

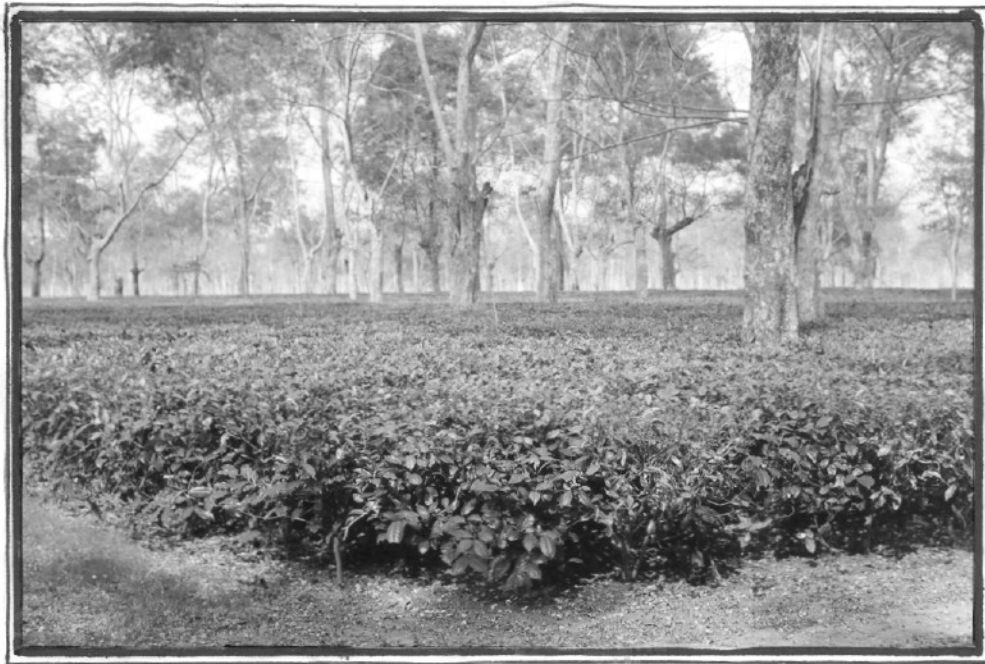


IPM PACKAGE NO. 46



# INTEGRATED PEST MANAGEMENT PACKAGE

FOR  
**TEA**



Government of India  
Ministry of Agriculture  
Department of Agriculture & Cooperation  
**Directorate of Plant Protection, Quarantine & Storage**  
N. H. IV, Faridabad - 121 001.

# IPM PACKAGE FOR TEA

## CONTENTS

Subjects	Page No.
Foreward	i
Preface	ii
Acknowledgements	iii
<b>I. Major Pests</b>	
A. Pests of National Significance	1
B. Pests of Regional Significance	1-3
<b>II. Pest Monitoring</b>	
A. Rapid Roving Survey	4
B. Pest Assessment	4
C. Traps for monitoring pests	5
D. Survey for biocontrol agents	5
E. Agro Eco System Analysis	6
F. Economic Threshold levels (ETL)	6
<b>III. Integrated Pest Management Strategies</b>	
A. Cultural Practices	7
B. Host Plant Resistance	8
C. Mechanical control	8
D. Biological control	9
E. Biocontrol using microbial agents	10
F. Use of Plant products for pest control	11
G. Use of Inorganic compounds/ hydrocarbon oils	11
H. Chemical control	11-17
<b>IV. Crop Stage-wise IPM Practices</b>	18-23
<b>V. Do's and Don'ts in Tea IPM</b>	24
<b>VI. Basic precautions in pesticides' usage</b>	25-26

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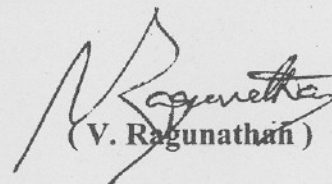
**DR.V. RAGUNATHAN**  
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**FOREWARD**

Integrated Pest management (IPM) approach has been globally accepted for achieving sustainability in agriculture. It has become more relevant due to a number of advantages like safety to environment, pesticide-free food commodities, low input based Crop Production Programme etc. Though IPM approach has been taken up since 1981, its impact has not been felt until 1994. Human Resource Development has helped to sensitise extension functionaries and farmers about the usefulness of IPM.

For successful implementation of IPM, the scattered information on various components of this eco-friendly approach forms basic necessity. In this direction, initial attempts were made in 1992 to harmonise the IPM Package of Practices of various crops. Subsequently concerted efforts were made in 1998, 2001 and 2002 to update and develop IPM package of practices for agricultural and horticultural crops. Presently, IPM package of practices for 51 crops have been finalised to help the extension workers and farmers to manage the pests/ diseases and to minimise the over use/ misuse of chemical pesticides. Efforts have been made to incorporate the relevant available technical input provided by the scientists of ICAR Institutes/ SAUs and State Departments of Agriculture. However, suggestions for further improvement in future publication/ revision will be of immense help. Hopefully, these IPM Package of Practices will be useful for the Researchers, Plant Protection Workers and Farmers alike.

April 1, 2002

  
(V. Raguathan)

## P R E F A C E

In order to minimise the indiscriminate and injudicious use of chemical pesticides, INTEGRATED PEST MANAGEMENT (IPM) has been enshrined as cardinal principle of Plant Protection in the overall Crop Protection Programme under the National Agricultural Policy of the Govt. of India. IPM is an eco-friendly approach for managing pest and disease problems encompassing available methods and techniques of pest control such as cultural, mechanical, biological and chemical in a compatible and scientific manner. The greater emphasis has been given on biological control including use of biopesticides.

