorch occurs when a shower of rain is followed immediately by very hot sun shine, so that the bark is 'steamed off'.

Ans. to Q. No. 4 : Violet root rot

Ans. to Q. No. 5 : a) False, b) True, c) True, d) False

Ans. to Q. No. 6 : Callus growth is due to the wounds made on the bush by some agents.

Ans. to Q. No. 7 : Debilityof the bush or complete absence of reserves.

Ans. to Q. No. 8 : Collection and destruction of the pupae of the caterpillar from the collar region of the bushes.

Ans. to Q. No. 9 : During December-March, four rounds nutrient solution (1 kg M.O.P. and 1 kg Magnesium sulphate in 100 liters water) may be sprayed in all unpruned bushes

as a safe guard against drought. Spraying of M.O.P. @ 2 kg in 100 liters of water also help to alleviate the drought effect.

9.8 MODEL QUESTIONS

Q.1. Describe the different adverse climatic conditions that affect the tea bushes? How do they cause physiological disorder? How to rectify them?

Q.2. What are the causes of sun-scorch? How does it affect the tea bushes? Describe the treatment of the affected bushes.

Q.3. Describe the cold weather practices to be undertaken in a tea garden.

Q.4. Write short note on :

a) Water logging and its effect on tea bush

b) Callus growth

c) Hail damage and its rectification

UNIT 10: COST FOR DEVELOPMENT OF TEA PLANTATION AND RECORD KEEPING IN A TEA GARDEN

UNIT STRUCTURE

10.1 Learning Objective

10.2 Introduction

10.3 Cost of Development of Tea Plantation

10.4 Book Keeping

10.5 Information to be Maintained in a Tea Garden

10.6 Let Us Sum Up

10.7 Answers to Check Your Progress

10.8 Model Question

10.1 LEARNING OBJECTIVES

After going through the unit, you will be able to :

- Calculate the labour requirement for developing a tea plantation.
- Compute the gross and net return from a tea plantation.
- Describe the different terms used in book keeping.
- Describe the different types of books.
- List out the different information to be maintained in a tea garden.

10.2. INTRODUCTION

Tea is a commercial crop with a long gestation period. However, now a days by adopting suitable agro-techniques, the crop could be harvested from the second year of planting. For developing a tea plantation in small scale, the growers have to invest a high amount of capital for labour cost in the year of planting. Thereafter, the maintenance cost is needed to run the plantation. The productivity of a tea plantation depends on many factors, mainly on the agro climatic conditions of the region and also on the management practices.

Further, for managing a plantation as an enterprise, we should have some knowledge of record keeping. Because good use of systems and records is an essential part of effective management for an entrepreneur. It is important that one develops the appropriate systems and records needed to implement a given policy. Records are important reporting devices that can help in carrying out a management effectively.

Being an entrepreneur, the owner-manager must give careful thoughts to the systems and procedures that gather the information used in carrying out policies. So one should be aware of the importance of systems and procedures as management tools.

Further, a concise discussion is made on the importance of book keeping and on the various types of books maintained in a business.

10.3 COST FOR DEVELOPMENT OF TEA PLANTATION

Tea cultivation requires large number of workers during its establishment i.e. in the years of planting tea. Thereafter, the labour requirement is less and the major labour force has to be engaged in plucking of green leaves and in the maintenance of the plantation.

Requirement of Labour

The requirement of labour for developing one ha tea plantation up to fifth year is shown in Table 9.1. During the first year, the labourers are required for different operations starting from surveying the area, land clearing, leveling, and soil preparation to planting tea and after care. All these operation have to be done within a period of 6-7 months (November to May).Therefore, all the operations have to be completed in time by engaging the required labour force.

Table 10.1 : Estimated requirement of labour for developing one ha plantation

Sl. No.	Head	Year-wise labour requirement (mandays) 1	2	3	4	5	Total (Number)
1	Clearing and leveling land	125					125
2	Surveying	10					
3	Soil/land preparation	250					250
4	Culvert/Road/Bridge etc.	60					60
5	Drainage	65					65
6	Organic matter application	30					30
7	Staking/planting / infilling/frtilizer application / transportation	460	47	24			507
8	Planting shade trees						
	i) Permanent -70 plants/ha	10					15
	ii) Temporary -280 plants/ha	20					30
9	Mulching @ 300 plants/md/round	150	50				200
10	Centering/recentering	10	20	30	40	40	140

