UNIT 1 : PRUNING OF TEA

UNIT STRUCTURE

1.1 Learning Objectives

1.2 Introduction

1.3 Pruning of Tea

- 1.3.1 Objectives of Pruning
- 1.3.2 Skiffing

1.4 Different Types of Pruning

- 1.4.1 Light Prune (LP) / Cut Across Prune (CA)
- 1.4.2 Medium prune (MP)
- 1.4.3 Heavy Pruning and Rejuvenation Pruning
- 1.4.4 Collar Pruning

1.5 Different Types of Skiffing

- 1.5.1 Deep Skiff (DS)
- 1.5.2 Medium Skiff (MS)
- 1.5.3 Light skiff (LS)
- 1.5.4 Level-off- Skiff (LVS)
- 1.5.5 Unprune (UP)

1.6 Methods of Pruning

- 1.6.1 Light Prune (LP) / Cut Across Prune (CA)
- 1.6.2 Medium Pruning

1.7 Pruning Cycle

- 1.7.1 Definition
- 1.7.2 Longer Pruning Cycles
- 1.7.3 Objectives of Longer Pruning Cycle
- 1.7.4 Choice of Pruning Cycle

1.8 Let Us Sum Up

1.9 Answers to Check Your Progress

1.10 Further Readings

1.11 Model Questions

1.1 LEARNING OBJECTIVES

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

- Explain the need of pruning.
- Describe the purposes of pruning.
- Define the different types of pruning and skiffing.
- Describe the methods of pruning and skiffing.
- Define a pruning cycle.
- Name the different pruning cycles.
- Select the pruning cycle considering the criteria of selection.

1.2 INTRODUCTION

The young tender shoots of tea plant constitute the economic yield of the tea crop. Therefore, the tea plant, which is a small tree by habit, under cultivation, is trained to form a low bush from early years to form a table for convenience for harvesting the young tender shoots for plucking. This has already been discussed under the Unit, “Young Tea Management”. Mature tea bushes are pruned at intervals to renovate the branch system for harvesting the maximum possible vegetative growth (shoots). Pruning is the most important cultural operation in commercial tea production and has influence on production and quality of the harvested crop.

In this unit, we shall discuss this important operation in detail.

1.3 PRUNING OF TEA

Tea plants, under cultivation, are kept low forming a spreading bush with a flat plucking surface so that the young tender shoots can be harvested conveniently. Tea being a perennial plant, unless controlled artificially, its vegetative and reproductive phases proceed side by side, the former continuously and the latter according to the seasonal rhythm. For tea production, the practice of bush management is directed towards keeping the plant continuously in the vegetative phase so that more and more shoots can be harvested. This paramount purpose is achieved by pruning.

1.3.1 Objectives of Pruning

Pruning of tea is a necessary evil in the sense that in spite of the huge loss of crop due to pruning, it has to be carried out periodically. The main purposes of pruning are as follows:

- To maintain a convenient height of the bush to facilitate plucking operation.
- To check the reproductive growth and maintain the bushes more or less in a vegetative phase.
- To stimulate the production of new set of vigorously growing, leafy branches replacing the old unproductive branches.
- To remove the dead, diseased and defunct wood, pest ridden branches for rejuvenating the bushes which have crossed the period of maximum productivity.
- To minimize the formation of banjhi shoots in the plucking table.
- To maintain the quality of the made tea.

1.3.2 Skiffing

Tea bushes are not pruned every year. In the present system of tea pruning in N. E. India, bushes are pruned every 2 to 4 years. However, it is still the usual practice to cut the bushes lightly at the end of the year. The light cut given to the bushes is known as skiffing. The skiffs are very light forms of cut and are not severe enough to be termed as 'prune'. Leaving the bushes unpruned (no pruning or skiffing) for one or two years in between two prune years is also common in N. E. India.

Introduction of skiffing has eliminated the necessity of pruning every year which was done earlier. The objectives of skiffing are:

i) To obtain an early crop.
ii) To obtain more first flush, second flush, and total crop.
iii) To thicken the pruning wood, and
iv) To improve the health of the bush.

1.4 DIFFERENT TYPES OF PRUNING

The systems of pruning vary with the stages of the life of a tea bush. These are: formative pruning, maintenance pruning and corrective pruning. Formative pruning is done to train the plants to form a low bush. The system of formative pruning has been described under young tea management. The different types of maintenance and corrective pruning as based on the severity of the cuts adopted on tea are described below.

1.4.1 Light Prune (LP) /Cut Across Prune (CA)



Top Hamper : Refers to the portion of the tea bush above the pruning level which supports the growth of shoots.

Light or top pruning is a maintenance pruning. It is a cut given 4-5 cm above the last prune level (i.e. leaving 4-5 cm new wood) in order to remove the congested top hamper and to renew the shoot system for more vigorous growth. The portion of the new wood left in the bush after the light prune is called stick. New shoots develop from the buds present on the sticks. While giving a light prune, it is to be noted that the pruning sticks are of optimum in thickness (pencil thick). If the thickness is not sufficient, pruning may have to be deferred.

In plains, the pruning cut is given across a flat level (parallel to the ground) but in sloping terrain pruning paralleled to the slope (i.e. slope pruning) is more convenient and popular.



Fig. 1.1 : A Light pruned tea bush

1.4.2 Medium Prune (MP)

The main purpose of medium pruning is to reduce the height of the bushes. When the height of the bush frame rises to an unmanageable height (beyond 80 cm) due to repeated light prune, it is cut back to a low height above the original frame forming prune. If the frame forming prune was given at 45cm, then medium prune can be given at any point above this height. Pruning is done followed by the removal of knots, diseased wood etc. even from below the general pruning height.

Removal of knots, unproductive wood, congestion of the bush frame and its sanitation, reduction of the proportion of unproductive wood are other objectives of medium pruning. Bushes must be rested (plucking is stopped) for six to eight weeks before carrying out medium pruning to have an adequate reserve of carbohydrates in the roots.



Fig. 1.2 : Bud breaking after pruning

Normally, reduction of bush height by medium pruning becomes necessary after every 15 to 20 years depending upon the original frame height and the pruning cycle followed.

1.4.3 Heavy Pruning and Rejuvenation Pruning

Heavy pruning as practised today in NE India is done with the sole objectives of improving the yielding capacity of some old but reasonably good sections of tea to minimize the loss of crop during uprooting and replanting of the uneconomic sections. Heavy pruning is, therefore, a part of the package of practices aimed at renovating the sections of run-down tea, and can be termed as rejuvenation pruning.

1.4.4 Collar Pruning

This is the severest type of pruning in which the entire above-ground portion is cut leaving only the maximum of 10 cm when the bush frame becomes unproductive and the root system is still healthy. It is also called Down Pruning.

1.5 DIFFERENT TYPES OF SKIFFS

The objectives of skiffing are to have an early high quality crop and total crop as well. Skiffing helps in removing the knotted and congested stems, thickening the branches and improving the general health of the bushes. It is also resorted to the bushes when there is a necessity of postponing the pruning operation.

Different forms of skiffing are practised which are described below.

1.5.1 Deep Skiff (DS)

When deep skiff is done after a light prune, it is a cut given midway between the pruning and tipping levels. For instance, for the tea tipped at 20 cm, deep skiffed is given at 10 cm above the previous pruning level.

D. S. after one or more years of level skiff or unpruned, it is a cut mid-way between the pruning level and the height of plucking

table at the end of the season, provided not more than 23 cm of growth is removed by the skiff. For instance, if plucking height at the end of the year is 30 cm above the pruning mark, the tea is to be deep skiffed at 15 cm. Thus, deep skiffing of tea bushes is done normally between 12–15 cm above the last light prune marks.

Deep skiffed tea gives more total and early crop than light prune tea without adversely affecting the quality .It is also less susceptible than unpruned tea to the effects of drought and pests infestation, such as red spider.

1.5.2 Medium Skiff (MS)

The main objective of medium skiffing is to remove the congestion of the dead and unproductive twigs at the top, which is the removal of the so-called “crow’s feet”.

Medium skiff is a cut often given at a height of 15 cm above the last pruning mark or 5 cm below the previous year’s tipping level. Normally, this is given just below the “crow’s feet” formed by last year’s plucking. It helps to remove congestion in the top hamper.



Crow’s feet : A structure or knot formed in the plucking table where a number of new flushes or shoots have developed from the same height due to repeated plucking.

1.5.3 Light skiff (LS)

This is a skiff at or upto 1 cm above the previous tipping level i.e. just deep enough to remove the majority of the plucking points and to leave the ‘crow’s feet’. Light skiff is given to re-establish a level.

1.5.4 Level-off- Skiff (LVS)

This is a skiff to remove the plucking points and the old leaves that stick above the plucking table at the end of the season. This cut is given at least 5 cm above the previous tipping level. It helps to tidy up the top of the bush.

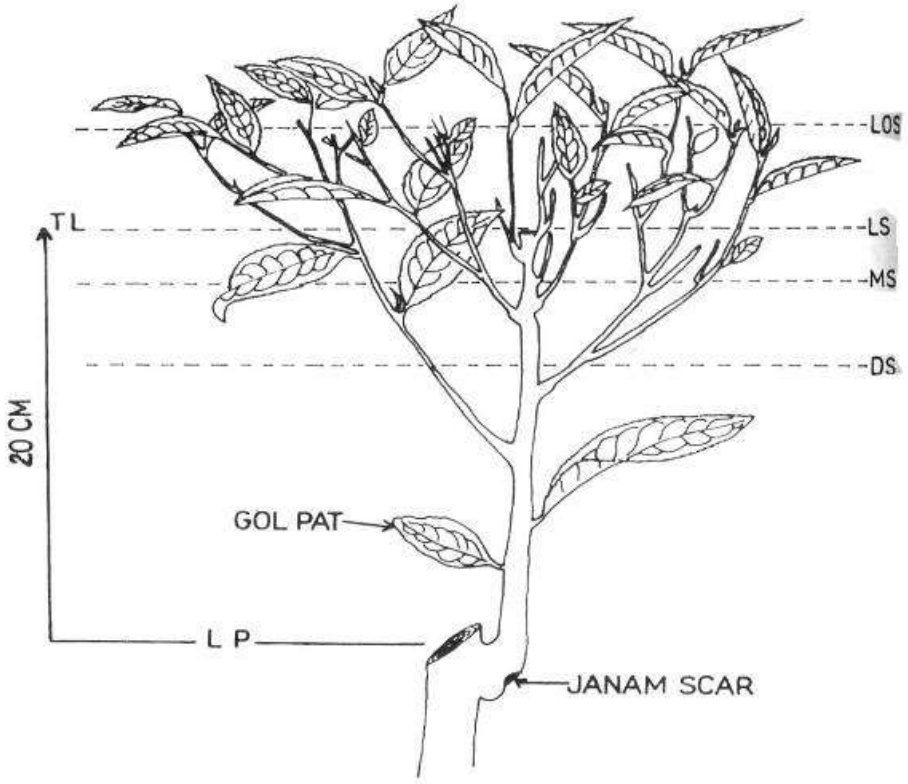


Fig. 1.3 : Diagramatic view of different types of pruning and skiffing

1.5.5 Unprune (UP)

Tea bushes plucked continuously without any skiff (untouched) is designated as unprune.

Choice of a skiff depends on a number of factors such as crop distribution, cost of plucking, availability of labour and quality of made teas. Drought, pest and disease susceptibility are the other important factors which also influence the choice. Deep skiff does not cause crop loss or reduce crop quality, but other forms of skiff affect quality of made tea adversely.

Time of skiffing : The time of skiffing is any time between mid-December and January. Deeper the skiff earlier is the skiffing time.

Skiffing during growing season : Under some unavoidable situation, if the tea bushes cannot be plucked for two to three weeks, it may be required to skiff the bushes. Normally, it is advisable to skiff the bushes as soon as possible at the height of the last plucking

and plucking should be followed at weekly round. In order to keep the crop loss to the minimum, skiffing should be completed as far as possible before the first week of September in the plain and the mid-August in hills.



CHECK YOUR PROGRESS

Q.1. What is skiffing?

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Q.2. What is the main objective of medium pruning?

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Q.3. Name two types of corrective pruning.

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Q.4. Fill in the blanks :

a) Light prune is a cut given _____ to _____ cm above the last prune level.

b) Normally, medium skiff is given just below the _____ formed by last year's plucking.

c) _____ skiff is a cut at or upto 1 cm above the previous tipping level i.e. just deep enough to remove majority of the plucking points .

d) The time of skiffing is at any time between _____ and _____.

e) Tea bushes plucked continuously without any skiff (untouched) is designated as _____.

f) Deep skiffing of tea bushes is done normally between _____ to _____ cm above the last light prune mark.

1.6 METHODS OF PRUNING

1.6.1 Light Prune (LP) / Cut Across Prune (CA)

Light pruning is carried out using a pruning knife that is not less than 450g in weight (20 cm knife). Splitting of branches and uneven cut is harmful. The cut should be clean, sharp and slanting. The cut ends should face inwards. If the pruning is done with lighter knives, wood splitting may occur.

A minimum of 4-5 cm new wood should be left at the time of pruning. A cut at low measures (i.e. leaving a little new wood) stimulates janam axil buds also to grow into a primary. As a result of inadequate allowance left after each pruning the wood at the pruned level fuses into a lump or a knot. From a knotty frame, the primaries go banjhi before attaining the tipping height.

The thickness of wood at the pruning height is another consideration. If, in the intended year of pruning the wood is not suitably thick, pruning is postponed by a year or more. On the other hand, in some vigorous tea under favorable growth conditions, stems thicken up rapidly and pruning at normal height compels to cut very thick stems. In this case, the height has to be increased to avoid cutting very thick stem. However, it is not advisable because rapid increase in frame height necessitates heavy pruning at shorter intervals.

Cleaning out : At the time of light pruning, knife cleaning out (KCO) should also be done. This operation involves the removal of the dead, diseased and crossing branches, dwarf banjhi shoots and snags from the bushes. However, excessive cleaning should be avoided.

Presence of banjhi shoots on a pruned bush retards the growth of new shoots resulting in the loss of second flush crop. Weak and crossing branches also tend to congest the centre of the bush and decrease the yield. Thus, judicious cleaning out maintains bush sanitation and increases its yield.