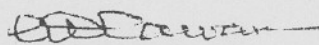
With a view to provide technical knowledge to the extension functionaries and farmers in the States, first National Workshop on IPM for harmonisation of Package of Practices was organized at National Plant Protection Training Institute (NPPTI), Hyderabad during June 29-30, 1992. Subsequently workshops were organized from April 15-17, 1998 and Nov. 5-6, 1998 at Directorate of Plant Protection, Quarantine & Storage, Faridabad and IPM package of practices for 20 crops were evolved on rice, cotton, vegetables, pulses, and oilseeds. In this series, two National Workshops on IPM have been conducted at NPPTI, Hyderabad and Dte. of PPQ&S, Faridabad during May 14-17, 2001 and Feb. 20-22, 2002 respectively to update 20 available IPM Packages and develop 31 new IPM Packages specially for Horticultural crops. In these workshops, 51 IPM Package of Practices for cereal crops (Rice, Wheat, Maize, Sorghum, Millets), commercial crops (Cotton, Sugarcane, Tobacco, Tea), pulse crops (Pigeonpea, Gram, Black gram/Green gram, Pea, Rajma), oilseeds (Groundnut, Soybean, Rapeseed/Mustard, Sesame, Safflower, Castor, Sunflower, Oilpalm), vegetables (Potato, Onion, Tomato, Brinjal, Okra, Chillies, Cruciferous vegetables, Leguminous vegetables, Cucurbitaceous vegetables), fruit crops (Citrus, Banana, Apple, Mango, Guava, Grapes, Pineapple, Sapota, Pomegranate, Litchi), spice and plantation crops (Small Cardamom, Large Cardamom, Black Pepper, Ginger, Coriander, Cumin, Fennel, Coconut, Cashew and Arecanut) have been finalised.

IPM technology manages the pest population in such a manner that economic loss is avoided and adverse side effects of chemical pesticides are minimized. The IPM packages encompasses various management strategies for containing the pest and disease problems. Pest monitoring is also one of the important component of IPM to take proper decision to manage any pest problem. It can be done through Agro-Ecosystem Analysis (AESAs), field scouting, light, pheromone, sticky/yellow pan traps. The economic threshold levels (ETL) of important pests and diseases are also given in the packages to take appropriate control measures when pest population crosses ETL.

These IPM packages developed with the technical inputs from experts from Indian Council of Agriculture Research, State Agricultural Universities, Central Directorate of Plant Protection, Pesticide Industries and State Departments of Agriculture/Horticulture will provide technical backup in the management of pests, diseases, weeds, nematodes and rodents in the Indian Agriculture and Horticulture. These will also be useful in reducing the pesticide residues in exportable agricultural commodities and would also help in the management of pests/diseases/weeds/nematodes which may get inadvertently introduced in the country.

IPM Package of Practices for Agricultural and Horticultural crops will be helpful to minimize the ill effects of chemical pesticides to promote the IPM for sustainable production. These packages will be useful for the researchers, extension workers and farmers alike who are engaged in the agricultural practices.

April 1, 2002

  
(A.D. Pawar)  
Director (IPM)

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# IPM PACKAGE FOR TEA

## I. MAJOR PESTS:

### A. Pests of National Significance

#### 1.0 Insect Pests

1.1 Tea Mosquito Bug (*Helopeltis theivora*)

1.2 Thrips (*Scirtothrips* Spp.)

#### 2.0 Acarine Pests

2.1 Red spider mites (*Oligonychus coffeae*)

#### 3.0 Diseases

3.1 Brown root rot (*Fomes lamaensis*)

3.2 Blister blight (*Exobasidium vexans*)

#### 4.0 Weeds

##### Monocots

4.1 *Cynodon dactylon*

4.2 *Paspalum conjugatum*

##### Dicots

4.3 *Ageratum conyzoides*

4.4 *Polygonum chinense*

### B. Pests of Regional Significance

S. No.	Insect Pests	Distribution
1.	<b>Major insect pests:</b>	
1.1	Greenfly ( <i>Empoasca flavescens</i> )	Assam (Cachar, Jorhat) & W.B. (Darjeeling, Dooars)
1.2	Looper caterpillar ( <i>Buzura suppressaria</i> )	Upper Assam, North bank, Eastern Dooars & Cachar Tamil Nadu & Kerala
1.3	Bunch caterpillar ( <i>Andraca bipunctata</i> )	Assam (Cachar, Jorhat) & W.B. (Darjeeling, Dooars)

1.4	Red slug caterpillar ( <i>Eterusia magnifica</i> )	Assam & Darjeeling Tamil Nadu (Nilgiris) & Kerala (Idukki Dist)
1.5	Shot hole borer ( <i>Euwallacea fornicatus</i> )	Tamil Nadu (Anamallais and Gudalur) Kerala (Idukki Dist)

#### Minor insect pests:

1.6	Flushworm ( <i>Cydia leucostoma</i> )	Assam & W.B. (Darjeeling) Utthanchal (Dehradun), Tripura, Tamil Nadu, Kerala & Karnataka
1.7	Leaf roller ( <i>Caloptilia theivora</i> )	Assam & W.B. (Darjeeling), Utthanchal (Dehradun), Tripura, Tamil Nadu, Kerala & Karnataka.
1.8	Tea tortrix ( <i>Homona cofferia</i> )	Assam & W.B. (Darjeeling), Utthanchal (Dehra Dun), Tripura Tamil Nadu, Kerala & Karnataka
1.9	Cut worm ( <i>Spodoptera litura</i> )	Assam & W.B. (Darjeeling), Utthanchal (Dehra Dun), Tripura Tamil Nadu & Kerala
1.10	Faggot worm ( <i>Eumeta cramari</i> )	Assam, Kerala (Vandiperiyar & Wynaad) & Tamil Nadu
1.11	Aphids ( <i>Toxoptera aurantii</i> )	Assam & W.B. (Darjeeling), Himachal Pradesh, Tamil Nadu, Kerala & Karnataka
1.12	Shoot mealy bug ( <i>Nipaecoccus viridis</i> )	Tamil Nadu & Kerala
1.13	Scales ( <i>Saissetia formicarii</i> ) ( <i>Eriochiton theae</i> ) ( <i>Saissetia coffeae</i> )	Assam W.B. (Darjeeling) Tamil Nadu & Kerala
1.14	Nettle grub ( <i>Thosea Spp.</i> )	Assam, Tamil Nadu & Kerala
1.15	Cockchafer grub ( <i>Holotrichia sp.</i> )	Assam (Cachar, Jorhat), W.B. (Darjeeling, Dooars), Terai Tamil Nadu & Kerala
1.16	Termites ( <i>Microcerotermes sp.</i> )	Assam (Cachar), Tripura