12.	Tipping/Plucking	50	100	150	250	300	850
13	Manual weed control @ 20md/round/ Chemical weed control	60	120	90	90	90	450
15	Application of plant protection chemicals @ 4md/round	12	12	12	16	16	68
16	Fertilizers application @100kg/md	12	12	12	12	12	60
18	Shade management @ 5 md/round	15	10	10	10	5	50
19	Maintenance of drain/fencing/roads/ bridge/culverts etc	–	10	10	10	10	40
20	Miscellaneous	3	2	2	2	2	11
	TOTAL MANDAYS	**1342**	**383**	**340**	**430**	**475**	**2970**
	TOTAL EXPENDITURE @ Rs. 200/manday	**2,68,400**	**76.600**	**68000**	**86000**	**95000**	**5,94,000**

* Assuming the total plant population = 15,000 per ha

Cost of Inputs

The requirement of different inputs and the estimated cost on the inputs for developing one ha tea plantation are given in Table 9.2 and the estimated non-recurring cost is given in Table 9.3.

Table 10.2 : Estimate of expenditure on materials (Recurring)

Sl. No.	Head	Year-wise expenditure (Rs.) 1	2	3	4	5	Total (Rs.)
1	Hiring of tractor	5600.00	–	–	–	–	5600.00
2	Pesticides/ fungicides	2500.00	4410.00	5600.00	6300.00	6300.00	25110.00
3	Herbicides	–	2000.00	2000.00	2100,00	2100.00	8200.00
4	Fertilizers	3500.00	9000.00	11000.00	13300.00	14000.00	50800.00
5	Growth regulators	–	2000.00	4000.00	4200.00	4200.00	1440000
6	Transportation of green leaf @ 35 paise/kg	–	1050.00	2800.00	3500.00	3850.00	11200.00
7	Misc.	2800.00	4000.00	7000.00	7000.00	7000.00	27800.00
	TOTAL	14400.00	22,460.00	32400.00	36400.00	37450.00	143110.00

Table 9.3 : Estimate of expenditure on materials (Investment)

Sl. No.	Head	Year-wise expenditure (Rs.) 1	2	3	4	5	Total (Rs.)
1	Culvert/hume pipes	9,000.00	–	–	–	–	9,000.00
2	Farm tools & implements	7,000.00	–	–	–	–	7,000.00
3	Leaf house (semi pucca 10' x14')	42,000.00	–	–	–	–	42,000.00
4	Planting material (tea)- 15,000 plants @ Rs. 5/- per plant	75,000.00	7,500.00	3750.00	–	–	86,250.00
5	Shade tree saplings @ Rs. 7/- sapling	3150.00	–	–	–	–	3150.00

6	Organic matter	20000.00	–	–	–	– 20000.00
7	Mulching materials - 20-30 tones	7,000.00	–	–	–	– 7,000.00
8	Goat proof fencing 400 running m (370 kg @ Rs. 80/- per kg/ Concrete post (180 no @ Rs. 100/- per post)	48,700.00	–	–	–	– 34,800.00
	Total	1,69,850	7,500.00	3750.00	–	–1,81, 100.00
	Interest @ 12.0% on investment**	20,382.00	900.00	450.00		21,732.00

**Since tea is a perennial crop giving yield upto an age of 60 years, the non-recurring expenditures are taken as investment and only the interest on investment is taken into account while calculating the total expenditure.

Abstract of expenditure for developing one ha tea plantation

Sl. No.	Head	Yearwise Expenditure (Rs.)				
		1	**2**	**3**	4	**5**
1	Labour	**1,34,200**	**38,000**	**34000**	**43000**	**47,500**
2	Materials					
	i) Non-recurr -ing (Interest on invest- ment @12%	20,382	900	450		
	ii) Recurring	14,400	22,600	32,400	36,400	37,450
	Total materials	34,782	23,500	32,850	36,400	37,450
	TOTAL (1+2)	1,68,982	61,500	66,850.	79,400	84,950

Per ha expenditure on mature tea plantation remains almost same from 5th year onwards

The income may vary depending upon the productivity of the plantation and the sale price of green leaf. The rates of price of green leaf are seen to vary from place to place and also in different months of the season. In computing the income, an average sale price Rs.17/ per kg of the green leaf has been considered. The return from one ha tea plantation is shown in Table 10.4.

Table10.4 : Gross and Net income from one ha tea plantation (in Rs.)

Particulars	Year					6 year
	1	2	3	4	5	onwards
Gross Income	–	34,000.00	76,500.00	1,14,750.00	1,57,250.00	2,38,000
Total cost (including plucking)	**1,68,982**	**61,500**	**66,850**	**79,400**	**84,900**	**84,900**
Net Income	(-)1,68,982	(-)27,500	(+)9650	(+)35,350	(+) 72,350	(+)1,53,100

CHECK YOUR PROGRESS

Q.1. List three operations where the labour requirements are higher.

