Plant Protection Code

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Policy on usage of Plant Protection Formulations in Tea Plantations of India

Issued

BY

Tea Board India

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FOREWORD

Consumers are now increasingly demanding products produced sustainably without adversely impacting the environment. Given this demand, the need to embrace sustainability becomes more and more important.

Tea Board is of the view that effective adoption for the food safety standards will enable the tea industry in safeguarding the plantation environment, welfare of the workers and small farmers and long term security of supply. Given this objective and in order to sustain the ever increasing appetite for Indian tea amongst the consumers, the need for judicious usage of Plant Protection Formulations (PPFs) has become more imperative.

With Support from Tea Board, the Tea Research Institutes (TRIs) in India - Tea Research Association (TRA) for North East India and UPASI Tea Research Foundation (TRF) for South India have after due experimentation and testing the efficacy of PPFs, have come out with firm recommendations for adoption of Integrated Pest Management practices for achieving effective control of pests and diseases with minimal use of PPFs that are safer to use in the tea plantations.

The TRIs have ensured that their recommendations comply with food safety standards as stipulated by FSSAI (Food Safety & Standards Authority of India) and the PPFs recommended for usage have been cleared by the Registration Committee of Central Insecticides Board (CIB) formed under the Insecticide Act 1968 which has the responsibility to check the data requirement of new pesticides and to ensure that pesticides allowed for use will not leave excessive residues on food commodities above the permitted maximum limits. It also liaises with international bodies like EPA and FAO/WHO, Codex etc. committees on harmonization of pesticide residues.

This document **'Plant Protection Code'** is being issued to the tea industry as a comprehensive guideline for safe usage of Plant Protection Formulations (PPFs) in the tea plantations in India.

It is envisioned that the compliance with the code will not only improve competitiveness amongst the tea farms but will also facilitate them in achieving compliance with national regulations and international regulatory standards. The code aims in safe usage of plant protection products and adherence to safety standards for production of safer, healthier and more environmentally friendly teas.

Saurav Pahari

Dy. Chairman
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PREAMBLE

The Plant Protection Code is guided by the following principles:

- PPFs are essential inputs in the tea cultivation for achieving optimum productivity under present Indian conditions.
- PPC aims to achieve sustainability through Good Agricultural Practices (GAP) including integrated pest management, promotion of alternative control strategies (Biological control etc.) to gradually reduce the dependence on chemicals.
- PPC shall focus on responsible chemical management that includes proper selection, judicious usage, safe storage and proper disposal, occupational health and safety and green chemistry.
- PPC is committed to minimizing the possible negative impact of pesticides on humans, wildlife and the environment. We will achieve this through effective governance, review and monitoring.

In this document the term "PPF" includes all Plant Protection Formulations covering insecticides, acaricides, fungicides, herbicides, bio-pesticides etc.

This is the sixteenth version of the code (Ver. 16.0). An expert technical group has been constituted to review and update this code with the ambition to gradually reduce/eliminate the WHO class II and III chemicals.

"The issue of Green Leaf testing (Made tea from BLFs if needed) including the details modality shall be considered in due course of time and will be updated subsequently".

"*No Commercial bio-pesticides are allowed to use in tea until it is registered with label claim on tea*"

INTRODUCTION

The climatic conditions of the tea growing regions of India are conducive for a large number of insects and mite pests, diseases and weeds that needs to be managed below the economic injury levels to avoid huge crop loss. Tea being a perennial mono crop, usage of plant protection formulations is inevitable.

In spite of using PPFs, tea industry as a whole, incurs crop loss ranging from 15-30% due to various pests, diseases and weeds. It is important for tea growers and manufacturers to maintain the yield and quality of tea leaf production. Often this is accomplished by using Plant Protection Formulations (PPFs). All PPFs have some level of toxicity and pose some risk to the people, wildlife and the environment.

However, in the last few years, there have been welcome efforts to adopt non-chemical control methods and to evolve an integrated management programme against the pests, diseases and weeds infesting tea. The large-scale adoption of the recommended integrated pest management (IPM) approach from the very beginning of the season will be most crucial in ensuring food safety and adequate crop protection. Looking critically at the practical aspects of IPM adoption in commercial tea gardens one has to be very careful in using pesticides.

PPFs are to be used ***only as a component*** of IPM. It is recommended that as far as possible one should avoid blanket sprays of any pesticides in tea fields in the growing season. This will only be possible when a very effective pest monitoring system is put in place at the grass-root level. Monitoring pests in tea sections from the beginning of the season and resorting to spot sprays to contain them well in time will considerably reduce their infestation in the plucking season with the consequent reduction in the load of chemicals in the tea ecosystem. This is very much possible.

The new pesticide policy addresses the constraints faced by the industry in choice of chemicals. The Tea Research Institutes continue to screen new potential chemicals both for efficacy and residues. The data being generated is submitted to CIB and Food Safety and Standard Authority of India (FSSAI) for label claim in tea and fixation of MRLS with the support from Tea Board.

The Central Insecticides Board and Registration Committee, Government of India, constantly review the usage of pesticides in India and up-date information with the help of pesticide industry on the safety of chemicals and those which pose a health hazard.

This comprehensive document 'Plant Protection Code' deals with the safe usage of crop protection products and that of methodologies to be followed to reduce pesticide residues in tea. The code encourages tea growers to critically review their use of PPFs, reduce the use of PPFs where possible and over time, apply the PPFs in the safest way possible.

CHAPTER 1

PLANT PROTECTION FORMULATIONS USAGE POLICY

1. Tea Research Institutes in India shall recommend only such Plant Protection Formulations (PPFs) - that have been cleared and registered **by the Central Insecticides Board and Registration Committee, Government of India, with label claim in tea**. The approved list of pesticides for use in tea is given in **Annexure-1**.