#### 2. Acarine pests:

2.1	Pink Mite ( <i>Acaphylla theae</i> )	Assam, W.B. (Darjeeling), Tamil Nadu, Kerala & Karnataka
2.2	Purple mite ( <i>Calacarus carinatus</i> )	Assam, W.B. (Darjeeling), Tamil Nadu, Kerala & Karnataka

#### Minor insect pests:

2.3	Scarlet Mite ( <i>Brevipalpus Spp.</i> )	Assam, W.B. (Darjeeling), Tamil Nadu, Kerala & Karnataka
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- |     |   |   |
|-----|---|---|
| 2.4 | Yellow Mite<br>( <i>Polyphagotarsonemus latus</i> ) | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 2.5 | Root Knot Nematode<br>( <i>Meloidogyne Spp.</i> )   | Assam (Cachar), Tamil Nadu (Anamallais &<br>Gudalur) Kerala |

### 3. Diseases:

- |     |  |   |
|-----|--|---|
| 3.1 | Grey blight<br>( <i>Pestalotiopsis Spp.</i> )        | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 3.2 | Red rust<br>( <i>Cephaleuros parasiticus</i> )       | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 3.3 | Collar & Branch canker<br>( <i>Phomopsis theae</i> ) | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 3.4 | Red root rot<br>( <i>Poria Spp.</i> )                | Assam, Darjeeling, Tamil Nadu, Kerala &<br>Karnataka        |
| 3.5 | Brown root rot<br>( <i>Phellinus Spp.</i> )          | Assam, Darjeeling, Tamil Nadu, Kerala &<br>Karnataka        |

### 4. Weeds:

#### Monocots:

- |     |                            |   |
|-----|----------------------------|---|
| 4.1 | <i>Axonopus compressus</i> | Assam, W.B. (Darjeeling), Tamil<br>Nadu, Kerala & Karnataka |
| 4.2 | <i>Eleusine indica</i>     | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 4.3 | <i>Imperata cylindrica</i> | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 4.4 | <i>Panicum repens</i>      | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |

#### Dicots:

- |      |                                    |   |
|------|------------------------------------|---|
| 4.5  | <i>Ageratum conyzoides</i>         | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 4.6  | <i>Eupatorium odoratum</i>         | Assam, W.B. (Darjeeling),<br>Tamil Nadu, Kerala & Karnataka |
| 4.7  | <i>Micania cordata</i>             | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 4.8  | <i>Mimosa pudica</i>               | Assam, W.B. (Darjeeling), Tamil Nadu,<br>Kerala & Karnataka |
| 4.9  | <i>Borreria Spp.</i>               | Tamil Nadu, Kerala & Karnataka                              |
| 4.10 | <i>Crassocephalum crepidioides</i> | Tamil Nadu, Kerala & Karnataka                              |
| 4.11 | <i>Conyza ambigua</i>              | Tamil Nadu, Kerala & Karnataka                              |



## II. PEST MONITORING:

### A. Survey/Field scouting:

Periodical survey at every ten days interval (depending upon pest/disease population). Observe at each area 100 plant at random. Record incidence of pest/disease/weed. Record population potential of different biocontrol fauna.

### B. Pest assessment:

The density of pest population in each area has to be assessed regularly during the pest season to start appropriate control measures in time. Method of assessment for important pests are discussed here.

**Thrips :** Thrips population will have to be assessed at periodic interval by collecting 100 shoots at random from each area and counting the number of adult and larval thrips. Attention may be paid to collect the shoots from the plucking table, below the plucking table and also from side branches.

**Tea mosquito bug :** The percentage of infestation has to be assessed by collecting 100 shoots from pluckers' basket and counting the infested shoots.

**Caterpillar pests :** Flushworm /leaf roller/ tea tortrix population has to be assessed by counting the number of infested shoots from bushes selected at random from that particular area.

**Red spider mites :** One hundred leaves may be sampled from different areas of the particular field and the number of infested leaves may be counted to find out percentage of infestation level.

**Eriophyid mites :** Pink & purple mite populations have to be assessed at periodical interval by collecting 100 leaves from 100 bushes selected at random from each area. From each leaf, pink & purple mites have to be counted with the help of hand lens.

**Shoot hole borer** : To assess the extent of SHB infestation in individual tea field, the fields has to be divided into 2 ha blocks and from each block one hundred stem cuttings are to be taken at random. Attention may be paid to collect stem of 1-1.5 cm dia and 20 cm long.

**Blister blight** : To assess the blister blight disease incidence, one hundred shoots of the same age (three leaves and a bud) and of uniform size have to be collected randomly from the harvest during every plucking interval. The collected shoots have to be examined for various stages of blister lesions. A shoot have to be counted as infected even if a single lesion was noticed. The disease incidence can be quantified on percentage basis.

**C. Traps for monitoring pests:**

- i) Yellow pan traps/sticky traps are used in tea gardens to monitor the population of thrips and aphids etc. @ 10 traps/ha.
- ii) Pheromone traps are used to monitor make moths of leaf roller *Caloptilia theivora* and *Spodopetera litura* @ 5 traps/ha. Install five traps with lures for each pests; keeping the distance of five meters between the traps. Traps should be installed in the field in such a way that the position of lure is always 6-12" above the crop canopy. Replace the lures once in 15 to 25 days depending upon the weather conditions. Economic Threshold Level of *S. Litura* is 8 to 10 moths per day per traps.

**D. Survey for biocontrol agents:**

So far, more than 80 species of parasitoids and 90 species of predators of insect pests of tea occurring in India have been reported. Periodical survey is conducted to record parasitoids, predators and entomopathogenic fungi, bacteria and viruses of tea pests. The objective is to locate the important parasitoids/predators/entomopathogens of that particular region.