.....

Q.2. Can you consider the expenditure for erecting barbed wire fence as investment?

.....

Q.3. Why labour requirement in a tea plantation goes on increasing after 5th year onwards?

.....

.....

(including

10.4. BOOK KEEPING

Meaning

Book keeping is that branch of knowledge which tell us how to keep records of various physical and financial transactions. The need for recording such events/transactions arises because of the following:

- it is difficult to remember the various information of field works as well as financial payments and receipts taking place during a period of time
- in modern forms of business entity, the control of business depends on different persons and the results are reported to the owners
- the financial information is required for the purpose of costing, budgeting, forecasting and planning and
- book keeping records are to be submitted to various government agencies like income tax and Sales tax authorities.

The essential idea behind maintaining such records is to show the correct position regarding various incomes and expenditures. Such records should be clear and systematic so that it can be easily understood. It should show to whom a payment has been made when and what for. The need for maintaining a record of income and expenditure in a clear and systematic manner has

Some Basic Terms

a) **Accounts :** An account is a statement which shows all the transactions/events relating to a particular item during a given period.

b) **Entity :** It means a thing that has a definite individual existence. Business entity means a specifically identifiable business enterprise like Warren Tea Ltd., Supar Bazar, ITC Ltd. etc.

c) **Transaction :** An event involving some value between two or more entities. It may be a cash transaction or a credit transaction.

d) **Assets :** Assets are economic resources of an enterprise expressed in monetary terms.

Assets are broadly classified into two types- Fixed and Current Assets.

Fixed Assets are assets held on a long term basis such as land, building, machinery, furniture etc. These assets are used for normal operations of the enterprise.

Current assets are the assets held on a short term basis such as debtors (accounts receivable), bills receivable, stock, cash and bank balances etc.

e) **Business :** Any activity carried on with profit motive.

f) **Books of accounts :** Books wherein transactions and events are recorded and summarised.

g) **Capital :** Amount invested by the owner in the firm may be in the form of cash or assets. Capital is an obligation and a claim on the assets of business.

h) **Liabilities :** Liabilities are obligations or debts that an enterprise has to pay at some time in future.

i) **Sales :** Sales are total revenues from goods and services sold to customers. It may be cash sales or credit sales.

Loss : The excess of expenses over income is the loss.

l) **Expenses :** An expenditure incurred for receiving some benefit or service e.g. depreciation, rent. wages, salaries, interest, electricity, postage, telephone etc. etc.

m) **Depreciation :** Decrease in the value of the fixed assets such as building, machinery, furniture etc. due to wear and tear or other reasons.

n) **Discount :** It is the deduction in the prices of the goods sold. It is offered in two ways:

Cash discounts– it is allowed for prompt payment by debtors.

Trade discount– it is deduction from the price list allowed for bulk purchase of goods.

o) **Purchases :** Purchases are total amount of goods procured by an enterprise on credit or on cash.

p) **Drawings :** Withdrawal of money and /or goods by the owner from the business enterprise for personal use. It reduces the investment of the owner.

q) **Debit :** It means the left side of an account.

r) **Credit :** It means right side of an account.

s) **Debtors :** Debtors are persons and/or other entities who owe to an enterprise an amount for buying goods and services on credit.

t) **Creditors :** Creditors are persons and/ or other entities who have to be paid by an enterprise an amount for providing the enterprise goods and services on credit.

u) **Journal :** A book for chronological record of daily transactions.

iii) **Nominal account–** Accounts relating to expenses, losses, income and gains.

w) Vouchers : It is a documentary evidence in support of a business transaction.

x) Invoice : It is a statement sent by the supplier along with the goods giving necessary details of goods, its quantity, rate, value, total amount payable and terms of payment.

y) Single Entry System : An incomplete system of maintaining accounts which does not exactly follow the principle of double entry system. Under this system, merely personal aspects of transactions are recorded. It offers no check on the accuracy of the posting and no safeguard against fraud because it does not provide any check over the recording of cash transactions.

z) Double Entry System : A system of recording business transaction where the two aspects of cash transactions are recorded to obtain complete record of dealings. Here detection of errors and fraud are easier. The system adheres to the rule that each transactions the debit account(s) must equal to the credit account(s) that is why it is called Double entry.

Book Keeping System

The essentials of a good system of record keeping are as follows:

- **Simplicity :** Records should be simple so that any person can make entry in the books, otherwise new person may

Suitability : It should be according to the nature of the firm. For big firms 50-100 books may be required whereas small entrepreneur can run with 2-3 books.