Cleaning out should be done soon after pruning and under no circumstances should it be delayed beyond the natural bud break time which depends on weather and the vigour of the bush. The vigorous sections should be cleaned out first.

Time of pruning : Pruning should be done in the cold weather i.e. between mid-November to mid-January. In general, the optimum time of the year to prune is when the plant is dormant or its growth rate is the slowest and carbohydrates reserves in roots are high. The exact time depends on the locality, climate, crop and quality requirement, seasonal crop distribution, susceptibility to pests and diseases etc.

In non-droughty areas pruning can commence as soon as the bushes go dormant in the winter, beginning from about the mid November and the operation should be completed by the third week of December.

In droughty areas, pruning should not commence before the first or second week of December and should be completed by mid-January. When pruning is delayed beyond mid-January there will be loss of crop depending on region and weather conditions.

In hills, pruning time can be advanced by about two weeks as the plucking season closes a little earlier.

Size of pruning knife : For carrying out the light prune in younger tea, the knife with 15 cm blade should be used. A knife with 20 cm blade is suitable for light prune/cut across prune in mature tea. The weight of the knife used for light prune should not be less than 450 gm. Lighter knives cause wood splitting. For cleaning out operation (KCO), a smaller knife of 7.5 -10 cm blade should be used.

1.6.2 Medium Pruning

Medium pruning is generally done between 45-55 cm followed by the removal of knots, diseased wood etc. even from below the general pruning height. All large cuts should be treated

with a protective bituminous paint, like Indopaste within 24 hours of the pruning, preferably on the same day. To prevent the bushes from sun-scorch, the branches may be lime washed and covered with the pruning litters immediately after the prune.

Medium prune is best done from mid-December to end January. In drought prone areas medium pruning should preferably be done in January. Under no circumstances this operation should be carried out before mid-November.

A few other precautionary measures are necessary before and after medium pruning to prevent the die-back and death of bushes.

- The bushes must have adequate reserve of carbohydrates in roots. Resting of the bushes for 6-8 weeks before pruning is, therefore, beneficial for root reserve.
- Adequate manuring before and after pruning is also important.

In medium prune tea, leaving at least two “breathers” (lung shoots) in the south west side of the bush has the following beneficial effects:

i) Provides shade to reduce sun-scorch
ii) Removes harmful metabolites from the roots
iii) Mobilizes growth substances towards the production of new shoots
iv) Contributes photosynthates to the roots
v) Influences growth of feeder roots.

However, if medium pruning is done at a time when starch reserves are optimum, no additional benefit would be obtained by retaining lungs in the year of prune or in the subsequent years. Lungs kept on the bush should be cut back after the new flush of shoots on the bushes has produced some leaves.

1.7 PRUNING CYCLE

1.7.1 Definition

The interval of time between two successive prunes is called a pruning cycle. A pruning cycle consists of a prune followed by lighter forms of cut (skiffing) or unprune for two to four years until the bushes are pruned again.

Substitution of annual pruning by longer pruning cycles through the introduction of skiff and/or unprune, in general, increases productivity of bush. But if the cycle of pruning is lengthened beyond four years, some of the branches will become very thick leading to a reduction in the number of pruning sticks.

1.7.2 Longer Pruning Cycles

Generally, in plains 2 to 4 years pruning cycles are followed as shown in Table 1.1.

Table 1.1 : Different pruning cycles followed in plains in N. E. India

Pruning cycle	Sequence off prune/skiffs	Area under each type of prune/skiff (%)
2 year cycle	LP-UP-LP LP-DS-LP	LP–50%, UP-50% LP-50%, DS-50%
3 year cycle	LP-UP-DS-LP LP-UP-UP-LP LP-DS-UP-LP LP-UP-DS-LP LP-UP-MS-LP	LP-33%, UP-33%, DS-33% LP-33%, UP-66%, LP-33%, DS-33%, UP-33%
4 year cycle	LP-UP-DS-UP-LP LP-UP-MS-UP-LP	LP-26%, UP-25%, DS-24%

In hills, however, the cycle can be extended to 6 years.

In longer pruning cycles, pruning should logically be done when the yield starts declining. However, this is not always possible

due to a number of practical difficulties. Therefore, pruning of each section of tea in an estate has to be decided on merit. A pruning cycle of fixed duration for all sections is not conducive to crop maximization. Furthermore, agronomic management and economic consideration require from time to time variations in the length of pruning cycles of different sections of tea within an estate.

1.7.3 Objectives of Longer Pruning Cycle

The main objectives of longer pruning cycles are:

i) To harvest more early and total crop.

ii) To harvest a more uniform crop distribution.

iii) To increase the growing period.

1.7.4 Choice of Pruning Cycle

The factors that influence the choice of pruning cycles are discussed below :

Crop and Quality requirement : With the tea of normal vigour generally higher yields are obtained with lighter cuts or with longer pruning cycles. The average percentage increases in crop with different forms of skiff and unprune over light prune (LP)is expected to be as follows:

Type of skiffing	Crop increase over Light prune (LP)
Deep skiff (DS)	10-15%
Medium skiff (MS)	15-20%
Light skiff (LS)	20-25%
Level 0ff skiff (LVS)/ Unprune (UP)	30-35%

This increase may be more or less dependent on the vigour of the bush, plucking, pest infestation etc. With the standard method of manufacture, the leaves from unpruned and light skiffed tea produce tea of lower quality than the leaves from pruned or deep skiffed tea.

Crop distribution : Pruning and skiffing methods can be profitably utilized to obtain increased and evenly distributed crop. By a careful admixture of various forms of skiff and prune in any tea garden, it is possible to increase the yield and even out the crop distribution.

The periodic crop distribution pattern (percentage) from different forms of prune/skiff is shown in Table 1.2.

Table 1.2 : Crop distribution pattern (%) from different forms of prune and skiffs

Season	LP	DS	MS	LS	UP
Early season (March-June)	22	28	32	40	45
Rain (July –Sept)	63	63	61	55	52
Back-end (Oct-Dec)	15	9	7	5	3
Total	100	100	100	100	100

The monthly crop distribution can vary under different agro-climatic conditions and management practices. Seasonal crop distribution pattern for different types of prune and skiff and different pruning cycles are shown in Table 1.3 and Table 1.4.

Table 1.3 : Crop Distribution in different month of the season (%) from different types of prune/skiff

Month	LP	DS	MS	LS/UP
January	–	–	–	–
February	_	_	–	–
March	_	–	–	9/10
April	1	3	6	9
May	5	9	11	11
June	11	11	12	11
July	15	17	17	15
August	16	18	17	12
September	20	18	16	13
October	20	15	13	13
November	11	9	8	6
December	1	–	–	–

Table 1.4 : Percentage crop distribution in different seasons from some pruning cycles

	Pruning cycle	Early season crop	Main season crop	Backend season crop
2 year cycle	LP-UP-LP	34	57	9
3 year cycle	LP-UP-DS-LP	32	59	9
4 year cycle	LP-UP-DS-UP-LP	35	57	8

Pest and Disease incidence : Unpruned or light skiffed bushes are more susceptible to a host of pests such as mites, caterpillars, scale insects, helopeltis, thrips as well as diseases like black rot etc. than the deep skiffed or pruned tea. Mite thrives on the foliage during winter and start multiplying next season as soon as the weather warms up. The residual population is directly related to the amount of foliage left at the time of pruning/skiffing.

Climate and Soil : Climate and soil of a region also affect the choice of a pruning cycle. The important elements of climate are rainfall distribution and temperature. Light textured soils have low moisture holding capacity and are more prone to drought. In droughty areas or years, unpruned sections suffer more from drought than the pruned sections. Usually, drought prone areas are always the first ones to be infested by mites and caterpillars. If drought prone areas wish to introduce unpruned years in their pruning cycles, then good shade must be ensured in the unpruned sections. Good weed control, particularly during October to April, will also help in conserving moisture loss by transpiration through weeds.

Labour availability : Unpruned and light skiffed sections require approximately 30 –40 per cent more mandays for plucking compared to pruned or deep skiffed teas. Hence, labour availability also influences the choice of pruning cycles.

Emphasis has now been shifted from extensive to intensive system of management in tea culture. Since pruning has profound influence on the productivity of a tea garden, pruning policy should receive important consideration while planning the programme.

The policy of pruning in a tea estate should ensure the following :

a) The bush health must be maintained so that maximum number of healthy shoots appear from the pruning sticks and majority of them reach the tipping height in time.

b) Harvesting of maximum possible crop maintaining acceptable quality throughout the season should be ensured.

c) Sections should be protected from pests and diseases, and

d) The height of the bush frame should be kept within reasonable limit for efficient plucking.



CHECK YOUR PROGRESS

Q.5. Why is cleaning out after light prune carried out?

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Q.6. What is the time of pruning in Assam?

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Q.7. What is a Pruning cycle?

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Q.8. Name a few pruning cycles recommended for the plain areas of N.E.India.

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Q.9. Fill in the blanks :

a) A pruning knife that is not less than _____ in weight and with _____ cm blade should be used.

b) Resting of the bushes for _____ to _____ weeks before light pruning is beneficial for root reserve.

c) For cleaning out operation (KCO), a smaller knife of _____ to _____ cm blade should be used.

d) UP and light skiffed bushes produce tea of lower quality than the leaves from _____ or _____ skiffed tea.



1.8 LET US SUM UP

- Pruning is the most important cultural operation in commercial tea production and has influence on production and quality of the harvested crop.
- For tea production, the practice of bush management is directed towards keeping the bushes continuously in the vegetative phase so that more and more shoots, i.e. crop, can be harvested. This paramount purpose is achieved by pruning.
- The objectives of pruning are to maintain a convenient height of the bush to facilitate plucking operation, check the reproductive growth, stimulate the production of new set of vigorously growing branches, remove the dead, diseased and defunct wood, pest ridden branches for rejuvenating the bushes which have crossed the period of maximum productivity and to maintain the quality of made tea.
- There are different types pruning such as formative pruning, maintenance pruning and corrective pruning. Light or top pruning is a maintenance pruning. It is a cut given 4-5 cm above the last prune level (i.e. leaving 4-5 cm new wood) in order to remove the congested top hamper and to renew the shoot system for more vigorous growth.
- Medium pruning, heavy pruning, rejuvenation pruning are the corrective pruning. Medium pruning is basically a height reduction pruning which needs to be done when the bushes attain an unmanageable height.
- In the present system of tea pruning in N.E.India, the tea bushes are not light pruned every year but pruned only every 2 to 4 years. However, the bushes are skiffed at the end of the year.

- There are different types of skiffing such as deep skiffing, medium skiffing, light skiffing and level-off–skiffing. When the bushes are not touched by knife, it is called unprune.
- The objectives of skiffing are to harvest an early high quality crop and total crop, helping the removal of the knotted and congested stems, thickening the branches and improving the general health of the bushes.
- Pruning is done in the cold weather i.e. between mid-November to mid-January in the plains of N.E.India. In general, the optimum time of the year to prune is when the plant is dormant or its growth rate is the slowest and carbohydrates reserves in roots are high. The time of skiffing is at any time between mid-December and January.
- In the year of light pruning, knife cleaning out is carried out. It is done to remove the dead, diseased and crossing branches, dwarf banjhi shoots and snags from the bushes. The operation should be completed before the bud break.
- The interval of time between two successive prunes is called a pruning cycle. A pruning cycle consists of a prune followed by lighter forms of cut (skiffing) or unprune for two to four years until the bushes are pruned again.
- Generally, in the plains of N.E. India 2 to 4 years pruning cycles are followed.
- Crop and quality requirement, climate and soil, incidence of pests and diseases, labour availability etc. influence the choice of pruning cycle.



1.9 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : The lighter form of cut which is not so severe like light prune is called skiffing.

Ans. to Q. No. 2 : The main objective of medium pruning is basically to reduce the height of the bushes when they attain an unmanageable height for plucking.

Ans. to Q. No. 3 : Medium pruning, Rejuvenation pruning.

Ans. to Q. No. 4 : a) 4-5 cm, b) crow's feet, c) Light skiff, d) Mid December to January, e) unprune

Ans. to Q. No. 5 : Cleaning out operation done to remove the dead, diseased and crossing branches, dwarf banjhi shoots and snags from the bushes for bush sanitation.

Ans. to Q. No. 6 : Pruning is done in the cold weather i.e. between mid-November to mid-January.

Ans. to Q. No. 7 : The interval of time between two successive prunes is called a pruning cycle.

Ans. to Q. No. 8 : The different pruning cycles are:

2-year pruning cycles: LP-UP-LP, LP-DS-LP

3-year pruning cycles: LP-UP-DS-LP, LP-UP-UP-LP, LP-DS-UP-LP, LP-UP-DS-LP, LP-UP-MS-LP

4-year pruning cycles: LP-UP-DS-UP-LP, LP-UP-MS-UP-LP

Ans. to Q. No. 9 : a) 450 g, b) 6-8 weeks, c) 7.5- 10 cm, d) light prune, deep skiff.



1.10 FURTHER READINGS

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



1.11 MODEL QUESTIONS

Q.1. What are the objectives of pruning of tea? Name the different types of pruning imparted to tea bushes. Explain the objectives of each.

Q.2. What is skiffing? Mention the objectives of skiffing.

Q.3. Describe the different types of skiffing. What is the time of skiffing in Assam?

Q.4. What do you mean by a pruning cycle? Mention a few pruning cycles recommended for the plain areas of N.E. India. What are the factors that affect the choice of a pruning cycle?

Q.5. Define the following

a) Crow's feet

b) Top hamper

c) KCO

d) Breathers or lungs.

UNIT 2 : PLUCKING OF TEA

UNIT STRUCTURE

2.1 Learning Objectives

2.2 Introduction

2.3 Objectives of Plucking

2.4 Plucking

- 2.4.1 Tipping
- 2.4.2 Maintenance Foliage
- 2.4.3 Plucking Systems
- 2.4.4 Standard of Plucking
- 2.4.5 Plucking Round
- 2.4.6 Creep
- 2.4.7 Breaking Back
- 2.4.8 *Banjhi* Shoots
- 2.4.9 Plucking Operation
- 2.4.10 Plucking Basket/Bag
- 2.4.11 Care and Handling of Green Leaves

2.5 Let Us Sum Up

2.6 Answers to Check Your Progress

2.7 Further Readings

2.8 Model Questions

2.1 LEARING OBJECTIVES

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

- Explain the principle and objectives of plucking.
- Define tipping.
- Describe the objectives of tipping.
- Justify the importance of maintenance foliage.
- Describe the plucking systems.
- Describe the plucking procedure.
- Describe the care and handling of green leaves.