    1.1 Only Tea Research Institutes in India are authorized to undertake efficacy and residue trials of new PPFs that have been cleared by CIB for other crops.

    1.2 The Advisory officers of TRA & UPASI TRF during their mandatory Advisory visits to tea gardens will take the inventory of PPFs used in each garden for compliance with the approved list mentioned in this document. For non-member gardens of TRIs, the ADTDs of Tea Board will carry out similar exercise.

    1.3 Tea gardens as and when they purchase the PPFs may send a sample for testing to the Tea Research Institutes to check its purity.

    1.4 The Development officers of Tea Board will ensure that only such PPFs as per Annexure 1 are used for plant protection in tea plantations including the small growers. The decision with regard to purchase and application of the PPFs would be decided jointly by the Tea Board's DOs and the Self-help groups of Small tea growers during their regular monthly meetings.

2. All the tea plantations shall keep the records of usage of PPFs.

3. All tea Plantations should follow IPM as given in Chapter 2 of this document.

4. The PPFs should not be used near the water bodies, wildlife habitats and human dwelling to ensure that there is no contamination beyond the application area.

5. There should be designated areas for preparation of spray fluids with clear signage for the workers. These areas must be away from any natural water bodies, drinking water sources, children's play areas, food stores, clinics and fish ponds.

6. The PPFs must be stored safely and correctly in facilities which are dry, well ventilated and should not be accessible to children and unauthorized people. The storage facility should be away from food and feed.

7. Storage areas should display information on hazardous chemicals in a way which is easily understandable for the workers (in a language they can understand or in pictorial formats), including information regarding their classification, the hazards they present and the safety precautions to be observed.

8. There should be provisions for training for workers on safe and appropriate usage of PPFs.

9. The tea plantation unit must regularly maintain and calibrate agrochemical application equipment and keep records of such equipment maintenance and calibration. A note on safe disposal of PPFs empty containers is given in **Chapter – 5.**

10. The Plantation unit must have emergency facilities and procedures available in the vicinity of PPFs storage to deal with spillage of PPFs (i.e. sand or sawdust) and with operator contamination (i.e. clean water). The procedure must indicate basic accident care instructions as well as contain the contact details of the ambulance, nearest hospital and the person trained in first aid.

11. During transportation of crop protection products, the plantation unit should ensure prevention of spilling and other accidents.

12. Safe interval of application of PPFs should be ensured as per recommendations of the authorized institutes.

13. Spraying and maintenance of spraying equipment should be done as per the advice of TRIs for the same.

14. The Plantation unit should use the water for spraying as per the advice of TRIs for the same.

15. Tea Board shall notify after due verification of accredited labs that offer testing facilities exclusively for tea products and recommend to tea industry from time to time to ensure compliance of tea industry all safety and quality measures.

Annexure: 1

 # List of CIB&RC approved Plant Protection Formulations for use in Tea plantations along with their MRLs fixed by FSSAI [Food Safety and Standards (Contaminants, Toxins and Residues), Third Amendment Regulations, 2018 (effective from 3.1.2019)]

Type of PPFs	Sl. No.	Name of PPFs	MRL (ppm)
Acaricides	1	Cyflumetofen 20 SC	0.05*
	2	Ethion 50 EC	5.0
	3	Etoxazole 10 SC	15.0
	4	Etoxazole 6% + Abamectin 1.5% SC	Etoxazole=15.0 Abamectin= MRL yet to be notified
	5	Fenazaquin 10 EC	3.0
	6	Fenazaquin 18.3% SC	
	7	Fenpyroximate 5 EC/SC	6.0**
	8	Flufenzine 20 SC	MRL yet to be notified
	9	Fenazaquin 10% + Bifenthrin 4% EC	Fenazaquin= 3.0 Bifenthrin= 30.0
	10	Hexythiazox 5.45 EC	15.0
	11	Propargite 57 EC	10.0
	12	Propergite 42% +Hexythiazox 2%EC	Propergite= 10.0 Hexythiazox= 15.0
	13	Pyridaben 20% WP	MRL yet to be notified
	14	Sulphur 80 WP	Not required
	15	Sulphur 40 WP	
	16	Sulphur 52 SC	
	17	Spiromesifen 22.9 SC	70.0
Insecticides	18	Azadirachtin 1 EC	-
	19	Azadirachtin 5 EC	
	20	Bifenthrin 8 SC	30.0
	21	Clothianidin 50 WDG	0.7
	22	Deltamethrin 2.8 EC	5.0
	23	Deltamethrin 11 EC	
	24	Dimethoate 30 % EC***	MRL yet to be notified
	25	Emamectin Benzoate 5 SG	0.06**
	26	Emamectin Benzoate 3% +Thiamethoxam 12% WG	Emamectin Benzoate= 0.06 Thiamethoxam = 20.0
	27	Fenpropathrin 30 EC	2.0
	28	Flubendiamide 20 WG	50.0
	29	Flubendiamide 19.92% w/w + Thiacloprid 19.92% w/w SC	Flubendiamide = 50.0 Thiacloprid = 5.0
	30	Flupyradifurone 17.09% w/w SL	MRL yet to be notified
	31	Quinalphos 25 EC	0.7**
	32	Spirotetramat 15.31% w/w OD	MRL yet to be notified
	33	Thiacloprid 21.7 SC	5.0
	34	Thiamethoxam 25 WG	20.0
	35	Thiamethoxam 12.6% + L-Cyhalothrin 9.5%	Thiamethoxam= 20.0 L-Cyhalothrin= 0.05*