### **E. Agro Eco System Analysis (AESA)**

It is an approach, which can be employed by extension officers/field officers and supervisors to analyze field situations with regard to pests, defenders, soil conditions, plant health, the influence of weather factors and their interrelationship for growing healthy crop. Such a critical analysis of the field situations will help in taking appropriate decision on management practices. The basis components of AESA are :-

1. Plant health
2. Built-in compensation abilities of the plants
3. Pest and defender population dynamics
4. Soil conditions
5. Weather factors
6. Past experience

The details of the AESA are given in Annexure-I.

### **F. Economic Threshold Levels (ETL):**

Based on extensive studies on crop loss due to pests, the ETL for important pests were worked out as under:

<b>Pests/disease</b>	<b>Economic Threshold Levels (ETLs)</b>
Tea Mosquito Bug	5% infestation
Thrips	three thrips per shoot
Shoot hole borer	15% infestation
Flushworms, Leaf rollers & tea tortrix	5 infested rolls per bush
Red spider mites	50% infested leaves
Pink & Purple mites	5 mites per leaf
Blister blight	35% infection.

### III. INTEGRATED PEST MANAGEMENT STRATEGIES

#### A. Cultural practices

Certain routine cultural operations such as plucking, pruning, shade regulation and weed control can be manipulated to reduce the incidence of pests and the intensity of their attack.

##### 1. Plucking

Populations of leaf folding caterpillars such as flushworms, leaf roller and tea tortrix can be reduced by their removal while plucking. Areas which would be severely infested by tea mosquito bug could be earmarked and black plucked to retard the growth of its population.

##### 2. Pruning/Skiffing

When an attack by *Helopeltis* becomes unmanageable the affected bushes may be skiffed to reduce the damage. Medium prune (60-70 cm) is best suited for shot-hole borer infested fields (except when other factors demand a different height of pruning). Longer pruning cycles will tend to increase the intensity of borer damage, especially in mid and low elevation areas.

##### 3. Shade regulation

Unshaded areas are more prone to the attack of thrips and mites. The recommendations on shade management, if adopted, will help to prevent the excessive build up of thrips and mites.

##### 4. Field sanitation

Weeds like *Mikania cordata*, *Bidens biternata*, *Emillia* sp., *Polygonum chinese* and *Lanatana camara* offer excellent hiding places and serve as alternate host for the tea mosquito bug. Growth of weeds and wild host plants near in and around tea fields may be controlled and this will help to reduce the growth of tea mosquito bug population.

##### 5. Fertilizer application

Application of higher levels of potassium fertilizers is known to reduce the incidence of pests and disease in several crops. Application of higher levels of potassium fertiliser (N : K<sub>2</sub>O = 1: 2) in the pruned year helps to decrease the incidence of shot-hole borer in the infested fields.

## **B. Host plant resistance**

Use of pest resistant varieties is one of the important components of non chemical pest management programme. Even low levels of resistance are important since the need for other control methods can be reduced. Being a perennial crop, research on clonal selection and breeding is primarily aimed at the production of high yielding and superior quality plants.

1. The Chineric varieties are more susceptible to the attack of red spider and scarlet mites while the Assam varieties are favoured by eriophyid mites.
2. Incidence of tea mosquito bug is more on China Jats and TV-1 is highly susceptible to this pest. Flushworm incidence is more on the clone UPASI-17, considered "Combod" in nature.
3. Soft wooded tea plants are easily damaged by termites.
4. Similarly, clones with high alpha spinasterol content are susceptible to damage by shot hole borer. Certain Sri lankan selections like TRI 2024 and TRI 2025 which are popular in S. India should be avoided in shot hole borer prone areas.

## **C. Physical/Mechanical control**

### **1. Manual removal**

Populations of foliage feeding caterpillars such as looper, bunch caterpillar, faggot worm flushworm, leaf roller and tea tortrix can be reduced to great extent by manual removal of larvae and pupae. The tea mosquito bug lay large number of eggs on the broken ends of plucked shoots. Intensive manual removal of stalks during plucking will help to reduce the incidence of tea mosquito bug.

### **2. Heat treatment**

Soil used in the nursery may be heated to 60-62°C for killing the infective juveniles. Mixture of sand and soil is spread on galvanised iron sheets to a thickness of 4-5 cm and heated from below. While heating, a little water is sprinkled now and then and the soil mixed thoroughly, by constant turning which is required for killing nematodes. Care is to be taken that the soil is not over heated since this will lead to phytotoxicity.

### 3. Use of light traps

Fluorescent light traps are useful in attracting the moths and other insects. They can be set up during the moths/beetles emergence season and the attracted moths/beetles can be killed mechanically or by using insecticides. These traps are useful for monitoring the activity of the pests and also as a tool in its suppression.

### 4. Trenching

Insulation of diseased patches by making trenches of 120 cm (4 feet) deep and 45 cm (1.5 feet) width surrounding the root of diseased plants help in preventing the spread of primary root diseases. When such isolation trenches are dug the solid from the trench should be thrown in the perimeter and not broadcast outside the trench.

### D. Biological control:

More than one hundred and seventy species of predatory and parasitic insects and mites have been reported from the tea estates of India. Efforts towards the conservation and augmentation of natural enemies in the tea eco-system offer significant advances in biological control programme of tea.

#### 1. Mites:

Phytophagous mites infesting tea are mainly preyed upon by several mites, mostly belonging to Phytoseiidae and Tydeidae. *Amblyseius herbicolus* and *Euseius ovalis* are the two common phytoseiids feeding on the eriophyids, *Acaphylla theae* and *Calacarus carinatus*. The stigmaeid, *Agistemus fleschneri* is an important predator of eggs and nymphs of *Oligonychus coffeae* in north east India.

Coccinellids are probably the second largest group of predators of phytophagous mites. *Cryptogonus bimaculatus*, *Jauravia quadrinotata*, *J. soror*, *J. opaca*, *Menochilus sexmaculatus* and *Stethorus gilvifrons* are the common species of coccinellids in tea fields.

#### 2. Thrips:

Anthocorids especially, *Anthocoris* and *Orius* spp. and the predatory thrips *Aeolothrips intermedius* and *Mymarothrips garuda* are the important predators of thrips. Recently a neuropteran predator, *Chrysoperla carnea* was found to feed on thrips and tea mosquito bugs in the field release @ 500-1000 adults/ha for the control of these pests.