2.2 INTRODUCTION

Plucking in tea is synonymous to harvesting in other crops. The tender apical portions of shoots consisting of two to three leaves and the terminal buds are nipped-off in plucking. These tender portions of the shoot constitute the economic yield of tea.

In the previous unit, we have discussed how the tea bushes are periodically pruned to keep the branches more or less permanently in a vegetative phase so that there is more and more new shoot growth. In tea cultivation, plucking which is carried out at 7 to 14 days intervals almost thorough the whole year, is one of the most important practices and it accounts for 15-20 per cent of the cost of tea production .Further, plucking alone involves about 60-70 per cent of the total labour force making the tea cultivation a labour intensive one.

In this unit, we shall discuss this important operation of tea cultivation.

2.3 OBLEVCTIVES OF PLUCKING

Plucking in tea is the harvesting of crop. During plucking, recurrent checks and stimulus are provided to the bush by continuous removal of vegetative organ at frequent intervals. This encourages regeneration of shoots on a tea bush. In this operation a delicate balance must be maintained between immediate gain and the capacity of the bush to generate new shoots for harvest.

The main objectives of a good plucking policy in a tea garden are:

a) To harvest maximum shoots for manufacture

b) To achieve a sound mix of yield and quality of the harvest.

2.4 PLUCKING

After pruning or skiffing, new shoots develop from the dormant buds on the sticks. These are called primaries. The primaries are decapitated or tipped at a predetermined height leaving some leaves below this level to make a flat plucking surface or table. Some of the primaries may become

dormant before reaching the height. However, some of such primaries may throw out a new flush and come above the plucking level.



Fig. 2.1 : Plucking of tea



Stick : The branches left on a pruned bush.
Stub : The basal portion of shoots left behind after plucking of the apical portions of shoots.

After a primary shoot has been tipped new shoots (laterals) arise from the axillary buds and these shoots are harvested or plucked when they grow above the tipping level. While plucking, normally a small piece of stem (stub) containing the *janams* are left behind on the bush .Plucking of the laterals again stimulates the production of new generation of shoots of the next higher order from the axils of the *janams* and the process continues. The process of harvesting the shoots above the table is called plucking in tea.

2.4.1 Tipping

The initial few rounds of plucking are called tipping. When the primaries grow above a predetermined height after pruning or skiffing, they are tipped or decapitated at that height parallel to the ground surface.

The main objectives of tipping are:

i) to establish a flat plucking surface for convenient plucking, and

ii) to stimulate the axillary buds below the level to grow to form the plucking surface or table.

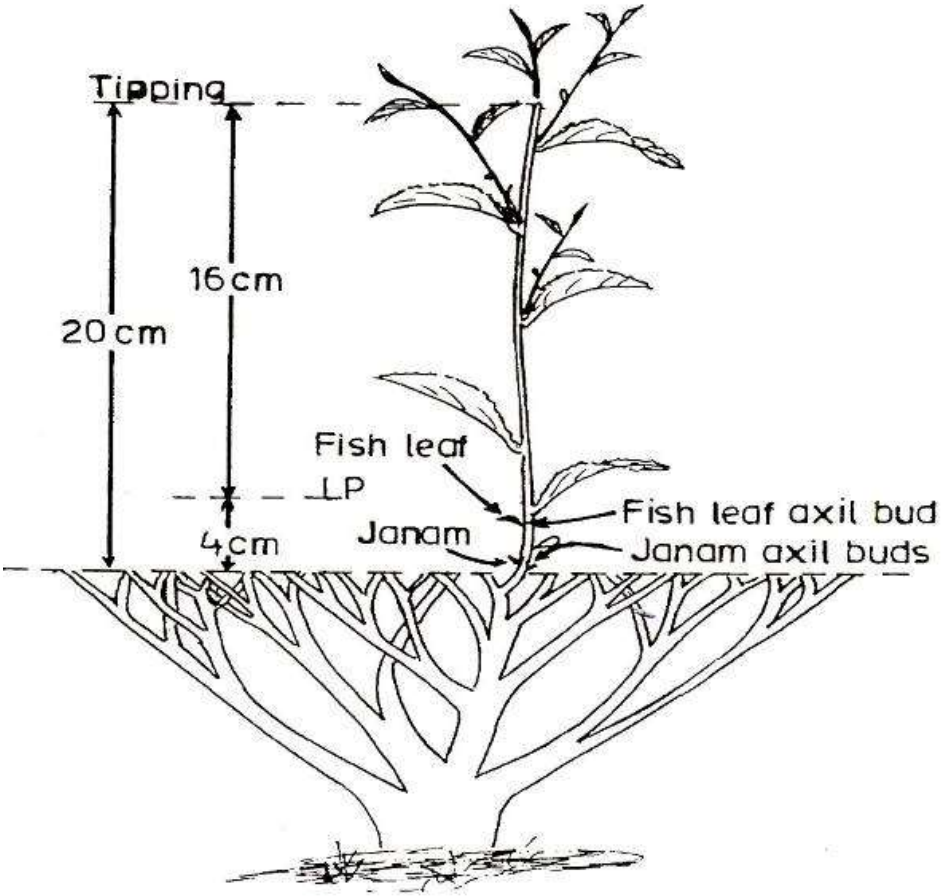


Fig. 2.2 : A light prune tea bush showing the maintenance leaf and tipping height

Tipping height : The best tipping height from the point of view of yield is the natural *banjhi* horizon of the shoot system on a pruned bush. This height in a normal bush is 20 cm which corresponds to 5 leaves on an average. However, the average height of 5 leaves may vary between 15 cm and 30 cm depending on the type of tea, its vigour and the thickness of the wood on which pruning is done.

The tipping heights for different types of prune of skiffs are given in Table 2.1

***Banjhi* horizon :** Refers to the average height at which most of the primaries arising from a pruned bush enter into dormancy (*banjhi stage*) for the first time. Also called model height of dormancy.

Table 2.1 : Height of tipping

Type of prune/skiff	Tipping height over the last pruning/ skiffing mark	Number of leaves retained in new lateral/ primaries
Light prune (LP)	20-25 cm	5
Medium prune (MP)	30 cm	5-6
Deep skiff(DS)	7-10	2-3
Medium skiff (MS)	4-5 cm	1
Light skiff (LS)/Level-off- skiff (LOS)/ Unprune	Same level	Nil (pluck *to janam*)

Tipping of the shoots should be done whenever the shoots reach the tipping level and carried out till the plucking table is full. In practice, tipping is started when about 30 percent of the bushes are ready for tipping and carried out selectively at green semi hard wood. In Assam and Assam hybrid, tipping-in-material (i.e. the shoot that is removed at tipping) should average four leaves and a bud irrespective of height of pruning. Thereafter, plucking is done in regular round. In light pruned and deep skiffed bushes measuring sticks should be used to tip the shoots in correct height.

2.4.2 Maintenance Foliage

All mature leaves left on the bush below the tipping and plucking surface are called the maintenance leaves or foliage. The growth of shoots which are harvested is dependent on the maintenance foliage. The young tea leaves cannot manufacture carbohydrate because they are not efficient for photosynthesis.

In a tea leaf the capacity of manufacturing food material develops gradually and a leaf does not attain full physiological efficiency until it has grown to half of its full size (it is about 5 weeks form unfolding of a leaf). Even the third leaf on an actively growing shoot imports photosynthates from the maintenance leaves.

Young shoots on a plucked bush are removed so fast and their constant removal stimulates production of new shoots at such a rapid rate that the maintenance leaves are essential for sustained productivity and survival of a plucked tea bush. The maintenance leaves manufacture carbohydrates which are translocated to the growing shoots for their growth. Photosynthetic efficiency of the maintenance foliage is retained for about 6 months after which it gradually declines and the leaves ultimately drop off after about 18 months.

By tipping the primaries/laterals in light prune or skiffed bushes at different heights, a new layer of maintenance leaves are provided to the bush for efficient photosynthesis.

2.4.3 Plucking System

The system of plucking followed in N. E India is the "*janam* plucking", that means shoots are plucked leaving the *janams.* The other systems of plucking adopted in other countries are fish leaf plucking and single leaf plucking.

In fish leaf plucking, shoots are plucked leaving the fish leaf, while in single leaf plucking it is done leaving the *janam,* fish leaf and one single foliage leaf.

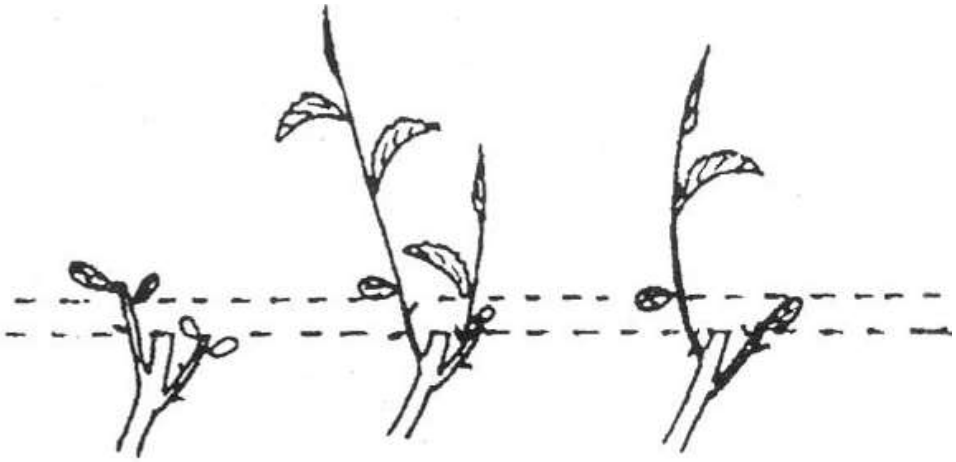


Fig. 2.3 : Different systems of plucking

Janam : When shoots on a bush start growing after a period of dormancy, small leaflets (cataphylls or bud scales) are first unfolded. These cataphylls are *janams* .Usually two *janams* are unfolded and drop off leaving scar on the stem.

2.4.4 Standard of Plucking

Standard of plucking denotes the type of shoots harvested. Depending on the length of plucking round or type of shoots harvested there are five standards of plucking. These are - fine, standard, medium, coarse and black.

However, only two standards of plucking are generally followed *viz.,* black and standard. In black plucking, almost all types of shoots above the plucking table are plucked while in standard plucking small shoots with one leaf are not plucked and are allowed to retain on the table. The types of shoots plucked under the two plucking standards are shown in Table 2.2.

Table 2.2 : Types of shoots plucked in Black and Standard plucking

Plucking standard	Types of shoots to be plucked
Black plucking	All one leaf and a bud shoots; all two leaves and a bud shoots; all three leaves and a bud shoots ;and single *banjhies*
Standard plucking	Large one leaf and a bud shoots; all two leaves and a bud shoots; small three leaves and a bud shoot; and single *banjhies*

As a long term policy, standard plucking is superior to black plucking for tea in the plains of N. E. India.

2.4.5 Plucking Round

Plucking round is the time interval in days between the successive plucking operations. It varies form 4-14 days, though 7 days round is the most common practice. Plucking should be adjusted to the time interval between unfolding of successive leaves on a growing shoot i.e. leaf period. If the leaf period is 4 days, then a shoot with one leaf and the growing bud (1+ bud shoot) of today will become a shoot with two leaves (2 + bud) within next four days and a shoot with three leaves (3 + bud) within eight days.



Leaf period : The time interval between unfolding of successive leaves on a growing shoot. It is also called phyllochron.

During the main growing season in N.E. India, the mean leaf period is four days in the population of seed grown tea. Based on this, a plucking round of 7 days has been adopted in N.E.India as the normal plucking round. In most of the tea estates tea bushes are plucked at weekly intervals from April to December and there is a marked dormant season during winter when practically no crop is harvested. Normally towards the end of the season when the growth rate declines the plucking round is extended.

Longer rounds of plucking increase the coarser leaf and *banjhis* both affecting the quality adversely. Normally, most of the shoots when they become larger with four leaves or more go *banjhi.*

The types of shoots that are available for plucking on a bush at different plucking rounds are given in Table 2.3.

Table 2.3 : Type of shoots available at different plucking rounds

Types of shoot left on bush	Type of shoot harvested at different plucking rounds		
	4 days	8 days	12 days
Bud	1+B	2+B	3+B
1+B	2+B	3+B	4+B
2+B	3+B	4+B	5+B

2.4.6 Creep

Undue rise of the plucking table results in loss of crop. The rise in the plucking table during the season due to continuous plucking is unavoidable. To avoid undue creep, it is advisable to pluck close to *janam*. Some amount of creep is bound to take place in the cropping months. However, the creep should not exceed the following limits (Table 2.3) under normal conditions.

Table 2.3 : Permissible creep

Type of Prune/ Skiff	Permissible creep		
	By end July	By end August	By end October/ November
Light Prune	2.5 cm	3.5 cm	5.6 cm
Deep Skiff	2.5 cm	3.0 cm	4.5 to 5.0 cm
Medium Skiff	2.5 cm	3.0 cm	4.0 cm
Unprune	2.5 cm	3.5 cm	4.0 cm

2.4.7 Breaking Back

Breaking back is generally a wasteful and expensive operation. It is an operation of removing the thick or knotted stems (stubs) to level off the plucking table. Longer rounds because of shortage of labour, improper supervision, etc. lead to undue creep. When this happens, breaking back becomes necessary.

Breaking back is also done to maintain the quality of green leaves. If the size of the shoot is large, then the shoot is plucked close to *janam* and the lower portion of the shoot is thrown away keeping the desired portion of the shoot.

In unpruned and medium skiffed teas, the effect of improper plucking can lead to more loss of crop. If the situation warrants, a very light 'airy skiff' to remove just the topmost *banjhis* can be given.

2.4.8 *Banjhi* Shoots



Single *banjhi :* A *banjhi* shoot with one leaf and the *banjhi* bud.