Fungicides	36	Carbendazim 12% + Mancozeb 63% WP	Carbendazim= 0.5 Mancozeb= 3.0
	37	Copper Oxychloride	150.0 (as elemental copper)
	38	Hexaconazole 4% + Zineb 68% WP	Zineb= 0.1*
	39	Hexaconazole 5 EC	5.0**
	40	Propiconazole 25 EC	6.0**
	41	Tetraconazole 3.8% w/w (4% w/v)	MRL yet to be notified
	42	Trifloxystrobin 25% + Tebuconazole 50% WG	MRL yet to be notified
Herbicides	43	Glyphosate 41 SL	1.0
	44	Glyphosate 71 SG	
	45	Glyphosate Ammonium Salt 5 SL	
	46	Glufosinate Amonium13.5 SL	0.01
	47	Oxyfluorfen 23.5 EC	0.2
	48	Paraquat Dichloride 24 WSC	0.2
	49	Paraquat Dichloride 24% + Oxyfluorfen 5% SC	Paraquat Dichloride=0.2 Oxyfluorfen=0.2
	50	Oxyfluorfen 2.5% + Isopropyl aminesalt of Glyphosate 41% w/w SC	Oxyfluorfen=0.2 Glyphosate=1.0
	51	Carfentrazone Ethyl 0.43% + Glyphosate 30.82% EW	Carfentrazone Ethyl= 0.02* Glyphosate= 1.0
	52	Indaziflam 1.65% w/w + Glyphosate-isopropyl ammonium 44.63% w/w SC	MRL of Indaziflam is yet to be notified
	53	Saflufenacil 70 % WG	MRL yet to be notified
	54	Triasulfuron 20% WG	MRL yet to be notified
	55	2,4-D amine salt 58 % WSC	0.05
	56	Glufosinate Ammonium 13.4% + Oxyfluorfen 4.8% w/w	Glufosinate Amonium=0.01 Oxyfluorfen=0.2

The above list is dynamic and may change from time to time based on the CIB approved list of pesticides for use in tea and this may be seen from the website of Tea Board.

* Maximum Residue Limit fixed at Limit of Quantification (LOQ). Tolerance limit of 0.01 mg/kg shall apply in cases of pesticides for which MRL have not been fixed

** Revised and operational vide FSSAI order No. F. No.SS-T007/1/2023-Standard-FSSAI dated 27th April, 2023

***** Ad-hoc approval given by CIB-RC under national exigency for one year.**

Copper Hydroxide, Profenophos and Bitertanol have been removed from this list following gazette notification of Ministry of Agriculture S.O. 2486 (E) dated 24th September, 2014 although MRL of Bitertanol in tea is fixed by FSSAI.

Note: *This list does not contain extremely and highly hazardous chemicals classified under World Health Organization (WHO) 1a & 1b and are fully aligned with the Rotterdam and Stockholm conventions.*

CHAPTER 2

INTEGRATED PEST AND DISEASE MANAGEMENT IN TEA PLANTATIONS

The IPM Concept

Integrated Pest Management (IPM) can be defined as a system that utilizes all suitable methods and techniques of control in as a compatible manner as possible, to maintain pest incidence at levels below those causing economic loss of crop. Effective IPM strategy can be developed, based on the knowledge of bio-ecology of pests and pathogens, economics of control measures and on the possible harmful effects of pesticides on human health, non-target organisms and the environment.

Several non-chemical approaches such as cultural, biological, physical and mechanical have been recommended for incorporation with chemical control measures against various pests of tea. Effective control of pests depends not only on the judicious use of chemical pesticides, but also on various cultural operations, which help in reducing pest population without any harmful effect on the environment and beneficial organisms.

Apart from proper planning for achieving success in IPM programme, knowledge on the following is essential.

- Correct identification of pests and diseases
- Biology of the causal organism
- Site of attack
- Damage symptoms
- Mode of migration/dispersal
- Alternate hosts

The concept of integrated pest management (IPM) in tea plantations was introduced during 1970's both in north and south Indian tea plantations which helped in minimizing the use of toxic agrochemicals. A well-defined IPM is a program which should be based on prevention, monitoring and control that offers the prospect to eliminate or drastically reduce the use of pesticides and to minimize the toxicity of and exposure.

Components of IPM

1. **Cultural practices:**

   Certain routine cultural operations such as bush sanitation, plucking, pruning, maintenance of shade and weed control can be manipulated to reduce the incidence of pests, diseases and weeds and the intensity of their attack. Application of higher levels of potassium fertilizers is known to reduce the incidence of certain sucking pests and diseases in several crops.

   Plucking: Populations of leaf folding caterpillars such as flush worms, leaf rollers and tea tortrix can be reduced by their removal while plucking. Areas, which would be severely infested by sucking insects like thrips, greenfly and tea mosquito bug, could be earmarked and black plucked to reduce the growth of its population.

   Pruning and skiffing: When an attack by TMB 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 and diseases like black rot, red rust, *Fusarium* die back especially in mid and low elevation areas.

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, mites and blister blight disease.

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

Fertilizer application: Application of higher levels of potassium fertilizers is known to reduce the incidence of pests and diseases in several crops. Commercial fertilizers can also be used to contain pest species. Application of higher levels of potassium fertilizer (N: K_2O:1: 2) in the pruned year helps to decrease the incidence of shot-hole borer in the infested fields.

Infilling the vacancies in field: Weeds are serious problem in young tea clearings, pruned fields and vacant patches in mature tea fields. These patches have to be infilled while pruning thefield to avoid weed growth and to increase bush population and yield.

2. Host plant resistance:

Use of pest resistant varieties is one of the important components of non chemical control strategies. 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 with practically no emphasis on resistance to pests or diseases. The available data could be successfully utilized, for selection of clones, seedlings etc. for replanting/new planting. The emerging information could be successfully utilized in the management of pests and diseases.

It is now realized that Chinery varieties are more susceptible to the attack of thrips, red spider and eriophyid mites while scarlet mites and greenfly favour Assam cultivars.