- **Economy in use :** Books should be such that it should be economic in use otherwise small firms cannot accept it if it is expensive.
- **Accuracy :** Information recorded in the books should be correct. Wrong books may lead to heavy losses and affects the goodwill of the farm.
- **Elasticity :** It is natural that there is every possibility to spend an expansion of the farm. Books should be such that without having any problem and expense, increase or decrease of farm activity may be done as per requirement.

Necessity of Book Keeping

a) **Limitations of human memory**. Capacity of human being is limited as to how much one can remember and that too how long. Proper recordings of transactions/events do away with the need of remembering.

b) **Owners and managers being different persons**. Written records supported by documentary evidences are essential to avoid any mistrust or doubt among owners and managers.

c) **Determination of amounts recoverable and payable by the business**. This information also helps in realizing debts and paying off the liabilities.

d) **Preparation of financial statement**. Every firm/business wants to know the profit earned or loss suffered during the year and its financial position at the end of the year. This is disclosed by Income Statement (Trading and Profit & Loss Account) and Position Statement (Balance Sheet) respectively. Book keeping records provide necessary data for preparing these statements.

Need for financial information. Financial information and data are needed for cost ascertainment, planning, budgeting and forecasting.

f) **Requirement of exercising control**. Size of business is growing and becoming complex. For exercising effective control the management institutes different controls which require periodic reports.

g) **Need for taxation authorities**. Book keeping records are regarded by the tax authorities as authentic and reliable for determining tax liability.

h) **Provide evidence**. Since book keeping records are backed by documentary evidences, therefore, the same are admitted by the courts as authentic evidence admissible in the court cases.

Branches of Record Keeping

To fulfill the various objectives of a firm/business/farm various branches of record keeping have been developed. The main among these are the following:

- **Financial Accounting :** The aim of this branch of accounting is to ascertain the profit or loss made during a certain period and the financial state of affairs at the end of the period and to maintain control over the firm property.
- **Cost Accounting :** Its aim is to ascertain the cost incurred for carrying out the various activities and to enable the management to exercise cost control by indicating avoidable losses and wastes.
- **Management Accounting :** The aim of management accounting is to supply the management the significant and necessary information in order to assist it in the discharge of its functions such as decision making, control etc.

Financial accounting : Financial accounting is the original form of

book keeping is the art and science of recording business transactions systematically and correctly involving the transfer of money in a set of books in a simple form.

Objectives of Accounting

Primary objective of accounting is to enable a person to ascertain accurately-

i) The amount he has gained or lost in the farm during a given period.

ii) The amount of his assets, liabilities and capital in the farm on any particular date.

In addition to the above information, however, an entrepreneur would like that his books should also show the following particulars:

a) How the amount he has gained or lost is made up?

b) How much money is receivable from the customers?

c) How much money is owing to the creditors?

d) What are the liabilities for payment of taxes, duties, revenues etc. to the government?

e) How is his farm stand in comparison to other similar farms?

This information can only be derived if an accurate and complete record is kept for all the farms events and transactions.

Advantages of Accounting

- **Assistance to management :** Accounting provides such information to the management which will enable

Comparative study : A systematic record will enable a firm to compare one year's result with those of other years and locate the significant factors leading to the change, if any.

- **Quick decision on bankruptcy :** In case one becomes insolvent, one has to explain many things about the past. Proper accounting helps him to do that.
- **Quick decision on disputed matters :** Differences of opinion may occur sometimes among partners. Systematic record is often treated by the courts as good evidence.
- **Proper decision on settlement of taxation liability :** Every firm has to pay taxes, duties, revenues etc. In some cases, the sales tax and income tax departments may impose heavy taxes as per their opinion. By showing the records, proper amount of the taxes may be paid.
- **Helps in raising loans :** Almost every enterprise requires additional funds for its growth. Such requirements are met by commercial banks and financial institutions in the form of granting loans. These institutions before sanctioning loans screen various statements prepared under accounting information such as Balance Sheet, Cash Flow statement etc.

Books of Accounts

Books of Accounts may be divided into two types:

- Principle Book and
- Subsidiary Books or Books of Original Entry

Principle Book or the Ledger : Ledger is that principal book of account in which all the business transactions finds their ultimate place

a) **Cash Book**. Cash Book is to record all cash receipts and all cash payments from day to day.

b) **Purchase Day Book**. It is to record all credit purchases of goods.

c) **Sales Day Book**. It is to record all credit sales

d) **Purchase Return Book or Return outward book**. It is for recording goods returned.

e) **Sales Return Book or Return inward book .**It is to record goods returned to the farm.

f) **Bills Received Book.** It is to keep records of the bills receivable.

g) **Bill Payable Book**. It is to keep records of the bills payable.

h) **Journal**. This is used to record all other miscellaneous credit transactions which cannot be filled into any other books of original entry.