Banjhi shoots above the plucking table or surface present a special problem. If they are not plucked, they tend to make the bush surface uneven .If a single *banjhi* is left on the plucking table until the bud starts to grow again, this shoot is normally to be plucked at a higher level since the stem of such a shoot generally becomes very hard.

2.4.9 Plucking Operation

The following points should be taken into consideration at the time of plucking.

- Plucking should be done from one end of a row or hedge (*pahi)* and completed the entire *pahi* before starting another *pahi* from the other end.
- The shoots should be plucked just below the fish leaf and above the *janam* mark
- While plucking, old leaves, hard potion of the tender growing shoot with two or three leaves, bruised leaves should not come into the plucking basket.
- The growing buds and the small shoots with one leaf should be left on the table.
- All the *banjhi* shoots on the plucking table should be removed.
- The old leaves protruding above the plucking table (*Khari* pat) should be removed to keep the table level. Those leaves should be removed completely and one portion should not be kept by tearing the leaves in the middle.
- The shoots below the tipping level or plucking table should never be plucked.
- Care should be taken to keep the creep within the permissible limit.
- Mikania (*Micania micrantha*) is a noxious creeper weed which sometimes covers the plucking table making the plucking difficult. The creeper should be uprooted along with the root while plucking.
- In drought prone areas, step up plucking by one leaf in unpruned bushes should be done in the beginning of the season.

Plucking Under Different Conditions :

Plucking during early season : For maximization of crop, unpruned bushes at the start of the year should be plucked close to the j*anam*

leaving small growing shoots with one leaf (1+B).If the bushes are not having adequate layer of maintenance foliage, the table should be raised by one full leaf at the beginning of the season.

Plucking during rain flush crop : Generally about 45 % of the annual crop is harvested during the peak cropping months of July to September. To achieve maximum production in this period, shorter plucking round may be followed. All *banjhi* shoots, protruding stub of mature leaves are removed from the plucking table. In unavoidable circumstances, very light skiffing may be imparted in unpruned bushes, but not as regular practice. Care should be taken to check the undue rise of the plucking table. Step up plucking during this period should not be done**.**

Plucking under droughty condition : Under droughty situation, liberal plucking may be practised at the beginning of the season to provide an active layer of green foliage in unpruned bushes. In case of severe defoliation or 'die back' of plucking points, the table should be raised or stepped up by one layer of foliage with the advent of new growth. The tipping height also should not be lowered in light pruned or skiffed bushes even if the primaries go *banjhi* below the tipping level.

Plucking of waterlogged bushes : Hard plucking at shorter intervals should be done to avoid *banjhi* formation.

Plucking during blister blight or pest attack : Prior to tipping, medium pruned and light pruned bushes experiencing severe infestation of blister blight which is expected to continue for some time due to favorable weather condition of its occurrence, should initially be tipped low retaining 3 or 4 layers of maintenance foliage in the bush. On expiry of the vulnerable weather condition and after the control of the disease, plucking table may be raised to the recommended height. In unpruned tea attacked by blister blight, all tender shoots should be removed through black plucking. In the event of pest infestation like thrips or helopeltis attack, black plucking should be done.

2.4.10 Plucking Basket /Bag

The pluckers may use small plucking baskets to keep the plucked green leaves and large baskets for unloading the leaves from the plucking basket. The basket may be made up of cane or bamboo. However, the baskets should be smooth to avoid bruising before damaging the green leaves. Nowadays, nylon bags are used which are light and airy. While plucking, it is to be noted that the pluckers do not keep the plucked leaves pressing tightly in the basket or bag. On the other hand, frequent unloading of the plucking basket or bags is also time consuming as every time the plucker has to come out from the *pahi.*

2.4.11 Care and Handling of Green Leaves

The plucked green leaves should be handled carefully to avoid any damage. If the leaves are bruised or damaged, it results in reddening of leaves. Such leaves produce inferior tea. The following care should be taken in handling the green leaves:

a) Don't allow the pluckers to keep the plucked leaves longer in their hands. The pluckers tend to keep more leaves in their hands and press them hard in their plucking basket to accommodate more leaves to save time. They should be instructed to put the leaves in the basket or the bag frequently.
b) Don't put the green leaves in the basket or bag pressing tightly. An ideal plucking basket measuring 55 cm x 55cmx 55cm should accommodate not more than 25 kg green leaves.
c) Don't keep the baskets containing the green leaves in sun.
d) Don't keep the plucked leaves longer in the field .They should be sent to the factory as early as possible. Arrangement should be made to send the leaves to the factory twice, at noon and in the afternoon after completing the plucking.

e) Before sending the leaves to the factory or before collecting the leaves by the agents, the green leaves should be spread thinly on bamboo racks (*chang)* under shade or in thatched-roofed house.

f) Care should be taken not to generate heat in the basket.

g) While transporting the green leaves,it is better to carry the leaves in baskets or plastic crates.

h) Never allow the workers to sit on the green leaves being carried in the vehicle.



CHECK YOUR PROGRESS

Q.1. What is tipping?

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.....

Q.2. What should be the tipping height for light pruned and deep skiffed bushes?

.....

.....

.....

Q.3. What is the system of plucking followed in N.E.India?

.....

Q.4. What is the normal plucking round followed in Assam?

.....

Q.5. What are the permissible limits of creep in LP, DS and MS bushes by end July?

.....

Q.6. State true or false :

a) The best tipping height from the point of view of yields is the natural *banjhi* horizon of the shoot system on a pruned bush. (True/False)

b) All mature leaves on the tea bush above the tipping level are called the maintenance leaves. (True/False)

c) All the *banjhi* shoots on the plucking table should not be removed. (True/False)

d) In black plucking, almost all types of shoots above the plucking table are plucked. (True/False)

e) In the event of pest infestation like thrips or helopeltis attack, standard plucking should be done. (True/False)

f) In drought prone areas, step up plucking by one leaf in unpruned bushes should be done in the beginning of the season. (True/False)

g) Longer rounds of plucking increase the coarser leaf and *banjhis* both affecting the quality adversely. (True/False)



2.5 LET US SUM UP

- Plucking in tea is synonymous with harvesting in other crops. The tender apical portions of shoots consisting of two to three leaves and the terminal buds are nipped-off in plucking.
- Plucking encourages regeneration of shoots on a tea bush.
- The initial few rounds of plucking are called tipping. When the primaries grow above a predetermined height after pruning or skiffing, they are tipped at that height parallel to the ground surface for establishing a flat plucking table.
- By tipping, the maintenance leaves are retained in the bush and those leaves support the new growth.
- The system of plucking followed in N.E India is the "*janam* plucking"
- Standard of plucking denotes the type of shoots harvested. The two common standards of plucking followed are-Standard plucking and Black plucking.
- Standard plucking is superior to black plucking for tea in the plains of N.E. India.

- Plucking round is the time interval in days between the successive plucking operations. It varies from 4-14 days, though 7 days round is the most common practice.
- Longer rounds of plucking increase the coarser leaf and *banjhis* both affecting the quality of made tea adversely.
- Undue rise of the plucking table, called creep, results in loss of crop. Some amount of creep is bound to take place in the cropping months. However, the creep should not exceed the permissible limits under normal conditions.
- Breaking back is an operation of removing the thick or knotted stems (stubs) to level off the plucking table.
- Green leaves after plucking should be handled with care to avoid damage.



2.6 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Initial few rounds of plucking done to establish a flat plucking table and also to encourage the growth of laterals is called tipping.

Ans. to Q. No. 2 : For light prune tea, the tipping height should be 20-25 cm above the prune mark leaving on an average 5 leaves on the primary. In deep skiff tea, it is 7-10 cm above the deep skiff mark leaving 2-3 leaves on the laterals.

Ans. to Q. No. 3 : *Janam* plucking

Ans. to Q. No. 4 : 7 day plucking round

Ans. to Q. No. 5 : 2.5 cm

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



2.7 FURTHER READINGS

- *Science and Practice in Tea Culture*. By D.N. Barua .Tea Research Association, Kolkata, Jorhat.
- *Field management in Tea*. Tocklai Experimental Station, TRA, Jorhat.



2.8 MODEL QUESTIONS

Q.1. What system of plucking is normally followed in N.E. India? What are the tipping heights for different types of prune and skiffed bushes?

Q.2. What is maintenance leaf? Describe the role of maintenance leaves.

Q.3. What are the different standards of plucking? What standards are normally followed in N.E. India?

Q.4. What is creep? Mention the permissible creeps in light pruned and skiffed bushes at different times of the season.

Q.5. Write note on the following

a) Breaking back

b) Black plucking

c) Primary

UNIT 3 : WEED MANAGEMENT

UNIT STRUCTURE

3.1 Learning Objectives

3.2 Introduction

3.3 Weeds in Tea Plantations

- 3.3.1 Types of Weed

3.4 Weed Control Methods

- 3.4.1 Manual or Mechanical Method
- 3.4.2 Chemical Method

3.5 Weed Control in Nursery

3.6 Weed Control in Young Tea

- 3.6.1 Mechanical Control
- 3.6.2 Chemical Control

3.7 Weed Control in Mature Tea

3.8 Let Us Sum Up

3.9 Answers to Check Your Progress

3.10 Further Readings

3.11 Model Questions

3.1 LEARNING OBJECTIVES

After studying the unit you will be able to:

- Explain the need for weed control in tea fields.
- Classify the weeds.
- List the important weeds found in tea fields.
- Name the different methods of weed control.
- Classify the different herbicides.
- Describe the procedure of herbicide application.
- Describe the weed control methods adopted in nursery, young tea and mature tea areas.

3.2 INTRODUCTION

Weeds are plants growing in an area where they are neither desired nor appreciated. Weeds compete with the crop for nutrients, sunlight, carbon dioxide, moisture and space. Most of the weeds harbor many pests and diseases which attack the crop. Some weeds hinder harvesting of tea by covering the plucking surface and also creating physical obstruction to the pluckers. Further, there are some weeds which may have allelopathic action on tea plant. The total effect of all these competitions results in low production and poor growth of the crop plant.

Control of weeds accounts for the second most expensive cultural item in the tea plantations. Depending on the intensity of infestation and weed species, the weeds cause yield losses upto 10–25 per cent.

In this unit, we shall discuss the weed species found in tea plantations, their classification and methods of weed control.

3.3 WEEDS IN TEA PLANTATIONS

Weeds are not a major problem and regular weeding may not be necessary in mature tea as its canopy covers the ground. But young tea plants suffer a permanent setback in vigour if proper weed control measures are not taken at appropriate time. Weeds are a problem in pruned fields and need for their control persists till the bushes cover the ground. The critical period of weed competition in the tea areas of Assam is between April and September.

Weeds not only compete with the tea bushes for nutrients and moisture, they also harbor insects and diseases, restrict branching and development of frame in young tea, reduce plucking efficiency due to the growth of creepers and thorny weeds. These apart, weed growth blocks the drainage and impedes the flow of water during rainy season.

3.3.1 Types of Weed

Weeds are classified on the basis of the duration of their life cycle into annuals, biennials and perennials. Annuals live and

produce their seeds in a single growing season. Biennials need two growing seasons; in one season they pass through their vegetative growth followed by the reproductive stage in the next season. The propagation of both annuals and biennials is mainly through seeds. Perennials live indefinitely and are propagated through seeds as well as vegetatively.

Morphologically major weeds belong to either monocotyledons (narrow leaved) or dicotyledons (broad leaved).

Several species of grasses and other monocotyledonous and broadleaved or dicotyledonous weeds infest the tea fields. The common weeds found in the tea fields in N.E. India are listed in Table 3.1.

Table 3.1 : Common weeds of tea in N.E. India

Botanical name	English Name	Local name
Broad leaved / dicotyledonous weeds		
Mikania micrantha	Mile a minute	Mikania or Japani habi
Borreria hispida	Bagracote	Gahori bon
Ageratum conzoides	Goat weed	Gondhowa bon
Chenopodium album	Smooth pig	Jilmil
Alternanthera sessilis	–	Matikaduri
Amaranthus spionsus	Spiny amaranthus	Hati khutura
Amaranthus viridis	Amaranthus	Khutura
Eryngium foetidum	–	Bondhania
Mimosa pudica	Sensitive plant	Nilaji bon
Oxalis corymbosa	Wood sorrel	Bor tengesi
Oxalis corniculata	Creeping sorrel	Saru tengsi
Eupotarium odoratum	Siam weed	German habi
Polygonum perfoliatum	–	Bagh asora
Polygonum chinensis	–	Madhusoleng
Grasses and other monocotyledonous weeds		
Imperata cylindrica	Thatch grass	Ulu or kher
Elusine indica	Goose grass	Bobosa bon

Setaria glauca	Fox tail grass	Bisa bon
Arundinella bengalensis	–	Topasali
Axonopus compressus	Carpet grass	Carpet ghah
Cynodon dactylon	Bermuda grass	Dubori bon
Setaria palmifolia	–	Noga habi
Saccharum spontaneum	–	Kahua
Digitaria sanguinalis	Crab grass	Makarjuli
Cyperus rotundus	Nut grass	Mutha ghah
Cyperus pilosus	–	Harkota bon
Paspalum conjugatum	Sour grass	Paspalum

3.4 WEED CONTROL METHODS

3.4.1 Manual or Mechanical Method

In tea, hand weeding, sickling, cheeling, forking and mulching are the conventional methods of weed control. Hand weeding is carried out in the nurseries and the newly planted tea areas where application of chemical herbicides is hazardous for the young plants.

Cheeling or surface scrapping is an efficient means of suppressing weeds with a minimum soil disturbance. This is useful in controlling the shallow rooted weeds when their density is high and a large area is to be weeded.

Sickling is generally done to control the vigorous growth of tall weeds and is often done before herbicide application. Deep rooted weeds growing around the collar of the bushes, done once in a year, can be removed by forking. Mulching is very effective in controlling weed growth.



Cheeling : Used to describe a term of cultivation in which surface of the soil (upto a depth of about 1-1.5 cm) is scraped with a cheeling hoe to suppress weeds. The cheeling hoe is a half moon-shaped flat hoe.

3.4.2 Chemical Method

Controlling weeds by herbicide application has become common practice in tea. However, manual weeding should



Herbicides : Chemical compounds used to control or kill weeds, they may be highly selective injurious to only certain kinds of weeds while not harming others.

supplement the chemical weed control and be a part of integrated weed management programme.