Incidence of tea mosquito bug is more on China Jats and the clone TV-1 highly susceptible to this pest. Flushworm incidence is more on the clone UPASI-17, considered "Cambod" in nature. Soft wooded tea plants are known to be easily attacked by termites. 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 arepopular in South India should be avoided in shot hole borer prone areas.

Screening of cultivars for susceptibility or tolerance to major pests must become a prerequisite for the release of new cultivars.

3. Physical control:

Population of certain tea pests can be reduced by heat treatment & soil solarisation, like nematode, eggs of looper caterpillars and light trapping the moths of looper caterpillars, red slug etc. Soil solarisation and heat treatment can be effectively employed to kill the juveniles of root knot nematodes in nursery soil.

Manual removal:

Populations of foliage feeding caterpillars such as looper, bunch caterpillar, faggot

worms, flushworm, leaf roller and tea tortrix can be reduced to a great extent by manual removal of larvae and pupae. The tea mosquito bugs lay eggs in the tender buds, leaves and stems. By black plucking huge number of eggs are removed.

Heat treatment and Soil solarisation:

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 galvanized 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. When the soil is too hot to handle with naked hand it would have attained the correct temperature of 60 - 65°C, which is required for killing nematodes. Care is to be taken that the soil is not over heated since this will lead to phytotoxicit y. Soil solarisation during summer (Feb-May) is also found quite effective in reducing the *Meloidogyne javanica* populations in the infested soil.

Use of Light traps:

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

4. Biological control:

More than one hundred and seventy species predators and parasites, entomopathogens, antagonists and hyperparasites are found to be highly effective in controlling several insect pests, pathogens and weeds. The minor status of several pests such as aphids, scale insects, flushworms, leaf rollers and tea tortrix is due to the action of these natural enemies. Often, the work of these beneficial arthropods goes unnoticed, especially when their hosts are minor pests. Efforts towards the conservation and augmentation of natural enemies in the tea ecosystem, could offer significant advances in biological control programme in tea in future.

Plant products such as Azadirachtin, Neem Kernel Aqueous Extract (NKAE) and extracts of several herbs having pesticidal properties are also found to be effective against several pests and pathogens. Sex pheromones form an important component of IPM which has been used successfully for controlling populations of lepidopteran insects and tea mosquito bug.

Mites:

Several predatory mites, mostly belonging to Phytosegiidae, Stigmaeidae and Tydeidae, mainly prey upon phytophagous mites infesting tea. *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 northeast India. Mites belonging to *Pronematus, Parapronematus* and *Tydeius* are also active in tea fields. In south Indian tea fields, *A. herbicolus* is the most common predator of the mite pest, *Acaphylla theae.* Populations of this predator reached the peak during December and February and a single predatory mite could consume more than 400 pink mites during its life span.

Coccinellids are probably the second largest group of predators of phytophagous mites. *Cryptogonus bimaculatus, Jauravia quadrinotata, J. soror, J. opaca,*

Menochilus sexmaculatus, Stethorus gilvifrons and *Stethous aptus* are the common species of coccinellids in tea fields.

Thrips:

Anthocorids belonging to, *Anthocoris* and *Orius* and the predatory thrips *Aelothrips intermedius* and *Mymarothrips garuda* are important natural enemies of thrips. Recently, in northeast India a neuropteran predator, *Chrysoperla carnea* was found effective against thrips and *Helopeltis* @ 500-1000 adults/ha.

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.* Six parasitoids and predators attack the black scale *Chrysomphalus ficus*.

Caterpillar pests:

Many natural enemies control populations of leaf folding caterpillars. *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 flush worms and percentage parasitism by this species. The leaf roller, *Caloptilia theivora* is heavily parasitised by the eulophid, *Sympiesis dolichogaster.* The incidence of parasitism varies between 20 and 83 per cent. This eulophid is playing a significant role in the suppression of leaf roller population. One egg, nine larval and four pupal parasitoids affect the tea tortrix *Homona cofferia*. 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.

Tea Mosquito Bug:

The eggs of tea mosquito bug are parasitized by a mymarid, *Erythmelus helopeltidis* Ghan. The incidence of parasitism in the field varied between 52 and 83%. Recently a reduvid predator, *Eugorus plagiatus* was recorded feeding on the nymphs and adults of *H. theivora*.

5. Pheromones:

Pheromone trap is yet another form of trap system that utilizes species-specific bbehavior-modifying chemicals for the management of noxious insects in agriculture. Synthetic pheromones play a significant role in organic tea production. The use of pheromones against tea pest management is not yet very popular except for some work on the female sex attractants of the flushworm (*Cydia leucostoma*) have been identified recently. Studies on the sex pheromones of tea looper are in progress. Laboratory and field assays have been conducted to evaluate the response of males to female sex pheromone compounds of tea mosquito bug, *H*. *theivora* and commercially available sex pheromones can be used as per the recommendation of 15/traps/ ha to trap the male Tea mosquito bug.

6. Botanical Control:

Azadirachtin, an oxygenated triterpenoid, obtained from the seed kernels of the neem tree, *Azadirachta indica* has been found effective against pink and purple mites and certain caterpillars. Formulations containing azadirachtin and their combination are recommended for pest control in tea. The aqueous extracts of some

local herbs like *Clerodendrum viscosum* (*Dhapat tita* in Assamese)*, Vitex negundo* (*Pasatia* in Assamese)*, Polygonum hydropiper* (*Patharua beholongani* in Assamese)*, Cassia tora, Xanthium strumarium (Agara* in Assamese*), Karanj* etc are found to be promising to suppress most of the insect and mite pests of tea including few diseases.