### 3. Scale insects and mealy bugs:

Scale insects and mealy bugs are subjected to the attack of several parasitoids. *Coccophagus cowperi* and *Encyrtus infelix* heavily parasitise *Saissetia coffeae*. The black scale *Chrysomphalus ficus* is attacked by six parasitoids and predators.

### 4. Caterpillar pests:

Populations of leaf folding caterpillars are controlled by many natural enemies. *Cydia leucostoma* in south India is parasitised by nine species of braconids, two ichneumonids and one encyrtid in addition to a pupal parasitoid belonging to *Ascogaster*. Among the larval parasitoids, *Apanteles aristaeus* is the most common species and a highly significant correlation exists between the population density of flushworms and percentage parasitism by this species.

The leaf roller, *Caloptilia theivora* is heavily parasitised by the eulophid, *Sympiesis dolichogaster*. The incidence of parasitism varied between 20 and 83 percent. This eulophid is playing a significant role in the suppression of leaf roller population.

The tea tortrix *Homona coffearia* is affected by one egg, nine larval and four pupal parasitoids. The ichneumonid larval parasitoid *Phytodietus spinipes* plays a significant role in the population regulation of this tortricid.

*Apanteles fabiae* and *A. taprobanae* parasitise the looper caterpillar, *Buzura suppressaria*. Recently another braconid, *Cotesia ruficrus* was recorded on looper. Tachinid, *Cylindromyia* sp. is the chief larval parasitoid of *Andraca bipunctata*, the bunch caterpillar in Assam.

### 5. Tea mosquito bug:

The eggs of tea mosquito bug are parasitised by a mymarid, *Erythmelus helopeltidis* Ghan. The incidence of parasitism in the field varied between 52 and 83 %. The neuropteran predator, *Chrysoperla carnea* was found to feed on tea mosquito bugs in the field. This predator was reared in the lab and released in the field at the rate of 500-1000 adults/ha for the effective control this pest in north-east India.

### E. Biocontrol using microbial agents:

Several microbes are pathogenic to tea pests. Formulations of the bacterial insecticide, *Bacillus thuringiensis* have been effectively used for the control of looper caterpillars, cutworms, flushworms and other lepidopterous pests. A local strain of *Beauveria bassiana* has been found effective against the shot hole borer.

Certain commercial formulations of the entomopathogenic fungus, *Verticillium lecanii*, *Paecilomyces fumosoroseus* and *Hirsutella thompsonii* were evaluated and found effective against pink, purple and red spider mites. These formulations are recommended for the control of mites. Use of *B.bassiana* @ 1kg/ha is recommended in north-east India for the control of tea mosquito bugs.

#### **F. Use of plant products for pest control:**

Insecticides derived from plants are used for tea pest control. Azadirachtin, a triterpenoid, obtained from the seed kernels of the neem tree, *Azadirachta indica* have been found effective against pink and purple mites and caterpillars. Formulations containing azadirachtin and their combination with synthetic insecticides are recommended for pest control in tea.

#### **G. Use of Inorganic compounds/ hydrocarbon oils:**

Formulations of sulphur and lime sulphur are effective against mites. Recently, spray oil from paraffinic base has been found effective against eriophyid and red spider mites. Since this oil does not leave any residues in tea, it could be incorporated in to the mite control programme in tea.

Copper oxychloride (COC) is widely used in tea in combination with triazole fungicides for the control of leaf disease of tea.

#### **H. Chemical control:**

Need based, judicious and safe application of pesticides are the most vital part in chemical control measures under IPM strategy. It involves developing IPM skills to play safe with environment by proper crop health monitoring, observing ETL and conserving natural biocontrol potential before deciding in favour of use of chemical pesticides as a last resort. Therefore, it is necessary to rely upon pesticides as per the list in Appendix I.



**A. INSECT PEST MANAGEMENT**

**1. Tea mosquito bug**

In southern India, chemicals like endosulfan 35 EC @ 1000 ml/ha; quinalphos 25 EC @ 750 ml/ha; chlorpyrifos 20 EC @ 750 ml/ha; fenthion 80 EC @ 200 ml/ha; endosulfan 35 EC + dichlorvos 76 EC @ 1000+350 ml/ha and quinalphos 25 EC + dichlorvos 76 EC @ 750+250 ml/ha are recommended. Whereas in north east India, metasystox 25 EC @ 1:400; cartap hydrochloride 50 SP @ 1:1000; ethofenprox 10 EC @ 1:1000 and alphasmethrin 10 EC @ 1:4000 are used.

**2. Thrips**

Chlorpyrifos 20 EC @ 750 ml/ha; Quinalphos 25 EC @ 750 ml/ha; Fenthion 80 EC @ 200 ml/ha; Diazinon 20 EC @ 750 ml/ha; Dimethoate 20 EC @ 500 ml/ha; Endosulfan 35 EC @ 1000 ml/ha; Quinalphos 25 EC + Dichlorvos 76 EC @ 750+250 ml/ha; Endosulfan 35 EC + Dichlorvos 76 EC @ 1000+350 ml/ha; Ethion 50 EC + Quinalphos 25 EC @ 500 +350 ml/ha.

**3. Shot hole borer**

In the pruned year as well as in the second year, bushes will be comparatively free from borer infestation. An increase in the infestation is seen by the end of the second year after pruning. If the percentage of infestation is at or above 15 %, it is necessary to adopt mid cycle control measures. Insecticides are to be applied in April, May, October and December, till the field is pruned. The Chemicals recommended are given below.

Fenvalerate 20 EC @ 500 ml/ha; Deltamethrin 2.8 EC @ 500 ml/ha; Cypermethrin 25 EC @ 250 ml/ha; Cypermethrin 10 EC @ 625 ml/ha; Quinalphos 25 EC @ 750 ml + Dichlorvos 76 EC @ 250 ml/ha; Chlorpyrifos 20 EC @ 1000 ml/ha

**4. Looper caterpillar**

In southern India, the chemicals which are recommended for the control of looper are fenvalerate 20 EC @ 180 ml/ha; deltamethrin 2.8 EC @ 180 ml/ha; cypermethrin 25 EC @ 120 ml/ha; Cypermethrin 10 EC @ 250 ml/ha; Chlorpyrifos 20 EC @ 500 ml/ha; Quinalphos 25 EC @ 500 ml/ha and Endosulfan 35 EC @ 750 ml/ha. Whereas in north east India, cartap hydrochloride 50 SP @ 1:1000 and ethofenprox 10 EC @ 1:1000 are recommended in addition to the above mentioned chemicals.