Classification of herbicides : On the basis of the nature of action, herbicides used in tea plantations can broadly be classified into two groups:

a) Pre-emergent herbicide, and
b) Post-emergent herbicide.

Post-emergent herbicides are further classified into two groups:

a) Contact and
b) Translocated or systemic.

Pre-emergent herbicides are applied in weed free ground and they act on the weed seeds preventing them to germinate. Simazine, Diuron and Oxyflurofen are pre-emergent herbicides. Pre-emergent herbicides are more or less safe for tea, when applied in recommended doses. However, Diuron must not be used in less than 3 years old tea.

Pre-emergent herbicides should be applied on clean and moist ground. It should not be applied on disturbed soil, nor should the soil be disturbed after its application. The efficiency of the herbicide is less in sandy soil.

Contact herbicide (e.g. Paraquat) causes wilting, necrosis and eventual death of the leaves. Translocated herbicides enter inside the plant tissues and control the weeds by interfering with their metabolic activities.

Herbicide application is most effective when the weeds are in their vegetative growth phase. Therefore, herbicides should be applied at this vulnerable stage i.e. before flowering. Once the weeds reach the flowering stage, it becomes difficult for them to translocate the herbicides. Cutting of the tops of tall weeds before applying translocated herbicide should be avoided as this will reduce herbicidal efficiency. If the weeds are more than 15 cm tall they should be sickled close to the ground and herbicide should be applied on resumption of new growth.

The mode of action and specificity of some of the herbicides are shown in Table 3.2.

Table 3.2 : Specificity and mode of action of some common herbicides

Herbicide	Mode of action	Specificity
Paraquat	Contact	Broad spectrum
2, 4-D	Translocated	Mainly used as broad leaf weed killer
Diuron	Translocated	Broad spectrum
Glyphosate	Translocated	Mainly used as grass weed killer
Simazine	Translocated	Broad spectrum
Dalapon	Translocated	Specific to grassy weeds

Rate of application : The optimum rates of application of different herbicides are given in Table 3.3.

Table 3.3 : Doses of herbicide application

Herbicide	Dilution (amount per 200 litres of water)
2,4-D Sodium salt	500g
2,4-D Diethylamide salt	250- 400 ml
Paraquat: First round	670 ml
Paraquat : Second round	500 ml
Dalapon	1.75 kg
Glyphosate	1.0-1.5 litre
Simazine	1.5-2.0 kg
Diuron	1.0 kg
Oxyflurofen	0.5 litre

Herbicide cocktails : The effect of herbicides is often enhanced by simultaneous use of suitable mixture of more than one herbicide at a time. The use of herbicide cocktails reduces the total cost of herbicides and their application. The selection of herbicidal combination or cocktail is related to the weed flora, intensity of infestation and their compatibility. Some of the herbicidal combinations commonly used in tea are shown in Table 3.4.

Table 3.4 : Different herbicide cocktails

Type of weed flora	Herbicide cocktail	
	In young tea	In mature tea
Predominantly grassy	Oxyflurofen + Glyphosate	Paraquat + Diuron or Paraquat + Simazine
Mixed weeds	Glyphosate + 2,4 -D	Paraquat + 2,4-D
Thatch and broad leaf	Glyphosate + 2,4 -D	Dalapon + 2.4-D

Adjuvants for herbicides : In order to increase the efficiency of translocated herbicides spray adjuvants are used. The spray adjuvants may be a wetting agent or a spreader (e.g. teepol), sticking agent (e.g. Triton AE or tenac, Monoxynol-10 (ASPA-80, Non-ionic surfactant (Dhunuvit) or fertilizers (Urea or sulphate of ammonia). A sticker or spreader helps during rainy or sunny weather respectively. A sticker helps in the retention of spray fluid on the weed surface and the spreader favours uniform spreading of the spray fluid over the foliage Addition of fertilizers enhances the herbicidal efficiency.

Wetting or sticking agents may be used either singly or in combination at 0.06% concentration. For effectiveness of sticking agents, 2 hour rain free period is necessary. Fertilizers like urea or ammonium sulphate may be mixed with 2, 4-D solution @ 0.5% (1 kg/200 litres).

Sprayers for herbicide application : For herbicide application , usually hand operated and pressure regulated Knapsack sprayers fitted with flood jet of flat fan nozzles is used since both types give wider sweep of spray to cover larger areas. Aspee Knapsack (16 litres capacity), Aspee Backpak (13 litres capacity), Aspee Milenium (16 litres capacity) etc. are the hand operated sprayers available in the market.

Generally, nozzle WFN 24 (nozzle code name) is used for spraying herbicides in young tea areas and for spot spraying. While

spraying in young tea, shield guard should be used. For spraying in mature tea, nozzle WFN 40 should be used. The nozzle WFN 62 is useful for spraying in drains, *hollas* and road side areas.

The amount of spray fluid required to cover a particular area will vary with type of sprayer, intensity of weed growth and mode of application. For uniform spray, 450 -500 litres per ha of spray fluid are needed in case blanket application and 300 litres per ha for spot application.

Spray delivery pressure should be maintained at 10 psi to 15 psi above which the delivery will be quicker. Upto 6 ha of land one well maintained sprayer is sufficient for the application of herbicides

Spraying of herbicides : Spray delivery height should be maintained at a uniform height of 25-30 cm above ground. In a rainy or in windy day spraying of herbicide should not be done. The **s**prayer used for herbicide application should not be used for application of pesticides.

The water used for the preparation of herbicide solution should be free from any other organic matter. Glyphosate requires clean water; otherwise, efficiency of the herbicide is greatly reduced.



CHECK YOUR PROGRESS

Q.1. What are the different methods of manual or mechanical control of weeds?

.....

Q.2. What are the different classes of herbicides?

.....

.....

Q.3. Name five systemic or translocated herbicides.

.....

Q.4. Name three adjuvant used in spraying herbicides.

.....

Q.5. What type of sprayers should be used in herbicide application?

.....

Q.6. State true or false :

a) Pre-emergent herbicides should be applied on clean and moist ground. (True/False)

b) *Mikania micrantha* is a creeper weed.(True/False

c) *Borreria hispida and Ageratum conzoides* are grassy weeds. (True/False)

d) Paraquat is a translocated herbicide. (True/False)

e) Dalapon is a translocated herbicide used to control grasses. (True/False)

f) Spray delivery height should be maintained at a uniform height of 25-30 cm above ground. (True/False).

g) Addition of fertilizers enhances the herbicidal efficiency (True/False).

h) For uniform spray, 450-500 litres per ha of spray fluid are needed in case blanket application and 300 litres per ha for spot application. (True/False).

3.5 WEED CONTROL IN NURSERY

Hand weeding is preferred to chemical weed control in tea nurseries. It is better to control the weeds by hard weeding method. Upto 6 month's growth of the tea cutting or seedling plants whenever hand weeding is done care should be taken so that the roots of the young tea plant are not exposed.

Herbicidal control of weed can be done by pre-planting application (2-3 weeks before planting of cuttings) of Simazine at the rate of 5 g per litre of water or Oxyflurofen at the rate of 2.5 ml per litre of water on the bare soil surface of sleeves or on prepared beds. This gives satisfactory control of weeds upto 6 months. If in the meantime weeds come up, spot hand weeding can be done. When the cuttings attain two flush growth (6

months), another dose of Simazine or Oxyflurofen may be applied at the same dose.

In case of seed nursery no herbicidal control of weed is to be advocated until the seedling attains 6 months growth. The nursery beds are to be prepared cleanly and after the sowing of seeds these beds are mulched properly. Hand weeding is the best method of controlling weeds in the initial stage. At the later stage Simazine or Oxyflurofen can be applied at the same dose mentioned for cuttings nursery.

3.6 WEED CONTROL IN YOUNG TEA

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. Weeds remove about 270 kg of N/ha in the year of planting causing stand loss and inhibition of branching. Initial infestation of perennial grasses like *Imperata cylindrica, Cynodon dactylon*, P*aspalum conjugatum* etc. cause severe setback to the growth of bush for several years.

Weed growth is most vigorous in young tea areas during March to October. During this period utmost care should be taken to protect the plants from weed competition. As soon as planting is completed the young tea area should be cheeled clean and mulched heavily with proper mulching materials.

3.6.1 Mechanical Control

The collar of the plants should be hand weeded upto a radius of 15 cm and the remaining part can be cheeled. But in no case cheeling is allowed to clean the collar of the plant.

The first round of hand weeding-cum-cheeling is done in March. In this round, weeds may be collected in between hedges of tea rows and in the next round half decomposed weeds are spread over the entire ground. The bulbous or rhizomes weeds such as

colocasia, fern etc. and creepers like mikania should be uprooted carefully and destroyed by placing these over the garden roads.

The next round of hand weeding-cum-cheeling in the last part of May may be followed by sickling. This way a total of five rounds of cheeling and 2-3 rounds of sickling may be required to control weeds mechanically in young tea areas during the year.

Growth of mikania should always be discouraged in the non-tea areas near young tea. Mikania acts as an alternate host of the sucking type of insects especially for tea mosquito bug.

If cheap manual labour is available it is always advisable to control weeds by hand weeding- cum-cheeling in young tea. Application of herbicides may reduce the initiation of branches from the lower portion of the plant.

3.6.2 Chemical Control

The timely control of weeds efficiently with fewer amounts of labour calls for the use of herbicides. Initially the cost may be higher but it is more economical in the long run than any other weed control methods.

In young tea areas weeds can be controlled with the application of following herbicides:

a) Hand weeding in the collar region of the plant followed by application of Paraquat (Gramoxone) @ 600ml per 200 litres of water and subsequent rounds with 500 ml in 200 litres of water.

b) When the area is infested with weeds like *Polygonum, Arundinella* etc. in such areas 1.5 liter of Glyphosat in 200 literes of water should be applied. Subsequent rounds can be sprayed with 1 litre of herbicide in 200 litres of water.

c) When the area is infested with broad leaf weeds, 2, 4-D applied at the rate of 500 g per 200 litres of water can control the weeds.

d) For mixed types of annual broad leaf and grass weeds, a cocktail of 2, 4-D and Paraquat at the above rate may be applied.

Dalapon or Diuron should not be used in young tea upto 3rd year. When contact herbicides are used utmost care should be taken to see that herbicide fluid does not fall on the basal stem of the young plant. Faulty application of Paraquat (Gramoxone) on the collar stem of young tea plants destroy the potential buds, which otherwise could come up as branches. Plastic guards should always be used while spraying the herbicide in young tea areas.

3.7 WEED CONTROL IN MATURE TEA

As mentioned earlier, the use of chemical is a better choice for controlling weeds in mature teas. However, if manual labour is available at a cheaper rate weeds can be effectively controlled by mechanical means.

Irrespective of the methods used, there should be a well laid out programme at least for 3 consecutive years for the whole tea garden section-wise.

Herbicides programmes vary according to the weed situations. A particular programme may be used as long the relevant weed situation exists. But the weed spectrum changes over the year and suitable programme for the new weed situation should be adopted.

Rational programme depends on

a) The extent and rate of new weed growth following initial application.
b) Regeneration capacity of the weed species.
c) Type of weeds persisting following the application of the herbicide.
d) The efficiency of the initial spray.

There is no single herbicide which can control all the weeds for the entire season. So, herbicides are applied either alone or in combinations. In a rational programme the following sequences should be planned.

a) A pre-emergence herbicide followed by a post emergence herbicide.
b) One post-emergence herbicide followed by another post-emergence herbicide.
c) Repetative application of the same or another pre-emergence or post-emergence herbicide.

The number of applications depends on the efficiency of the herbicide used and the intensity of weeds appearing after one application. Normally 3-4 rounds of application may be needed in March–April, May-June and September–October. The number gradually reduces year after year.

Herbicidal combinations in a programme : The following herbicides can be used in a programme.

Table 3.5. Herbicide Programme

Type of herbicide	Time of application	Herbicide(s)	Spray volume (lit/ha)
Contact	Post -emergent	Paraquat	450-500
Contact + Translocated	Post-emergent	Paraquat + Diuron Paraquat + simazine Paraquiat + 2,4-D	450-500 450-500 450-500
Translocated	Post-emergent	2,4-D + Dalapon + Glyphosat	350-400
Translocated	Pre-emergent	Diuron , Simazine, Oxyflurofen	400-450

- **Paraquat + Diuron.** This mixture should not be used in tea under 3 years of age. Paraquat 1.5 litre + Diuron 750 g should be mixed in 500 litres of water. This cocktail is effective against *Paspalum scrobiculatum (koda millet)*, *Axonopus compressus*(carpet grass) like perennial weeds and other annual grasses along with broad leaf weeds.
- **Paraquat + 2, 4-D.** When the area is infested with broad leaf weeds like *Boreria hispida*(Gahori bon) and annual grasses, this cocktail is effective.

- **Paraquat + Simazine**. This mixture acts in the similar way as Paraquat + Diuron
- **Dalapon + 2, 4-D.** In this mixture Dalapon controls the perennial grasses, particularly *Imperata cylindrica* (the thatch) and 2, 4-D eliminates the broad leaf weeds.
- **Paraquat.** Paraquat alone in recommended dose i.e. 670 ml/200 litres of water at 10-15 days interval for 4-6 rounds beginning from April controls *Imperata cylindrica* (thatch) and *Axonopus compressus* (carpet grass) Subsequent rounds should be applied @ 500ml/200 litres of water.
- **Simazine, Diuron and Oxyfluorfen.** These are the pre-emergence herbicides which can be used alone in October before the rain ceases and pruning/skiffing starts.
- **2, 4-D.** This can control broad leaf weeds specially *Boreria hispida* (Gahori bon)
- **Glyphosate**. Glyphosate can be used as a broad spectrum post-emergence translocated herbicide. This is the most efficient herbicide for controlling perennial weeds like *Arundinella bengalensis (*topasali), *Polygonum perfoliatum* (bagh asora), *Polygonum chinensis* (madhu soleng), *Saccharum spontaneum* (kohua) etc. @ 1.5 litres per 200 litres of water and *Axonopus compressus* (carpet grass), *Imperata cylindrical* (thatch), *Paspalum conjugatum* (sour grass), *Setaria palmifolia* (nogahabi), *Digitaria sanguinalis* (crab grass), *Cynodon dactylon* (duburi bon) etc. @ 1 litre per 200 litres of water.