7. Use of Inorganic compounds:

Formulations of sulphur and lime sulphur are effective against tea mites. Recently, petroleum-based horticulture oil formulation (non-ionic ethoxylate from paraffinic base) at 0.5% concentration has been registered as a synergist to increase the efficacy of approved pesticides against major tea pests.

8. Chemical control:

Growing concern on food safety, increasing consumer awareness, stringent regulations and fixation of very low MRLs have reduced the choice of pesticides to be applied on tea. The choice is limited to a few for which Maximum Residue Limits (MRLs) in tea have been declared by the FSSAI. Simultaneously, the regulations on MRL by European Union, Codex etc., impose restrictions on the use of pesticides on tea.

Need based, judicious and safe application of pesticides is the most vital aspect of pesticide usage under IPM programme. It involves developing IPM skills to play safe with environment by proper crop health monitoring, observing ETL and conserving the natural bio-control potential before deciding in favour of use of chemical pesticides as a last resort. Moreover, safety harvest intervals (waiting period) for different pesticides have also been established in tea based on the field data enerated during the last few years. These data will help the industry to decide the harvesting interval after the application of the chemicals and to keep their residue levels below the MRL prescribed by EU.

MANAGEMENT OF SOME MAJOR TEA PESTS IN NORTH EAST INDIA:

Monitoring

Monitoring and proper identification of pest species are the cornerstones of an IPM programme. In tea-producing countries like China and Japan, monitoring is relatively easy as tea is grown in small areas. However, in countries like India, where tea is grown over several hundred hectares, convenient monitoring, and supervision are done by dividing larger areas or sections of the tea gardens into manageable sizes or blocks with the help of natural boundaries such as roads, footpaths, main drains, etc., which will enable convenient supervision and the right time to take suitable action. This type of monitoring is termed the "micro-management system". In this system, "micronized blocks" are administered by a ‘block in-charge," who is accompanied by a spotter and sprayer. Spotters are people who are trained to identify insect pests/diseases and the nature of damage they inflict. Each spotter is assigned to one block, where he regularly inspects his area for initial pest attacks. Spotters normally follow two types of observations for detecting tea pests: direct and indirect methods. Direct observations are carried out by visually observing pests such as looper caterpillars, red slug caterpillars, green hoppers, nettle grubs, scale insects, and red spider mites on tea bushes that are visible to the naked eye, while indirect observations are based on feeding damage by insects such as the tea mosquito bug and green hopper, thrips, which are either very small or highly mobile. In some instances, light and coloured sticky traps are also used for detecting the initial pest build-up of thrips, green hoppers, and whiteflies. Upon detection of a pest attack, the spotter flags the affected bush with a coloured flag (one

coloured) in the centre and places four coloured flags (another coloured) in square formation around the periphery of the affected bush. These flags act as indicators for pest attacks on tea bushes. Such flagged bushes are immediately hard plucked (if possible) and then sprayed with respective pesticides. After having sprayed, the flags are reversed, which acts as an indicator that effective management practice has been done. One of the major advantages of this system is that, it reduces the amount of pesticides used, thus preventing blanket spraying and reducing the cost of pest control. The success of this system will, however, involve complete teamwork between the top garden management and the gross-roots level workers to prevent pest outbreaks and improve the overall health and vigour of tea bushes and the eco-friendly environment.

1. Tea Mosquito Bug (*Helopeltis theivora*)

The percentage of infestation has to be assessed by collecting 100 shoots from plucker's basket and counting the number of infested and un-infested shoots to work out the percent infestation.

- A closer plucking schedule helps to remove inserted eggs and early nymphs of *H. theivora* before they cause more damage. In severe infestations, level of skiff (LOS) operations should be followed to minimize the infestation by the next generation.
- Removal of the alternate host of *H. theivora* such as Guava (*Psidium guajava*), Oak (*Quercus* spp.), Melastoma (*Melastoma* sp.), Thoroughwort (*Eupatorium* sp.), Fragrant thoroughwort (*Eupatorium odoratum*), Dayflower (*Commelina* spp.), Sesbania (*Sesbania cannibina*), Jackfruit (*Artocarpus heterophylla*), Bortengeshi (*Oxalis acetocello*), Ornamental jasmine (*Gardenia jesminoid*), Mulberry (*Morus alba*), Kadam (*Enthocephalus cadamba*), Jamun (*Eugenia jambolana*), Boal (*Ehretia acuminata*), Mikania (*Mikania micrantha*), *Acacia moniliformis*, *Duranta repens*, *Piper hemiltonii*, *Phlogacanthus thirsyfiorus*, *Ficus benjamina*, *Sida cordifolia*, *Cannabium sativam*, *Ixora* sp, *Persea bomycina*, *Pteridium aquilium*, *Murraya koenigii* and *Premna latifolia* from in and around plantations would give a good control. Wild plants (noneconomic) nearby the fields having feeding spots of *H. theivora* have to be eradicated, as far as possible.
- The ecotone (border) between forest line and tea plantation need to be kept clear of weed and noneconomic plants. Bamboos near tea areas – should not make over shaded.
- Keep all the drains functional to avoid water logging during the monsoon. Localized depressions should be prevented.
- *H. theivora* prefers moist conditions and mild temperatures. For that reason, populations of this pest are often higher under heavy shade. Regulate the shade in densely shaded area areas lopping of the lower branches of shade trees. Moderate shade of 60% is preferable.
- In closely planted tea field, the side branches of tea bushes have to be removed to improve ventilation.
- Un-cut drain sides are an ideal protected area for tea mosquito bug. Therefore, side branches of the tea bushes near drain sides should be cut, and attention should be paid during spraying for proper coverage.
- During cold weather practices, pruning/ skiffing should be resumed from periphery towards the centre and around 50-60 bushes should be kept untouched for a day or two in the centre to serve as a trap for adults and after thorough spraying of recommended pesticides these bushes should be pruned/skiffed.
- During cold weather, proper bush sanitation, like the removal of parasitic plants on tea, bushes, cuts all twiggy, thin, diseased tea branches, etc. An

alkaline wash or lime wash should be done.