### 5. Bunch caterpillar

Endosulfan 35 EC @ 750 ml/ha; Quinalphos 25 EC @ 500 ml/hl; Fenitrothion 50 EC @ 1000 ml/ha.

### 6. Green fly (Jassid)

Endosulfan 35 EC @ 750 ml/ha; Quinalphos 25 EC @ 500 ml/ha; Malathion 50 EC @ 1000 ml/ha.

### 7. Red spider mites

Ethion 50 EC @ 750 ml/ha; Fenpropathrin 10 EC @ 500 ml/ha; Wettable sulphur 80% @ 1 kg/ha; Quinalphos 25 EC @ 750 ml/ha; Dicofol 18.5 EC @ 1000 ml; Ethion + Dicofol @ 500+500 ml; Dicofol + Quinalphos @ 500+350 ml/ha;

### 8. Eriophyid mites

1. dicofol 18.5 EC @ 1000 ml/ha; 2. Ethion 50 EC @ 750 ml/ha; 3. Wettable Sulphur 80% WP @ 1000 ml/ha; 4. Neem formulation 0.03-0.15 % Aza @ 1000 ml/ha; or Neem formulation 1% Aza @ 200-400 ml/ha or Neem formulation 5% Aza @ 100-200 ml/ha.

### 9. Caterpillars/ mealy bug/bettle grub/aphids/ scale insects

Fenvalerate 20 EC @ 180 ml/ha; Deltamethrin 2.8 EC @ 180 ml/ha; Cypermethrin 25 EC @ 120 ml/ha; Cypermethrin 10 EC @ 250 ml/ha; Chlorpyrifos 20 EC @ 500 ml/ha; Quinalphos 25 EC @ 500 ml/ha; Endosulfan 35 EC @ 750 ml/ha.

### 10. Cockchafer grub

Soil application of endosulfan 35 EC @750 ml/ha Soil around each bush may be treated with 1 litre of the spray fluid. Application may preferably be carried out with a soil injector to achieve good control; If this type of application is not possible. soil around the plant may be loosened and one litre of the diluted chemical applied using knapsck sprayer after removing the nozzle. Application has to be repeated after one month.

While taking up insecticide application, few rows of non-infested bushes at the periphery of the infested areas may be covered as a precautionary measure. Organic manure/compost should be thoroughly examined for eggs or grubs/ larvae or pupae of cockchafer beetles before applying in the field.

## 11. Termites

Termites can be controlled by spraying with endosulfan 35 EC or chlorpyrifos 20 EC @ 20 ml in 10 litres of water or imidacloprid 200 SL @ 4 ml in 10 litres of water.

## 12. Root knot nematodes

Application of granular nematicides such as aldicarb 10 G or carbofuran 3 G or phorate 10 G @ 2.5 g/plant for young plants and 5g/plant for older plants is effective for management of eelworms. Recent findings revealed that application of a broad spectrum soil sterilant, basamid G @ 40 g/sq.m. soil was very effective against eelworm.

For the control of mature eelworm in mature tea, apply carbofuran @ 25 g/bush immediately after pruning and repeat the application after three months.

### B. Disease Management:

1. **Blister blight** : This disease will be effectively controlled by adopting the following spray schedule.

Schedule	Dosage per hectare	Spray interval (days)
<b>Fields under plucking</b>		
Copper oxychloride + Nickel chloride	210 g each with 0.05% Triton AE	5
Contaf or Controll + Copper oxychloride	200 ml + 210 g with 0.05 % Triton AE	7
Baycor + Copper oxychloride	100 g + 210 g with 0.05 % Triton AE	7-10
Tilt + Copper oxychloride	125 ml + 210 g with 0.05 % Triton AE	7-10
<b>Fields recovering from pruning</b>		
Copper oxychloride +Safnik	350 g + 350/700 ml with 0.05 % Triton AE	3
Contaf or Controll + Copper oxychloride	200 ml + 210 g with 0.05 % Triton AE	5
Tilt + Copper oxychloride	125 ml + 210 g with 0.05 % Triton AE	5

### 2. Brown and Gray blights

The brown and gray blights may be controlled by spraying dithane M45 / captan or Carbendazim - 30g / 5g in 10 litres of water

3. **Stem diseases:** Affected portions could be removed during rejuvenation and apply COC in linseed oil on pruning cuts. Apply tar coal & sand (1:9) at the holes at the time of pruning.

#### 4. **Root diseases**

Remove surface mulching around the stem and collar. Drench the soil with Diathane M-45 / captan-30 g in 10 litres of water and also avoid soil rehabilitation.

### **Trenching**

Insulation of diseased patches by making trenches of 120 cm deep and 45 cm width surrounding the diseased plants help in preventing the spread of primary root diseases. When such isolation trenches are dug the soil from the trench should be thrown in the perimeter and not broadcast outside the trench.

### **C. Weed Management Practices:**

#### **a. Weed management in nursery.**

##### Cultural /Physical/mechanical

1. Collect top soil from relatively weed free area.
2. Spot hand weeding on grown up seeding.
3. Remove all the undecomposed crop residues from the proposed nursery.

##### Chemical Herbicides

1. Pre-emergent herbicides should not be used on seed nursery.
2. Periphery drains of the nursery may be sprayed with herbicide.
3. Apply simazine 1.5 kg or oxyfluorfen 0.5 liter in 200 liter of water on bed or sleeves where cuttings will be propagated after 3-4 weeks.

#### **b. Weed Management in young tea:**

##### Cultural/Physical/Mechanical

1. Keep the collar region weed free by hand weeding.
2. Remove obnoxious grasses, rhizomes, creepers, colocassia, fern etc. from the section.
3. Mulching on clean ground of newly planted tea.
4. Replenish mulch where necessary.