POINTS TO REMEMBER

- Do not allow the weeds to overgrow. If already overgrown, resort to sickling before application of herbicides.
- Blanket application should only be undertaken where weed growth is almost uniform covering maximum ground area. Otherwise go for spot application.
- Select appropriate herbicides depending on predominant weed flora.

- Localized growth of weeds should be controlled by spot application of herbicides.
- Use clean water for preparation of herbicide solution.



CHECK YOUR PROGRESS

Q.7. What are the post emergent herbicides which are not applied in young tea below 3 years of age?

.....

Q.8. What herbicide should be applied in an area infested with broad leaf weeds?

.....

Q.9. What types of weeds can be controlled by Glyphosate?

.....

.....

.....

.....

Q.10. Fill in the blanks :

a) In case of seed nursery no herbicidal control of weed is to be advocated until the seedling attains _____ month's growth.

b) For mixed types of annual broad leaf and grass weeds,a cocktail of _____ and _____ may be applied.

c) Plastic guards should always be used while spraying the herbicide in _____ tea areas.



3.8 LET US SUM UP

- Control of weeds accounts for the second most expensive cultural item in the tea plantations. Depending on the intensity of infestation and weed species, weeds cause yield losses upto 10 –25 per cent.

- Weeds are not a major problem in mature tea but a problem in the young tea areas.
- The critical period of weed competition in the tea areas of Assam is between April and September.
- Weeds not only compete with the tea bushes for nutrients and moisture, they also harbor insects and diseases, restrict branching and development of frame in the young tea, reduce plucking efficiency due to the growth of creepers and thorny weeds.
- Weeds are classified on the basis of the duration of their life cycle into annuals, biennials and perennials. Morphologically major weeds belong to either monocotyledons (narrow leaved) or dicotyledons (broad leaved).
- Several species of grasses and other monocotyledonous and broad leaved or dicotyledonous weeds infest the tea fields.
- Weeds can be controlled manually or by application of herbicides. Hand weeding, cheeling, forking, sickling, mulching are the methods of mechanical or manual methods of weed control. In nursery and young tea, manual weeding is preferred to chemical weed control.
- On the basis of the nature of action, herbicides used in tea plantations can broadly be classified as pre-emergent herbicide and post-emergent herbicide. Post-emergent herbicides are further classified into two groups-contact and translocated or systemic.
- Paraquat is a contact herbicide.2, 4-D. Diuron, Dalapon, Oxyflurofen, Glyphosat are translocated herbicides. Some of these herbicides are specific to certain group of weeds whereas some are broad spectrum.
- The effect of herbicides is often enhanced by the simultaneous use of suitable mixture of more than one herbicide at a time.
- In order to increase the efficiency of translocated or systemic herbicides spray adjuvants are used.
- For herbicide application. usually hand operated and pressure regulated Knapsack sprayers fitted with flood jet of flat fan nozzles are used.

- Hand weeding is preferred to chemical weed control in tea nurseries.Dalapon or Diuron should not be used in young tea upto 3rd year.
- Herbicides programmes vary with the weed situations. A particular programme may be used as long the relevant weed situation exists. But the weed spectrum changes over the year and suitable programme for the new weed situation should be adopted.
- There is no single herbicide which can control all the weeds for the entire season. So, herbicides are applied either alone or in combinations.
- The number of applications depends on the efficiency of the herbicide used and the intensity of weeds appearing after one application. Normally 3-4 rounds of application may be needed in March –April, May-June and September –October. The number gradually reduces year after year.



3.9 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Hand weeding, cheeling, sickling, mulching.

Ans. to Q. No. 2 : Pre-emergent and Post emergent herbicides. Post emergent herbicide are of two types-contact and systemic or translocated.

Ans. to Q. No. 3 : Dalapon, 2, 4-D, Diron, Oxyflurofen, Glyphosat

Ans. to Q. No. 4 : Teepol, Triton AE, Tenac

Ans. to Q. No. 5 : Hand operated, pressure regulated Knapsack sprayer.

Ans. to Q. No. 6 : a) True, b) True, c) False, d) false, e) True, f) True, g) True, H) True.

Ans. to Q. No. 7 : Dalapon and Diron

Ans. to Q. No. 8 : 2, 4-D

Ans.to Q. No. 9 : Glyphosate can be used as a broad spectrum post-emergence translocated herbicideto control *Arundinella bengalensis* (topasali), *Polygonum perfoliatum* (bagh asora), *Polygonum chinensis*

(madhusoleng) *Saccharum spontaneum* (kohua) *Axonopus compressus* (carpet grass), *Imperata cylindrical (*thatch), *Paspalum conjugatum* (sour grass), *Setaria palmifolia* (nogahabi), *Digitaria sanguinalis* (crab grass), *Cynodon dactylon* (duburi bon) etc.

Ans. to Q. No. 10 : a) 6, b) Paraquat, 2, 4-D, c) young.



3.10 FURTHER READINGS

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



3.11 MODEL QUESTIONS

Q.1. How do weeds affect tea? What types of weeds are seen in tea fields?

Q.2. What are the different mechanical methods of weed control in tea? How to control weeds in young tea?

Q.3. What are the different classes of herbicides? Give the rate of application and specificity of each herbicide.

Q.4. What is a herbicide mixture? Why is it necessary to apply? Give examples of a few such mixtures used for different weed situation.

Q.5. What type of sprayers is used in spraying herbicides? Give the following information (a) requirement of spray fluid for one ha area (b) Nozzle size (c) Delivery pressure and height.

UNIT 4 : TEA PESTS AND THEIR MANAGEMENT

UNIT STRUCTURE

4.1 Learning Objectives

4.2 Introduction

4.3 Tea Pests and their Management

- 4.1.1 Leaf and Shoot Pests
- 4.3.2 Stem and Branch Pests
- 4.3.3 Other Pests

4.4 Sprayers and Application of Pesticides

- 4.4.1 Sprayers
- 4.4.2 Target Sites for Application
- 4.4.3 Application of Pesticides

4.5 Integrated Pest Management

4.6 Let Us Sum Up

4.7 Answers to Check Your Progress

4.8 Further Readings

4.9 Model Questions

4.1 LEARNING OBJECTIVES

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

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

4.2 INTRODUCTION

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. Many species of insects, mites and nematodes infest tea plants and cause damage to the plant. Pest damage in tea often leads to a significant impact on productivity, in both short term and long term.

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

4.3 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.

4.3.1 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*), Scarlet mite (*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.



Fig. 4.1 : (a) Red spider infested tea (b) Red spider mites

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.

The rate of application of different acaricides are given in Table 4.1.

Table 4.1 : rate of application of acaricides against Red spider mite

Acaricides	Rate of application (Per 100 litres of water)	
	For High Volume sprayer	For Low Volume sprayer
Propergite 57 EC	250 ml	500 ml
Fenazaquin 10 EC	250 ml	500 ml
Profanofos 50 EC	100 ml	200 ml
Fenpyroximate 5EC	50 ml	100 ml
Hexythiazox 5.45%EC	80 ml	160 ml
Neem Extract (Azadirachtin 5%)	70 ml	140 ml

In mite prone areas, for effective control of the mites, the following schedule may be adopted:

- January-February : One round of spraying with any recommended pacaricides with high volume sprayer and wetting of all the leaves on both surfaces with spray fluid should be done.
- March-April : Monitor the field properly. Examine the presence of eggs or larvae using a hand lens. If infestation is widespread, one round of any one of the above pesticides should be sprayed. Monitor after one week. If infestation still persists, one more application should be done at 15 days interval.
- May-June : If infestation is present, spray one round of application with any one of the recommended acaricides with high volume sprayer should be done.
- July–August : If required, one round of spraying with the above pesticides should be done. In case the infestation is sporadic, spot spray may be done.
- September-October : Spot spray with any one of the above pesticides or sulphur formulation should be done.
- November–December: Spot spray with any one of the above pesticides.

In normal situation, the following spray schedule could to be adopted to keep the pest under control.

Months	Pesticide	Rate of application	
		High Volume Sprayer	Low Volume Sprayer
June-July (One round)	Fenpyroximate 5EC or	1 : 2000	1 : 1000
	Hexythiazox 5.45% EC or	1 : 2500	1 : 1250
	Neem Extract (Azadirachtin 5% w/w)	1 : 1500	1 : 750
August-September (One round)	Propergite 57EC or	1 : 400	1 : 200
	Fenazaquin 10EC or	1 : 400	1 : 200
	Neem Extract (Azadirachtin 5% w/w)	1 : 1500	1 : 750

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.



Fig. 4.2 : Tea Mosquito Bug

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.

The rate of application of different insecticides are given in Table 4.2.

Table 4.2 : Rate of application of insecticides against Helopeltis

Insecticides	Rate of application (Per 100 litres of water)	
	For High Volume Sprayer	For Low Volume Sprayer
Thiomethoxam 25 WG	20 g	40 g
Quinalphos 25 EC	250 ml	500 ml
Diflubenzuron 25WP	100 ml	200 ml
Deltamethrin2.8 EC	50 ml	100 ml
Alfamethrin 10EC	50 ml	100 ml
Neem extract (Azadirachtin 5%)	70 ml	140 ml

If infestation is mild to moderate, Thiomethoxam 25WG / Quinalphos 25EC/ Diflubenzuron should be sprayed.

If the infestation is very severe, one round of synthetic pyrethroid should be sprayed followed by Thiomethoxam 25WG at 7 days interval. The follow-up rounds should be only need based.

Repeated application of the same chemical should be avoided.

Spraying Technique : Before spraying the whole field, about 8-10 rows of the bushes covering the outer periphery of the section or field should be sprayed first and then the remaining part of the section should be sprayed in opposite direction as shown in Fig. 4.3.This barrier spraying helps to trap the migratory and mobile population of tea mosquitos.

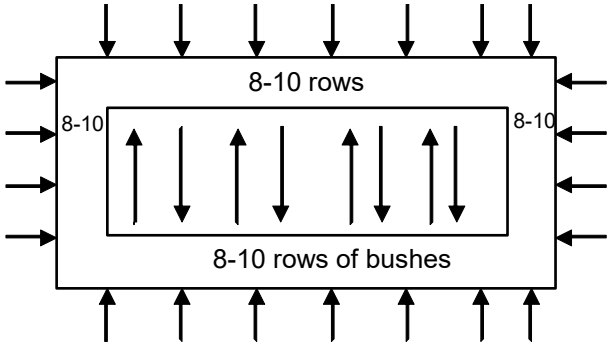


Fig. 4.3 : Spraying Technique for Helopeltis

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.



Fig. 4.4 : Common Looper Caterpillar

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.

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.



Fig. 4.5 : Bunch caterpillar

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.



CHECK YOUR PROGRESS

Q.1. Name the important pests which attack the leaves and the shoots.

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Q.2. What are the four important mite pests of tea?

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and .....

Q.3. Name three important caterpillars which attack tea plants.

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and .....

Q.4. Which parts of the tea bush are infested by Helopeltis?

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.....

Q.5. Name three synthetic pyrothroids and two neem formulation used in tea for controlling pests.

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Q.6. State true or false :

a) Different pests infest every part of the tea plant, the leaves, stem, root, flowers, but the maximum number of pests occurs on the foliage. (True/False)

b) The peak period of infestation of red spider mite is during the dry winter season. (True/False)

c) Mites are leaf eating pests. (True/False)

d) Scarlet mite mostly feed on the upper surface of the leaf. (True/False)

e) The nymphs and adults of *helopeltis* suck the sap from buds, young leaves, and tender stems and shoots. (True/ False)

f) The barrier spraying helps to trap the migratory and mobile population of tea mosquitoes. (True/False)

g) Synthetic pyrethroids should not be mixed with neem formulations. (True/False)

Thrips : Several species of thrips (*Thripidae*) infest tea and cause heavy damage by feeding on the buds, tender leaves and older tea under plucking. The tea thrips (*Scirtothrips dorsalis*) is common in Assam and N. E. India.

The nymphs and adults cause damage to the tender leaves. The initial symptom of attack is light brownish discoloration of the tip and the basal part of leaves. Latter on 2-4 sand papery layers appear on either side of the mid rib. Badly damaged leaves appear rough, deformed and curled and the shoot growth is retarded with the formation of corky tissues on the bark.

Droughty spell encourages rapid build-up of thrips population.



Fig. 4.6 : Thrips

Control measures : The following measures may be adopted to control the tea thrips:

- Hard plucking should be done in the infested areas
- The area should be kept weed free
- Caustic washing should be done on the bush frame
- The soil may be stirred to kill the pupae

In case of unpruned tea, spraying of pesticides should commence as soon as the attack is noticed on the new growth from the mid February to early March. In the badly infested areas, spraying should preferably be done after hard plucking.

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.

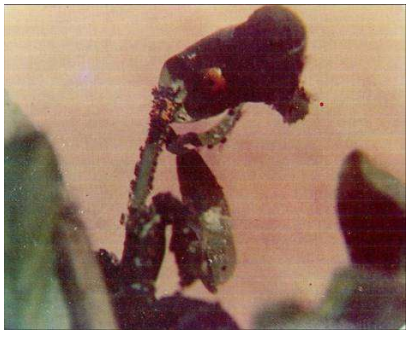


Fig. 4.7 :Tea Aphids

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.

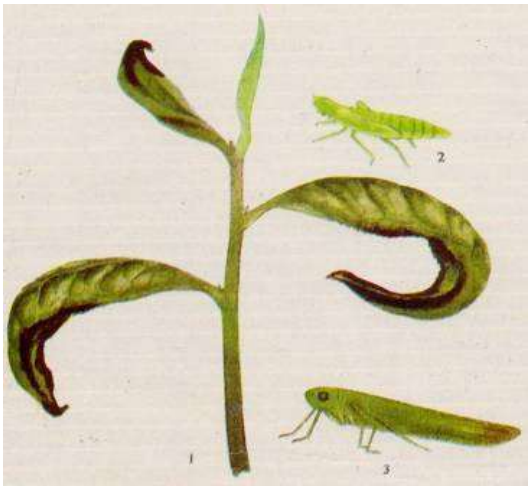


Fig. 4.8 : Tea Jassids

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.