Classification of Account

Accounts are of two types viz.,

a) Personal account and

b) Impersonal Accounts

a) Personal Account: Three types viz.,

i) Natural Person's Personal Account e.g. Pankaj's a/c,

ii) Artificial Person's Personal Account e.g. KKHSOU a/c, SBI a/c

iii) Representative Personal A/c e.g. Prepaid Insurance a/c.

b) Impersonal Account : Two types viz.,

i) Real Account

ii) Nominal Account, e.g. Salary a/c, Rent a/c, Wage a/c etc.

Real Accounts are of two types:

Rules of Debit and Credit (Classification based)

a) Personal Account: Debit the receiver
   Credit the giver
b) Real account: Debit what comes in
   Credit what goes out
c) Nominal Account: Debit Expenses and losses,
   Credit income and gains

10.5 INFORMATION TO BE MAINTAINED IN A TEA GARDEN

Meteorological information : Records on daily, monthly and total rainfall, daily temperature and the records on lightning, hail and such other natural calamities.

Employment record : Record of staff members and workers which include different categories like male, female, adolescent, hired or family labour.

Land utilization pattern : Total area of the garden, area under tea, nursery, buildings, roads and paths, drains and any other purposes.

Nursery : Layout of the nursery with area, number of beds, plants raised in different season, type of materials propagated –clones, clonal seeds. Records on nursery practices, labour engaged etc.

Planting record : Area planted, preparation of land, practices adopted, labour engaged for different operations.

Sectional history : Section Number and area under each section, planting material used, year of planting, spacing, existing plant population. Soil testing report-fertility status of the section. Shade tree species used and spacing. Drainage status, Manuring and pruning/skiffing followed Pest and disease incidence, chemical applied-number of rounds, quantity of different pesticides /herbicides applied doses etc. Labour engaged in different operations. Green leaf yield, yield in different plucking rounds, sales price, Commission on green leaf sales, transportation, green leaf cess etc.

CHECK YOUR PROGRESS

Q.4. Mention the essentials of a good record keeping system.

.....

.....

Q.5. What are the objectives of accounting?

.....

Q.6. What are the two types of books of account?

.....

Activity

Visit a nearby small tea garden and collect information on

1. Record keeping procedure
2. Total number of Labour Engaged
3. Total cost during establishment of the garden
4. Total green leaf production and market

10.6 LET US SUM UP

- Tea cultivation requires large number of workers during its establishment i.e. in the years of planting tea. Thereafter, the labour requirement is less and the major labour force has to be engaged in plucking of green leaves and in the maintenance of the plantation.
- For young tea plantation, the labour requirement for during the initial 5 years plucking is comparatively less. The labour requirement goes on increasing from 5th years onwards. However, the requirements

transactions and events in a correct and systematic manner in a set of books and interpreting the results thereof.

- The essentials of a good system of record keeping are -simplicity, quickness, complete in record ,suitability, economy in use ,accuracy and elasticity
- Primary objective of accounting is to enable a person to ascertain accurately the amount he has gained or lost in the farm during a given period and the amount of his assets, liabilities and capital in the farm on any particular date.
- Books of Accounts may be divided into two types (i) Principle Book and (ii) Subsidiary Books or Books of Original Entry.
- The tea plantations should maintain a series of information on the plantation, weather conditions etc.

10.7 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Land clearing, Pit dogging and Planting

Ans. to Q. No. 2 : Yes.

Ans. to Q. No. 3 : On attaining the maturity the green leave yield goes on increasing, hence for plucking the green leaves more and more labourers are to be engaged.

Ans. to Q. No. 4 : Simplicity, quickness, complete in record, suitability, economy in use, accuracy and elasticity.

Ans. to Q. No. 5 : Primary objective of accounting is to enable an entrepreneur to ascertain accurately the amount he has gained or lost in the farm during a given period and the amount of his assets, liabilities and capital in the farm on any particular date

Ans. to Q. No. 6 : Principle Book and Subsidiary Books or Books of Original Entry.

10.8 MODEL QUESTIONS

Q.1. Prepare estimates of expenditure on various heads to develop a tea plantation of 5 ha.

Q.2. List out the various operations to be carried out for developing a tea plantation from the beginning to the stage of maturity.

Q.3. What do you mean by Book Keeping? What are the objectives of book keeping?

Q.4. Define the following terms

a) Assets

b) Liabilities

c) Sales