- Time of spraying should coincide with surfacing of the pest at the bush table. Nymphs and adults of *H. theivora* generally feed in the morning and late afternoon hours. Hence, spraying operation against this pest should be carried out early in the morning or late in the afternoon.
- Follow barrier spraying method.
- Spray systemic insecticides like Thiamethoxam 25 WG or Thiacloprid 21.7% SC or Clothianidin 50 WDG in alternate rounds. Use of synthetic pyrethroid (Deltamethrin 2.8 EC, Bifenthrin 8% SC, Fenpropathrin 30 etc) should be restricted to rainy period only in short rain free period. The follow up rounds should be only need based depending on the fresh infestation.

Insecticides recommended for management of tea mosquito bug:

Insecticides	Dilution	
	HV	LV
Deltamethrin 2.8 EC/11 EC	1: 2000	1: 1000
Bifenthrin 8% SC	1: 1600	1: 800
Thiamethoxam 25 WG	1: 4000	1: 2000
Thiamethoxam12.6% +L Cyhalothrin 9.5%	1: 2666	1: 1333
Emamectin Benzoate 3% + Thiamethoxam 12% WG	1:2000	1:1000
Quinalphos 25 EC	1: 400	1: 200
Fenpropathrin 30 EC	1: 1600	1:800
Neem Extract (azadirachtin 5% W/W)	1: 1500	1: 750
Clothianidin 50 WDG	1:4500	1:2250
Thiacloprid 21.7%	1:1000	1:500
Flupyradifurone 17.09% w/w SL	1:533	1:267

- Detection and marking of the initial pest-build up sites can help containing and managing the pest through spot spraying. Such operation would reduce the pesticide load that results from routine, blanket applications.
- Application of conventional rehabilitatory spray (Boric acid 0.1% + $ZnSO_4$ 1% + Urea 1%) or *Bacillus subtilis* (TRA stain)@5% will give effective recovery in severely tea mosquito bug infested area. These treatments should be done only after recovery of the pest.
- Crude aqueous extracts of native plants, viz., *Clerodendrum viscosum* (leaves and succulent stem), *Polygonum hydropiper* (leaves and succulent stem), *Cassia alata* (leaves and succulent stem), and *Vitex negundo* (leaves and succulent stem) @ 5-10% concentration may also be applied in cases of low and moderate infestation of the pest.
- Spray 2% potassium chloride (KCL) or mined potassium sulphate (K_2SO_4) straight or in combination with insecticides and this will impart physiological resistance to plants against sucking pests.
- Some natural control agents (Reduviid bug: *Sycanus collaris*, Lacewing: *Chrysoperla carnea*, *Mallada boninensis* ; Spider: *Oxyopes* spp.; Praying Mantis and Mermethid Nematodes*: Hexamermis sp*) of *H. theivora* have been reported as potential natural enemies of tea mosquito bug. Encourage the population of natural enemies by legitimate use of pesticide; and by giving emphasis on non-chemical methods of pest control.

2. Tea thrips (*Scirtothrips dorsalis*) & Jassids (*Empoasca flavescens*)

- Populations of thrips and jassids have to be assessed at periodic intervals by

collecting 100 shoots at random from each area and counting the number of adult and larval thrips.

- Collect the shoots from the plucking table, below the plucking table and also from the side branches.
- Caustic washing of the trunk of the bushes after cleaning the mosses and lichens and stirring of soil around the collar region will kill the pupae.
- Thrips and leafhopper populations can be controlled to a great extent if plucking round is in between 5 and 7 days and as per requirement black plucking is done. Keep the sections weed free.
- Yellow colour sticky traps may be used for thrips and Jassid control. On shade tree collars just above tea plucking table a band of bright yellow polythene sheet of 45 cm wide can be fixed. In absence of shade trees, yellow polythene sheet can be fixed on both sides of a board (45 cm x 45 cm). The yellow sheet is to be smeared with a sticky long lasting glue made with 300 g Hot Melt Pressure Sensitive Adhesive (HMPSA) Grade OMW 4017 (viscous liquid), in one litre thinner or Tolunene. The pests will be attracted and stucked up on the yellow sheet. The yellow sheet once covered with trapped insects can periodically be removed by diesel followed by washing with detergent and water. The sticky gum should be smeared again after drying the sheet. Around 50-70 traps should be used per ha.
- Light/fire traps are useful in reducing the tea Jassid populations.
- Shade less patches are more vulnerable to these pests and therefore moderateshade (60%) in tea plantation is preferable.
- Treat with pesticide immediately after plucking, subject to minimum gap 7 days in between spraying and plucking.
- To manage infestation of thrips adopt hard plucking and then apply recommended systemic insecticides like Thiamethoxam, Thiacloprid or Clothianidin alternately at fortnight intervals. In rainy period any recommended synthetic pyrethroid can be applied in short rain free period followed up with systemic insecticides, if weather clears up and pest is still active.