5. Control weeds by spot sickling and light cheeling.
6. Sickle the area 15 days before spraying of herbicides.

Chemical:

1. Hand clean the collar region and other area, apply 2,4-d@ 1.5 kg in 500 Ltr. of water/ha.
2. Apply 3 L Glyphosate in 600 L of water for grass weeds.
3. Apply 2,4-D 1.25 kg + Glyphosate 3 L in 600 L of water/ha for mixed types of weeds.

**c. Weed Management in mature tea:**

Cultural/Physical/Mechanical:

1. Cheel where weeds prevails, remove ferns, colocassia, mikaniaa, creeper etc.
2. Light hoeing, forking as per need in heavy soil/old section
3. Spread cheeled materials uniformly over the ground.
4. Cheel the area where chemical weed control is not advocated.
5. Sickle in slopy area.
6. Sickle the area 15 days before spraying any herbicide.

Chemical:

1. Apply 2,4-D 1.5 kg + Glyphosate 3 L in 600 L of water/ha when mixed types of weeds prevail.
2. Apply Paraquat 2 kg in 500 L of water/ha.

**Spray equipment :** Hand operated Knapsack sprayers fitted with SRW spraying lance which has a pressure regulator cum trigger cut off with stainer (TCR) is recommended. The pressure should be regulated to  $1.06 \text{ kg/cm}^2$  (15 psi) in the case of blanket application.

**Spray volume :** The spray volume requirement varies depending upon the intensity of weeds and vacancy percentage of the field. Generally 450 litres of spray volume / ha may be required for blanket application, whereas for spot application the spray volume requirement may range from 100 to 200 litres / ha.

**Nozzles :** For chemical weed control three types of nozzles are recommended. WFN 0.040 is recommended for blanket application while WFN 0.024 nozzle should be used

for spot application. VLV-50 nozzle may be used both for blanket as well as spot application.

#### **D. Rodent Management:**

Tea bushes are generally damaged by making burrows in the field and eating away the roots. Rats (*Rattus sp*) & bandicoots (*Bandicota sp.*) gnaw the roots and the stem situated below the ground.

Working Index - 25 live burrows/ha

Management Practices:

Destroy rodent burrows and trim the bunds to avoid harbourage of rodents.

Rodenticide :

Bromadiolone 0.005% @ 10-15 gms per burrows to be placed inside the living burrows.

#### IV. STAGE-WISE IPM PRACTICES TO BE ADOPTED

Crop stage / pest & diseases	IPM practices	Activities
<b>1. Nursery plants:</b>		
Aphids	Cultural practice	Hand removal of infested shoots
	Biological control	Allow predators to build up If pest persists spray neem formulation
Flushworm,	Cultural practice	Hand removal of infested shoots & pupae
Leaf roller & tea tortrix	Chemical practice	If pest persists spray recommended insecticide
	Biological control	Allow natural enemies to build up If pest persists spray neem formulation
Eelworm	Mechanical practice	Heat treatment of the soil at 60 - 65°C
	Chemical practice	Apply recommended chemicals to the soil
<b>2. Young tea</b>		
Aphids	Cultural practice	Hand removal of infested shoots
	Biological control	Allow predators to build up If pest persists spray neem formulation
Flushworm,	Cultural practice	Hand removal of infested shoots & pupae
Leaf roller & tea tortrix	Chemical practice	If pest persists spray recommended insecticide
	Biological control	Allow natural enemies to build up

		If pest persists spray neem Formulation.
Shot hole borer	Cultural practice	Avoid planting susceptible clones in the shot hole borer prone areas
	Biological control	Spray entomogenous fungus, <i>B. bassiana</i>
	Chemical practice	Spray recommended insecticide.
<b>3. Mature tea</b>		
Tea Mosquito Bug	Monitoring	Regular field assessment
	Cultural practice	Black plucking , weed control Hand removal of egg laid stalks while plucking
	Chemical practice	Spraying in the early morning or evening hours with the recommended pesticides
Thrips	Monitoring	Use yellow pan water trap Regular field assessment
	Cultural practice	Shade regulation
	Chemical practice	Spray recommended pesticide and drench the shoots in the plucking table, below the plucking table and also side branches.
Greenfly (Jassid)	Monitoring	Regular field assessment
	Cultural practice	Hand removal of eggs & nymphs while plucking
	Biological control	Spray entomogenous fungus <i>B. bassiana</i>
	Chemical practice	Spraying with recommended insecticides.



Looper caterpillar	Cultural practice	Hand removal of larvae & pupae
	Biological control	Allowing natural enemies to build up
	Chemical practice	Application recommended insecticides
Bunch caterpillar	Cultural practice	Hand collection of larvae & pupae Light trap collection of moths
	Biological control	Allowing natural enemies to build up
	Chemical practice	Spraying of recommended insecticides
Red slug caterpillar	Cultural practice	Hand removal of larvae & pupae
	Biological control	Allowing natural enemies to build up
	Chemical practice	Application recommended insecticides
Shot hole borer	Monitoring	Assessment of SHB infestation level at the end of second year or beginning of third year using the standard sampling method.
	Cultural practice	Medium type of pruning Application of higher levels of potassium fertiliser (N : K <sub>2</sub> O = 1: 2) in the pruned year.
	Biological practice	Spraying of wettable powder formulation of <i>Beauveria bassiana</i> during May end and October Insecticide spraying - April & December ; <i>Beauveria</i> spraying - May & October)
	Chemical practice	Post prune spraying with any one of the recommended insecticides. Mid-cycle chemical control measures in the third and fourth years if the average percentage of infestation in the new wood is at or above 15%.