Fig. 4.9 : Flush worm

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.



Fig. 4.10 : Scale insect

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.

4.3.2 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.

4.3.3 Other Pests

Cockchafer Grub (*Holotrichia impressa)* : The grub attacks the roots of the young plants below three years of age. Clonal plants are more affected than the seedling plants. The larva eats away the bark in the collar region of the plants just below the soil surface either in ring or in patches resulting in the death of the plant.

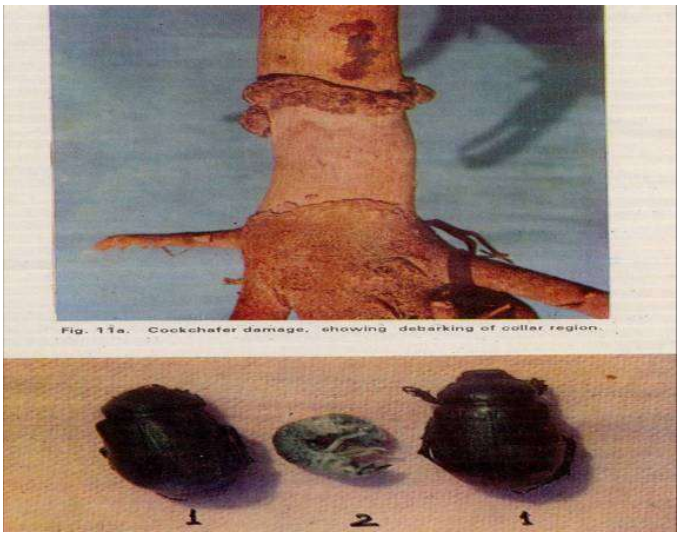


Fig. 4.11 : Cockchafer grub infestation and the grubs

Extensive callus growth develops when the bark is eaten away in girdle and the plants die. However, the damage is healed up by callus growth when the debarking is less extensive and does not completely girdle the tap root. The major part of the damage is caused during June-August.

Control measures :

- Mulching should be done away from the collar region.
- Young tea areas should be kept weed free.
- The debris and the soil around the collar of the plant should be removed and treated with Endosulfan or Chloropyrifos.
- The surface soil around the collar of each plant in the affected area should be loosened and about 250 ml of Endosulfan or Chloropyrifos solution, prepared at a dilution of 1:300 should be applied around the collar of the plants. A second application should be given within 2-3 weeks.

- Hand collection of beetles from shade trees, fencings, wooden posts should be done during March-May.
- At the time of spring planting (April-May), 250 ml of Endosulfan or Chloropyrifos solution, prepared at a dilution of 1:300 should be applied around the collar of the plants. A second application should be given during June-July.

Brown Cricket (*Brachytrypes portentosus*) : Brown cricket is one of the most destructive pests in nursery. It lives in burrows in the soil. At night, it comes out of the burrows and cuts off the leaves and tender shoots and often it drags them into the burrows in the soil. It also cuts the roots of the young plants and the nursery seedlings.



Fig. 4.12 : Brown Cricket

Control measures : Application of Endosulfan or Quinalphos @ 1:400 or Synthetic pyrethroids at 1:2000 in to the burrows after removing the soil and plugging the mouth of the burrows gives effective control. Application of sufficient plain water or waste engine oil followed by flooding with water drives the cricket out of the burrows when they can be killed.

Termites : A number of termite species are responsible for considerable damage to mature teas. Two species of termites cause damage to the tea plants. They are:

a) Live wood eating termites (*Microcerotermes sp.*) and
b) Scavenging termites (*Odontotermes sp*.)

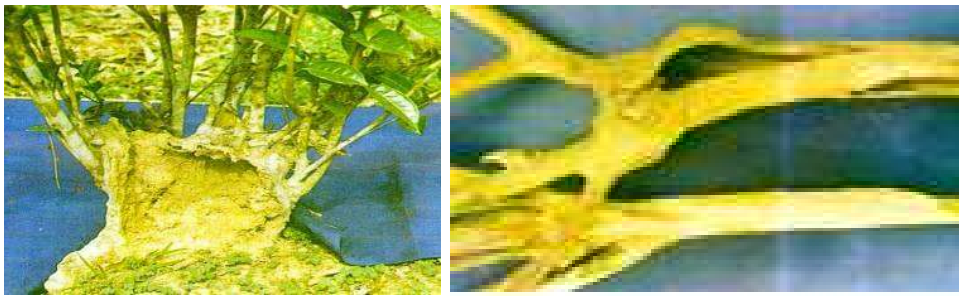


Fig. 4.13 : Termite infestation

Live wood eating termites attack the living, dead and rotting wood of the tea bushes under covered earthruns. They first attack the dead wood before going to healthy tissues. Fine channels are then excavated along the heartwood and these are progressively enlarged and eventually the stems are hollowed out leaving a thin layer of wood and the bark. The attack gradually spreads to other branches causing destruction of the frame and main stem and ultimately resulting in the death of the bush.

The scavenging termites have their nests in mounds or underground and reach their target under covered earthruns. Normally, they feed on the dead, dying and crumbly wood and rarely attack healthy wood but the removal of the dead tissues leads to further death of the adjoining healthy tissues.

Continued removal of such tissues leads to the formation of cavities and hollows in the stems and with the increasing damage the cavities and hollows are enlarged. The cavities and hollows are in due course filled up with earth carried by the termites.

Another species of scavenging termites, the mound building termites (*Odontotermes assamensis*) construct mounds of 3-4 feet high and cover considerable space and alter the physical and chemical properties of the soil. The nature of damage is similar to that of scavenging termites.

Control measures :

- The dead and dying branches of the bush should be removed and the cut ends be covered by bituminous paint or Copper oxychloride.

- During cold weather, soil around the collar region should be stirred or forked and applied with Endosulfan or Chloropyrifos at 1:300 dilutions @ 250 ml spray fluid per bush in case of young tea and 500 ml per bush in mature tea bush.
- The termite mounds should be completely destroyed by removing the honeycomb chamber, earthen cells and galleries. All the excavated mound soils must be removed from the site. After that 100 ml of Endosulfan or Chloropyrifos mixed with 2-4 buckets of water should be applied per mound.

Tea Seed Bug (*Poecilocoris latus*) : Tea seed bug is the most destructive pest in tea seed *barie* which causes premature fall of seeds or produces unviable seeds. The bug sucks the sap of the seed cotyledons as a result of which a whitish patch develops and the attacked seeds do not attain maturity and falloff. If the attack by the seed bug is in the later stage of the seed formation, the seeds shrivel up (shrink) or become cheesy, while others become rotten as a result of saprophytic fungi or weak fungal parasites.

Control measure :

- Hand collection of the bugs with the help of a bamboo pole with a small tin container fixed at its upper end may be done.
- Application of Endosulfan/Quinalphos/Dimethoate @ 1:400 during July-August (2-3 months before flowering), February-March (after pollination) and May-June should be done to control the tea seed bug.

4.4 SPRAYERS AND APPLICATION OF PESTICIDES

4.4.1 Sprayers

The job of spraying machines used for application of pesticides on the target sites is to breakdown the spray fluid into fine droplets under pressure for uniform coverage of the area

sprayed. Both hand sprayers and power sprayers are used for application of pesticides. Hand sprayers are called high volume sprayer and the power sprayers are called low volume sprayers.

The high volume sprayers (hand sprayers) need to be fitted with hollow cone nozzles which normally discharge 450 ml fluid per minute under an operating pressure of 40 psi. For efficient operation of hand sprayers continuous pumping is necessary.

The low volume sprayers or the motorized mist blowers atomize the spray fluid to extremely fine droplets. The low volume sprayers normally discharge 0.5 -2.0 liters per minute. However, a discharge rate of one liter per minute is ideal.

For application of pesticides Nozzle NMD 60450 or BAN 75450 should be used in hand operated sprayers. In case of power operated sprayer, Nozzle AMN should be used.

4.4.2 Target Site for Application

The knowledge of the target sites for different pests and method of spraying is very essential for efficient pest control. The target sites of spraying against different tea pests are given in Table 4.3.

Table 4.3 : Target of spraying for different tea pests

Pest	Target of spraying	Remark
Red spider and Purple mite	Both surface of the leaves of the whole canopy	Thorough coverage
Pink mite	Both surfaces of the leaves in the top and mid hamper of the bush	Thorough coverage
Scarlet mite	Lower surface of the leaf and stems of the whole canopy	Spray from old to young leaves

Thrips	Tender shoots, lichen and mosses, cracks and crevices of the bush frame and soil surface	Thorough spray
Jassids	Under surface of the leaves in the top and mid hamper of the bush	Thorough spray
Helopeltis	Whole canopy, weeds and soil surface	Adopt barrier spray
Lopper caterpillar	Whole bush canopy and shade tree trunk	Spray at the early stage and thorough spray
Bunch caterpillar	Mid and top hamper of the bush	Spray at the early stage and thorough spray

4.4.3 Spraying of Pesticides

The following care should be taken during spraying:

- Pesticides should be used in rotation.
- Use of conventional sprayers is preferable.
- 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.

4.5 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.

f) _____ eating termites attack the living, dead and rotting wood of the tea bushes under covered earthruns.

Q.8. State true or false :

a) Tea jassid is commonly known as 'green flies'. (True/ False)

b) Tea seed bug is the most destructive pest in tea seed *barie.* (True/False)

c) Droughty spell encourages rapid buildup of thrips population.(True/False)

d) The low volume sprayers atomize the spray fluid to extremely fine droplets.(True/False)

e) A minimum of 2 days gap between insecticide/acaricide application and plucking should be maintained.(True/ False)

f) Spraying pesticides during hot midday sun is preferred. (True/False)

g) The high volume sprayers normally discharge 0.5 -2.0 liters per minute. (True/False)



4.6 LET US SUM UP

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- Many species of insects, mites and nematodes infest tea plants and cause damage to the plant
- 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.
- 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. 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.
- Scarlet mite mostly feeds on the under surface of the leaf, particularly around the petiole. Its sucking leads to yellowing of leaves and brownish discoloration of the mid rib. Severe infestation results in premature defoliation
- 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 mites attack 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.
- 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.
- 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 and they should be controlled before the damage becomes serious.
- Both hand sprayers and power sprayers are used for application of pesticides. Hand sprayers are called high volume sprayer and the power sprayers are called low volume sprayers. The high volume sprayers (hand sprayers) need to be fitted with hollow cone nozzles which normally discharge 450 ml fluid per minute under an operating pressure of 40 psi .The low volume sprayers or the motorized mist blowers atomize the spray fluid to extremely fine droplets. The low volume sprayers normally discharge 0.5 -2.0 liters per minute.
- The knowledge of the target sites for different pests and method of spraying is very essential for efficient pest control.
- 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. 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.



4.7 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 : a) True, b) True, c) True, d) False, e) False, f) False, g) True.



4.8 FURTHER READINGS

- *Field Management in Tea*. Tea Research Association, Tocklai Experimental Station.
- *Tea Cultivation-Comprehensive Treatise*. By N.Ghosh Hajra.International Book Distributing Co., Lucknow.
- *Pests of tea in north east India and their control*. Memorandum No.27. Tocklai Experimental Station, TRA, Jorhat.



4.9 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?

UNIT 5 : TEA DISEASES AND THEIR MANAGEMENT

UNIT STRUCTURE

5.1 Learning Objectives

5.2 Introduction

5.3 Tea Diseases-Casual Agencies and Classification

- 5.3.1 Causal Agencies
- 5.3.2 Classification of Tea Diseases
- 5.3.3 Common tea Diseases

5.4 Description of Tea Diseases and their Management

- 5.4.1 Seedling Diseases
- 5.4.2 Primary Root Diseases
- 5.4.3 Secondary Root Diseases
- 5.4.4 Primary Stem Diseases
- 5.4.5 Secondary Stem Diseases
- 5.4.6 Primary Leaf Diseases
- 5.4.7 Secondary Leaf Diseases

5.5 Let Us Sum Up

5.6 Answers to Check Your Progress

5.7 Further Readings

5.8 Model Questions

5.1 LEARINING OBJECTIVES

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

- Name the causal agencies of diseases in tea plants.
- Classify the different diseases.
- Describe the symptoms of the diseases.
- Discuss the pre-disposing factors for the occurrence of the diseases.
- Describe the management practices of both the primary and secondary diseases.

5.2 INTRODUCTION

The word 'disease' signifies any abnormal, adverse changes in the plant metabolism brought about by any external agency affecting its health and production. Tea is cultivated under varying soil and climatic conditions remote from its natural habitat. Moreover, it is subjected to different cultural practices which are widely at variance with its natural conditions of growth. The cultivated tea crop is, therefore, highly susceptible to attacks by diseases.

Disease causes various harm to the tea plants ranging from significant reduction in crop yield, death of young and mature plants, poor frame-formation, great set-back in recovery from pruning, especially medium prune, to total failure of nursery.

Diseases of the tea bush are caused by various agencies. In this unit, discussion will be made on the common diseases caused by fungi and algae only which bear some commercial significance.

5.3 TEA DISEASES-CASUAL AGENCIES AND CLASSIFICATION

5.3.1 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.

5.3.2 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.

5.3.3 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 5.1 : 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*

5.4 DESCRIPTION OF TEA DISEASES AND THEIR MANAGEMENT

5.4.1 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.

5.4.2 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:



Fructification :
Production of spores by a fungus.

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.



Fumigant : A toxic chemical which is volatile at room temperature, used against soil pests and pathogens.

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 the excavated soil of the planting pit @ 200 g/pit.

5.4.3 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.

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 and Diplodia diseases occur together since their attack is favoured 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.1. What is the main agent that causes all common diseases in tea?

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Q.2. What is a primary disease?

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Q.3. Name four primary root rot diseases of the tea bushes.

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Q.4. Can we control primary root rot diseases by using chemicals? Name one such chemical method.

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Q.5. What are the predisposing factors responsible for the violet root rot disease?

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Q.6. Name one bio agent used for preventing some primary root rot diseases.

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Q.7. State true or false :

a) Damping off is a nursery disease. (True/False)

b) Red rust is a disease caused by a bacteria. (True/False)

c) Affected bushes by Violet root rot bear leathery and yellowish leaves and carry few plucking points, become unproductive and finally die. (True/False).