Insecticides recommended for management of tea thrips/ jassid:

Insecticides	Dilution	
	HV	LV
Quinalphos 25 EC	1: 400	1: 200
Thiamethoxam 25 WG	1: 4000	1: 2000
Thiamethoxam12.6% +L Cyhalothrin 9.5%	1: 2666	1: 1333
Emamectin Benzoate 3% + Thiamethoxam 12% WG	1:2000	1:1000
Bifentrin 8 SC	1: 1600	1: 800
Deltamethrin 2.8 EC	1: 2000	1: 1000
Clothianidin 50 WDG	1:4500	1:2250
Thiacloprid 21.7%	1:1000	1:500
Spirotetramat 15.31% w/w OD	1:667	1:333

- The common plants that have pesticidal properties, like *Clerodendrum viscosum*, *Polygonum hydropiper*, *Cassia tora*, *Vitex negundo*, *Pongamia pinnata*, *Sapindus mukorossi*, etc., should be applied in a mixture at a 5-10% concentration (high volume). The fresh vegetative matter (leaves, flowers, and soft stems) should be crushed and soaked for 3–4 days, followed by straining with muslin cloth. The extract from 10 kg of herbs should be mixed with 100 litres of water (10%) and sprayed. It can be applied as a routine spray, to reduce infestations of most of the common pests, like thrips and green flies, to a great extent. After application of

these botanicals, if any pest is found active, then only the above recommended pesticides should be used.

- For effective thrips and jassid management, the spraying target should be the lower part of the leaf. A hand-operated, calibrated Knapsak sprayer is preferable for this operation.
- Different kinds of spiders such as the white gray spider, the black spider, the long-legged spider, small black spider, Carabid beetles, ladybeetles, and dragonflies feed on leafhoppers. All these natural enemies prey on both young and adult hoppers, but they seem to prefer the nymphs. Anthocorids belongs to, *Anthocoris* and *Orius* and the predatory thrips *Aeolothrips intermedius* and *Mymarothrips garuda* are important natural enemies of thrips. Preservation of natural enemies is therefore very important for better control of these pests.

3. Red spider mite (*Oligonychus coffeae*)

- One hundred leaves may be sampled from different areas of the particular field and the number of mites on leaves may be counted to determine the average number of mites per leaf.
- Unshaded conditions are favourable for red spider mite infestations. Therefore, planting shade trees at the recommended spacing will reduce mite buildup.
- To prevent migration of red spider mites by restricting the pluckers from entering into un-infested areas from infested areas and cattle trespass inside the teasections should be stopped.
- Protect the roadside bushes from dust by growing hedge plants like Phlogacanthus thrysiflorus (titaphool) or applying water on such dusty roads at regular intervals, and restrict cattle trespass and the pluckers from entering the un-infested areas from an infested field.
- Removal of alternate hosts (*Borreria hispida*, *Scoparia dulcis*, *Melochia corchorifolia* and *Fussiala suffruticosa*) in and around plantations would give a good control.
- The bushes in ill-drained or waterlogged areas are subjected to increase red spider mite damage, than those in well drained areas. Therefore, inadequate drainage is not only harmful to the tea plants but also creates conditions conducive to the buildup of red spider mite (*O. Coffeae*).
- 'Matidals' facilitate the movement of RSM from alternate hosts to tea bushes, so removal of 'matidals' is a must to minimize their attack. Improvement of bush hygiene by knife cleaning and lime washing in the pruned sections during cold weather will reduce red spider mite infestation.
- Red spider mite incidence is high on the bushes receiving heavier doses of nitrogen but potash and phosphorus application decreased the amount of red spider in tea. Therefore, appropriate fertilization practice is necessary.
- Red spider mite affected fields should get a new tier of maintenance foliage since the infested bushes are very week due to defoliation of maintenance leaves.
- If mite is found active apply the recommended acaricides at fortnightly intervals. Alternate acaricides should be used in repeat round, if fresh infestation is noticed.Coverage of both surfaces and foliage is necessary. During full cropping seasons control measures should be undertaken as spot treatment only.
- For pruned tea monitoring is necessary soon after tipping.
- Avoid spraying during middle hours of the day in sunny weather. Thorough drenching of top, middle and bottom hamper of bushes with spray fluid is

necessary to kill the residual population.

- Some indigenous plant species, viz. *Clerodendrum infortunatum* (Bhant), *Cyclosorus opulentum* (Fern), *Cassia alata* (Dadmurdan), *Pongamia pinnata* (Karanj), *Azadirachta indica* (neem), *Adhatoda vasica* (adosa), *Phlogocanthus thrysiflorus* (lal basak), *Acorus calamus* (Vacha), *Polygonum hydropiper* (Machoti), *Annona squamosa* (Ata), *Tithonia diversiflora* (wild sun flower), and *Urtica dioica* (sisnu) were found to be effective against the red spider mite. Application of 2-3 rounds of 5% aqueous extract of the above mentioned botanicals alone or in mixture at a 7-day interval should be done in mildly or moderately red spidermite infested tea sections for effective control.
- Application of two rounds of 1% sesame oil or karanj oil at 7 days interval may give effective control of red spider mite under field condition.
- Two round applications of indigenous Neem Kernel Aqueous Extract (NKAE) [Neem powder + Organic synergists @ 1:1] at a 7-day interval showed promising results to minimize red spider population at field level.
- Application of lime sulphur @ 1:40 dilutions during cold weather drastically reduced the carryover of red spider mites to the next season.

Acaricides recommended for management of red spider mite:

Acaricides	Dilution	
	HV	HV
Cyflumetofen 20 SC	1:550	1:275
Ethion 50 EC	1: 400	1: 200
Fenazaquin 10 EC	1: 400	1: 200
Fenazaquin 18.3% SC	1:1000	1:500
Fenpyroximate 5EC/SC	1: 1500	1: 750
Hexythiazox 5.45 EC	1: 1000	1: 500
Propargite 57 EC	1: 400	1: 200
Spiromesifen 240 SC	1: 1000	1:500
Etoxazole 10 SC	1: 1600	1: 800
Pyridaben 20 WP	1: 1000	1:500
Propargite 42% + Hexythiazox 2% EC	1: 400	1: 200
Bifenthrin 8 SC	1: 1600	1: 800
Fenazaquin 10% + Bifenthrin 4% EC	1: 400	1: 200
Fenpropathrin 30 EC	1: 1600	1: 800
Spirotetramat 15.31% w/w OD	1:667	1:333
Etoxazole 6% + Abamectin 1.5% SC	1:1100	1:550
Sulfur Formulation 80 WG	1: 200	1: 100