		Four rounds of recommended insecticide spraying during April, May, October and December.
Red spider, pink & purple mites	Monitoring Cultural practice Biological control  Chemical practice	Regular field assessment Shade regulation Drench the foliage with spore suspension of entomopathogens ( <i>Verticillium lecanii</i> ) Drench the foliage with the recommended acaricides
Aphids	Monitoring Cultural practice Biological control	Regular field assessment Hand removal of infested shoots Allow ing predators to build up If pest persists spray neem formulation
Flushworm,	Monitoring Cultural practice	Regular field assessment Hand removal of infested shoots/larvae/ pupae
Leaf roller & tea tortrix	Biological control	Allow natural enemies to build up If pest persists spray neem formulation
Termites	Cultural practice Chemical practice	Removal of affected portion Application of organochlorine chemicals
Eelworm	Chemical practice	Application of systemic granular fumigants

### Diseases Management:

Blister blight	Monitoring	Use spore trap/Regular field assessment
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Cultural Practice

Hand removal of infested leaves. Maintain the plucking interval Pruning during November/December is effective to reduce the disease incidence for new clearing. Avoid broad leaved Assam jats (Assam is more susceptible than China and Cambod).

Chemical practice

Drench the foliage with the recommended fungicides

Collar canker & Thorny stem blight Cultural practice

Remove the affected portion during rejuvenation.

Avoid intensive harvesting using flat shears.

Maintain a proper balance of nitrogen and potassium fertilizer

Biological control

Wound dressing and soil application of *Trichoderma* and *Gliocladium*.

Avoidance of pre-disposing factors.

Avoid mulching and fertilizer application close to the stem collar and planting in gravelly soil.

Chemical practice

Apply Copper Oxychloride (COC) in linseed oil on pruning cuts.

Apply tarcoal & sand (1:9) at the holes at the time of pruning.

Soil drenching with carbendazim.

Red, brown & black root disease.

Cultural practice

Removal of infected tissues.

Uproot the infected bushes and burnt it.

Insulation of diseased patches by making trenches of 120 cm (4 feet) deep and 45 cm. (1.5 feet) width surrounding the diseased plants help in preventing the spread of primary root diseases.

Biological control

Apply bio-control agents (*Trichoderma harzianum* & *Gliocladium virens*).

Chemical practice

Drench the soil with the recommended chemicals.

Soil fumigation.

V. DO'S AND DON'TS IN TEA IPM:

S.No.	DO'S	DON'TS
1.	Grow only recommended variety	Do not grow variety not suitable for the region
2.	Adopt cultural means to control looper caterpillar	Do not grow <i>Dalbargia assamica</i> as shade in looper prone area.
3.	Green crops must be planted in young tea to avoid red spider mite.	Do not keep more than 18-24 months of green crops in young tea for avoiding the red spider mite.
4.	Prune/deep skip the section which is heavily infested by tea mosquito bug during last season.	Do not allow other alternate host i.e. <i>Melostoma Malbathricum L. Jasminum Scandens Vahl, Mikania Micrantha.</i>
5.	Prepare a schedule of weed control measures.	Do not allow weeds in bunds, along drains, foot paths and vacant patches.
6.	Apply pre-emergent herbicide on clean and moist soil.	Do not spray pre-emergent herbicides on slopes.
7.	Start light pruning tea above 20 cm from pruning mark.	Do not wait for all the shoots to come up to tipping level. Start tipping even if 5% of the total bushes have come up to tipping level.
8.	Take cutting from the mother bush. Primary shoots having no lateral growth are good for cutting.	Do not bring the bushes under plucking if cuttings are taken.
9.	Cutting should be taken either in the morning or late afternoon.	Do not expose the cutting to sunlight.
10.	Monitor the incidence of pests by assessing the population in the field.	Do not allow the pest to reach ETL.

## BASIC PRECAUTIONS IN PESTICIDE USAGE

### A. Purchase:

1. Purchase only JUST required quantity e.g. 100,250,500 or 1000 g/ml for single application in specified area.
2. Do not purchase leaking containers, loose, unsealed or torn bags.
3. Do not purchase pesticides without proper/ approved LABELS.

### B. Storage:

1. Avoid storage of pesticides in the house premises.
2. Keep only in original container with intact seal.
3. Do not transfer pesticides to other container.
4. Never keep them together with food or feed/ fodder.
5. Keep away from the reach of children and livestock.
6. Do not expose to sun-light or rain water.
7. Do not store weedicides along with other pesticides.

### C. Handling:

1. Never carry/ transport pesticides along with food materials.
2. Avoid carrying bulk - pesticides (dusts / granules ) on head, shoulders or on the back.

### D. Precautions for Preparing Spray Solution:

1. Use clean water.
2. Always protect your NOSE, EYES, MOUTH, EARS and HANDS.
3. Use hand gloves, face mask and cover your head with cap.
4. Use polyethylene bags as hand gloves, handkerchiefs or piece of clean cloth as mask and a cap or towel to cover the head (Do not use polyethylene bag contaminated with pesticides).
5. Read the label on the container before preparing spray solution.
6. Prepare spray solution as per requirement.
7. Do not mix granules with water.
8. Concentrated pesticides must not fall on hands etc. while opening sealed containers. Do not smell the sprayer tank.
9. Avoid spilling of pesticide solution while filling the sprayer tank.
10. Do not eat, drink, smoke or chew while preparing solution.
11. The operator should protect his bare feet and hands with polyethylene bags.

**E. Equipment:**

1. Select right kind of equipment.
2. Do not use leaky, defective equipment.
3. Select right kind of nozzle.
4. Don't blow/clean clogged- nozzle with mouth. Use old tooth- brush tied with the sprayer and clean with water.
5. Do not use some sprayer for weedicide and insecticide.

**F. Precautions for applying pesticides:**

1. Apply only at recommended dose and dilution.
2. Do not apply on hot sunny day or strong windy condition.
3. Do not apply just before the rains and also after the rains.
4. Do not apply against the wind direction.
5. Emulsifiable concentrate formulations should not be used for spraying with battery operated ULV sprayer.
6. Wash the sprayer and bucket etc with soap water after spraying.
7. Containers, buckets etc. used for mixing pesticides should not be used for domestic purposes.
8. Avoid entry of animals and workers in the fields immediately after the spraying.

**G. Disposal:**

1. Left over spray solution should not be drained in ponds or water lines etc. Throw it in barren isolated area, if possible.
2. The used/ empty containers should be crushed with a stone / stick and burried deep into soil away from water source.
3. Never re-use empty pesticide container for any purpose.