5.4.4 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 healthy wood.



Desnagging : Removal of all dead and diseased wood by knife after a medium ,heavy or low pruning.

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.

5.4.5 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 leaf the 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.

5.4.6 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 can produce 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 withers and 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 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.

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 pruning cycle should be followed in the disease prone areas.

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.

5.4.7 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.



CHECK YOUR PROGRESS

Q.8. Chose the correct answer :

a) Branch canker is a primary/secondary disease

b) Blister blight occurs in hot and sunny/moist and cloudy weather.

c) Black rot is a fungal /algal primary/secondary leaf/ root disease.

d) Black plucking/Standard plucking should be done when Blister blight appears in areas under plucking.

e) Black rot/Red rust is caused by two species of the genus *Corticium* namely, *invisum* and *theae* which occur at the same time.

Q.9. Name two secondary leaf diseases of tea.

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5.5 LET US SUM UP

- 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 bushes 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.
- Black root rot, Charcoal stump rot, Red root rot, Brown root rot are the primary root diseases which are serious and all these are caused by soil borne fungi.
- The primary root rot diseases do not show any apparent symptoms and once the tea bushes are infected, all infected bushes die. The diseased bushes must be uprooted along with the adjoining healthy

bushes and before replanting the area should be properly rehabilitated.

- Soil fumigation may also be adopted against the pathogens.
- Violet root rot, Diplodia and Rhizoctonia are the common secondary root diseases of tea caused by fungi.
- 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. By improving the general health and vigor of the plants through judicious cultural and manurial practices the incidence of other secondary root diseases can be reduced.
- Branch canker and die-back of primary are the common primary stem diseases of tea.
- The dead bushes attacked by branch canker should be removed. Vacancies may be infilled as soon as possible.
- 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 the management of Branch canker disease
- Red rust is a secondary stem disease caused by an alga. Being secondary disease, it 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.
- Blister blight is a primary leaf disease of tea. The fungus, *Exobasidium vexans* attacks the young succulent leaves and stems of tea under cool, misty weather with little or no sunshine.
- Black rot is another common leaf disease of tea. Spraying of copper fungicide @ 1:400 dilutions should be done in general during April-May at fortnightly interval for two rounds wetting thoroughly the undersurface of the leaves and the stems for controlling Black rot along with other cultural practices.

- 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 liters of water with a motorized power sprayer are found to be effective against Blister blight along with other cultural practices.
- Brown blight and grey blight are two common secondary fungal leaf diseases. For the 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.



5.6 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q. No. 1 : Fungi.

Ans. to Q. No. 2 : 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. 3 : Black root rot, Charcoal stump rot, Red root rot and Brown root rot

Ans. to Q. No. 4 : Yes, the fumigant. Durofume, consisting of equal parts of methyl bromide and ethylene di-bromide in the ratio of 1:1 as one soil fumigant that can be used in controlling primary root rot diseases.

Ans. to Q. No. 5 : Water logging and lack of soil aeration are the main factors.

Ans. to Q. No. 6 : *Trichoderma*

Ans. to Q. No. 7 : a) True, b) False, c) True.

Ans. to Q. No. 8 : a) primary, b)moist and cloudy weather, c) fungal,primary, leaf, d) Black plucking, e) Black rot

Ans.to Q. No. 9 : Grey blight and Brown blight.



5.7 FURTHER READINGS

- *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.



5.8 MODEL QUESTIONS

Q.1. What are the causal agencies that cause diseases in tea plant? Name the agencies.

Q.2. 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.3. Under what condition does Blister blight occur? Describe the symptoms of the disease and its control measures.

Q.4. What is a red rust disease? Describe the pre disposing factors for red rust infection. How to control Red rust?

Q.5. What are the causes of Branch canker disease? How does it affect the tea bush? Describe the control measures against branch canker.

UNIT 6 : PHYSIOLOGICAL DISORDERS IN TEA AND THE COLD WEATHER OPERATIONS

UNIT STRUCTURE

6.1 Learning Objectives

6.2 Introduction

6.3 Adverse Climatic and Soil Conditions

- 6.3.1 Drought
- 6.3.2 Waterlogging
- 6.3.3 Sun Scorch
- 6.3.4 Lightning
- 6.3.5 Hail

6.4 External Agencies

- 6.4.1 Heat Damage
- 6.4.2 Manure Injury
- 6.4.3 Callus Growth
- 6.4.4 Debility or Lack of Reserves

6.5 Cold Weather Management

- 6.5.1 Management of the Pruned Bushes
- 6.5.2 Management for Pest Control
- 6.5.3 Management of Drains
- 6.5.4 Foliar Nutrition
- 6.5.5 Other Management Practices

6.6 Let us Sum Up

6.7 Answers to Check Your Progress

6.8 Model questions

6.1 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.

6.2 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 the productivity of tea in the next season. This aspect will also be discussed in this unit.

6.3 ADVERSE CLIMATIC AND SOIL CONDITIONS

6.3.1 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.

6.3.2 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.

6.3.3 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.

6.3.4 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.

6.3.5 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.

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Q.2. What physiological disorders are brought about by drought?

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Q.3. What are the reasons for sun scorch?

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Q.4. What root disease is common in waterlogged soil?

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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)

6.4 EXTERNAL AGENCIES

6.4.1 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.

6.4.2 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.

6.4.3 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.

6.4.4 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.

6.5 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:

6.5.1 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.

6.5.2 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.

6.5.3 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.

6.5.4 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.

6.5.5 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?

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Q.7. Sometimes tea bushes completely die out for no apparent reason, following a medium pruning. What is the reason for that?

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Q.8. What cold weather practices are important for controlling the caterpillar pests?

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Q.9. How can the effects of drought be reduced by some cold weather operations?

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6.6 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.



6.7 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.



6.8 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 7 : COST FOR DEVELOPMENT OF TEA PLANTATION AND RECORD KEEPING IN A TEA GARDEN

UNIT STRUCTURE

7.1 Learning Objective

7.2 Introduction

7.3 Cost of Development of Tea Plantation

- 7.3.1 Requirement of Labour
- 7.3.2 Cost of Labour and Inputs
- 7.3.3 Income

7.4 Book Keeping

- 7.4.1 Meaning
- 7.4.2 Some Basic Terms
- 7.4.3 Good Record Keeping System
- 7.4.4 Necessity of Book Keeping
- 7.4.5 Branches of Record Keeping
- 7.4.6 Objectives of Accounting
- 7.4.7 Advantages of Accounting
- 7.4.8 Books of Account
- 7.4.9 Classification of Accounts
- 7.4.10 Rules for Debit and Credit

7.5 Information to be Maintained in a Tea Garden

7.6 Let Us Sum Up

7.7 Answers to Check Your Progress

7.8 Model Question

7.1 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.
- Explain the importance of book keeping in a tea garden.

- 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.

7.2 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.

7.3 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.

7.3.1 Requirement of Labour

The requirement of labour for developing one ha tea plantation up to fifth year is shown in Table 7.1. 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 7.1 : Estimated requirement of labour for developing one ha plantation

Sl. No.	Head	Year-wise labour requirement (mandays)					Total (Number)
		1	2	3	4	5	
1	Clearing and leveling land	125					125
2	Surveying	10					10
3	Soil/land preparation	50					50
4	Culvert/Road/Bridge etc.	60					60
5	Drainage	65					65
6	Organic matter application	30					30
7	Staking/planting / infilling @ 25 md/ 1000 plants	375	40				415
8	Planting shade trees i) Permanent -70 plants/ha	10	5				15
	ii) Temporary -280 plants/ha	20	10				30
9	Mulching @ 300 plants/md/round	150	50				200
10	Centering/recentering	15	20				35
11	Pruning/skiffing/KCO	–	–	40	10	50	100

12	Tipping/Plucking	50	200	250	360	300	1160
13	Manual weed control @ 20md/round	120	100	60	60	60	400
14	Chemical weed control @ 4md/round	–	16	16	12	12	56
15	Application of plant protection chemicals @ 4md/round	16	28	36	40	40	160
16	Fertilizers application @100kg/md	8	20	20	15	15	78
17	Foliar application of nutrients etc. @ 4md/round	8	16	16	16	16	72
18	Shade management @ 5 md/round	15	10	10	10	10	55
19	Maintenance of drain/fencing/roads/ bridge/culverts etc	–	20	15	15	15	65
20	Miscellaneous	5	10	10	10	10	45
	TOTAL MANDAYS	**1132**	**545**	**473**	**548**	**528**	**3226**
	TOTAL EXPENDITURE @ Rs. 100/manday	**1,13,200**	**54,500**	**47,300**	**54,800**	**52,800**	**3,22,600**

* Assuming the total plant population = 15,000 per ha

7.3.2 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 7.2 and the estimated non-recurring cost is given in Table 7.3.

Table 7.2 : Estimate of expenditure on materials (Recurring)

Sl. No.	Head	Year-wise expenditure (Rs.)					Total (Rs.)
		1	2	3	4	5	
1	Hiring of tractor	4000.00	–	–	–	–	4000.00
2	Pesticides/ fungicides	1800.00	3150.00	4050.00	4500.00	4500.00	18000.00
3	Herbicides	–	1500.00	1500.00	1500,00	1500.00	6000.00
4	Fertilizers	2500.00	6500.00	8000.00	9500.00	10000.00	36500.00
5	Growth regulators	–	1500.00	3000.00	3000.00	3000.00	10500.00
6	Transportation of green leaf @ 25 paise/kg	–	750.00	2000.00	2500.00	2750.00	8000.00
7	Misc.	2000.00	3000.00	5000.00	5000.00	5000.00	20000.00
	TOTAL	10300.00	16400.00	23550.00	26750.00	26750.00	103000.00

Table 7.3 : Estimate of expenditure on materials (Investment)

Sl. No.	Head	Year-wise expenditure (Rs.)					Total (Rs.)
		1	2	3	4	5	
1	Culvert/hume pipes	7,000.00	–	–	–	–	7,000.00
2	Farm tools & implements	5,000.00	–	–	–	–	5,000.00
3	Leaf house (semi pucca 10' x14')	30,000.00	–	–	–	–	30,000.00
4	Planting material (tea)- 15,000 plants						
	@ Rs. 3/- per plant	45,000.00	4,500.00	2,250.00	–	–	51,750.00
5	Shade tree saplings @ Rs. 5/- sapling	2,250.00	–	–	–	–	2,250.00

6	Organic matter	15,000.00	–	–	–	–	15,000.00
7	Mulching materials - 20-30 tones	5,000.00	–	–	–	–	5,000.00
8	Goat proof fencing 400 running m (370 kg @ Rs. 60/- per kg/ Concrete post (180 no @ Rs. 70/- per post)	34,800.00	–	–	–	–	34,800.00
	Total	1,44,050.00	4,500.00	2,250.00	–	–	1,50.800.00
	Interest @ 12.0% on investment**	17,286.00	540.00	270.00			18,096.00

**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	1,13,200.00	54,500.00	47,300.00	54,800.00	52,800.00
2	Materials					
	i) Non-recurr -ing (Interest on invest- ment @12%	17,286.00	540.00	270.00		
	ii) Recurring	10,300.00	16,400.00	23,550.00	26,000.00	26,750.00
	Total materials	27,586.00	16,940.00	23,820.00	26,000.00	26,750.00
	TOTAL (1+2)	1,40,786.00	71,440.00	71,120.00	80,800.00	79,550.00@

@ 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.15/ per kg of the green leaf has been considered. The return from one ha tea plantation is shown in Table 7.4.

Table7.4 : Gross and Net income from one ha tea plantation (in Rs.)

Particulars	Year					6 year onwards
	1	2	3	4	5	
Gross Income	–	28,125.00	67,500.00	1,01,250.00	1,38,750.00	1,87,500.00
Total cost (including plucking)	1,40,786.00	71,440.00	71,120.00	80,800.00	79,550.00	79,550.00
Net Income	(-)1,40,786.00	(-)43,315..00	(+)3,620.00	(+)20,450.00	(+)59,200.00	(+)1,07,950.00



CHECK YOUR PROGRESS

Q.1. List three operations where the labour requirements are higher.

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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?

.....

.....

7.4 BOOK KEEPING

7.4.1 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 given rise to the subject of book keeping.

Book keeping, therefore, may be defined as the art and science of recording classifying and summarizing the information in terms of money, transactions and events in a correct and systematic manner in a set of books and interpreting the results thereof.

7.4.2 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.

j) **Profit :** The excess of income over expenses is the profit.

k) **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.

v) **Accounts :**

i) **Personal account–** Account relating to individuals, firms, associations or companies.

ii) **Real account–** Accounts relating to all assets and properties.

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.

7.4.3 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 get it difficult.
- **Quickness :** Time is valuable; records should be such that to find and see any information, time wastage should not be there.
- **Complete in record :** Record should be complete otherwise it will not give the actual picture.

- **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.

7.4.4 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.

e) **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.

7.4.5 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 accounting .The name given to the system is book keeping as

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.

7.4.6 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.

7.4.7 Advantages of Accounting

- **Assistance to management :** Accounting provides such information to the management which will enable it in planning, decision making and controlling.
- **Facility in the valuation of business :** If someone wants to sell his farm, the accounts maintained by him will enable him to ascertain the proper purchase price. It helps both the buyer as well as the seller of the business.

- **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.

7.4.8 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 in the shape of accounts in a classified form. This book supplies all the necessary information regarding the working of a business.

Subsidiary Books or Books of Original Entry : The usual subsidiary records maintained in a commercial firm are :

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.

7.4.9 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:

i) Tangible e.g. Cash a/c, Building a/c, Machinery a/c etc.

ii) Intangible e.g. Goodwill, Copy Right, Trade mark etc.

7.4.10 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

7.5 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. etc.



CHECK YOUR PROGRESS

Q.4. Mention the essentials of a good record keeping system.

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Q.5. What are the objectives of accounting?

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.....

.....

Q.6. What are the two types of books of account?

.....



7.6 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 vary with the yielding ability of the plantation or the area.
- Depending upon the agro-climatic conditions, the yield of green leaf during the initial five years and on attaining the maturity varies.
- 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.
- Record keeping may be defined as the art and science of recording classifying and summarizing the information in terms of money,

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.



7.7 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.



7.8 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

d) Real Account

e) Discounts