- Red spider mites are attacked by several native natural enemies, especially by predatory insects and mites. Phytoseiid mites (*Agistemus* sp, *Amblyseius* sp., *Cunaxa* sp., *Exothorhis* sp, *Neoseiulus* sp, *Pronematus* sp.), ladybird (Coccinellid: *Jauravia quandrinotata, Menochilus sexmaculatus, Micraspis discolour, Scymnus* sp., *Stethorus sp,)* beetles and their larvae and lacewings (*Mallada* sp., *Chrysopa* sp., *Chrysoperla* sp.) are common predators. So conserve and preserve the natural enemies present in the natural tea ecosystem by minimizing the load of chemicals for their natural regulation.

4. Looper complex (*Buzura suppressaria*, *Hyposidra talaca*, *Hyposidra infixaria*)

Out of the above looper complex *H. talaca* is found to be the most damaging one in entire North east India. Population can be assessed by direct counting of the

number of active caterpillars from bushes selected at random from a particular area.

- Manual removal of caterpillars and moths in case of infestation in limited area.
- Collection of chrysalids from the soil around the collar region and cracks andcrevices of tea plants in old sections during the cold weather.
- As caterpillars prefer to pupate in the cracks and crevices of old tea bushes, cleaning and bush sanitation with alkaline wash after pruning will be helpful in minimizing the looper attack in coming season.
- The eggs are laid in clusters inside the cracks and crevices of the bark of the shade trees like *Albizzia odoratissima, A. lebbek, Acacia lenticularis, A.auriculiformis, Derris robusta, Jarul, Sisso* etc. Old trees with lose and cracked barks are preferred. To minimize egg deposition by the looper moths light scrapping of bark, removing moss and parasitic plants followed by lime washing of the shade tree trunks up to a height of 6m is beneficial. Eggs on cracks and crevices of shade tree trunk should be burnt with *mashal* (burning torch) or by application of effective insecticide up to around 6m. Highest egg laying was observed during November to March with a peak in December-January.
- As these caterpillars are polyphagous in nature, cleaning of weed is essential in an around the tea sections.
- Light traps should be placed to attract and collect the moths. For an area of 10 ha one light trap (Actinic BL light or NCIPM, ICAR designed light trap) should be placed. The light trap should be placed during early evening as soon as it is dark for 3-4 hours on road, vacant patches inside tea areas at about 0.5m - 0.6m above the plucking table, so that it is visible from distance. Monitoring and detection of 1st instar caterpillars to apply insecticide.

Insecticides recommended for management of Looper caterpillars:

Insecticides	Dilution	
	HV	LV
Flubendiamide 20 % WG	1:5000	1:2500
Emamectin Benzoate 5 % @ SG	1:2500	1:1250
Emamectin Benzoate 3% + Thiamethoxam 12% WG	1:2000	1:1000
Deltamethrin 10 EC	1: 2000	1: 1000
Bifenthrin 8% SC	1: 1600	1: 800
Quinalphos 25 EC	1: 400	1: 200

- Use of synthetic pyrethroid should be restricted to rainy period only.
- Hand collection of residual population after insecticide application wherever possible.
- Under severe infestation newly hatched caterpillars disperse from the shade trees with the help of salivary thread in huge numbers. In such case spraying of shade tree should be done using foot sprayer or other specialized sprayer.
- Effective native natural enemies like *Cotesia ruficrus* (Hymenoptera: Braconidae), *Sycanus collaris* (Fabricius) (Hemiptera: Reduviidae), and *Oxyopes shweta* Tikader (Araneae: Oxyopidae) are reported to manage the tea looper (*H. talaca*) in the field. *Entomopathogenic nematodes* (EPN) *Steinernema* sp. and *Heterorhabditis sp. were* also recorded as tools of IPM for *H. talaca* in north-east India.
- TRA-developed nuclear polyhedrosis virus (NPV) formulation shows very

promising results in the management of tea looper at the field level (CIB data generation is in progress)

5. Scale Insect:

Scale insects belong to the families Coccidae and Diaspididae, order Hymenoptera. Those with soft scales belong to family Coccidae and those with armoured scales to family Diaspididae; mealy bugs belong to family Pseudococcidae. There are several species of scale insect observed in tea gardens and the common ones are *Eriochiton these* (Green) on tea stem; *Fiorinia theee* (Green) on tea leaf, *Ceroplastes rubens* (Mask ell) on tea stems.

Now scale insects have become the major problem of the gardens in North East India. The scales are the silent killers of bushes if not noticed at the early stage of infestation. Scale insects are difficult to control because their waxy or cottony covering serves as a protective barrier to traditional contact insecticides. However, a pest management program that incorporates natural, mechanical, and/or chemical controls (as described below) should provide satisfactory control of most scale-infected tea plants. The first and probably the most important step of scale insect management is early detection of the pest.

As they are mostly active on branches the tea bushes. Infestation is not noticeable if not checked properly. Growth of black sooty mold is also an indicator of scale infestation.

- Clones like TV1, Teenali 17, and P126 etc. are more prone to scale infestation; therefore regular vigilance is required for early detection.
- Although the scales are often well controlled by beneficial predators and parasites, due to climate change and over dependence of synthetic pyrethroids reduce the natural enemy population which led to enhanced scale population at present.
- Field and plant sanitation are very important to minimize the pest incidence. Removal of weeds (reservoirs of pests), adequate shade, suitable fertilizers, improvement of drainage system, TRA recommended cold weather practices, ground sanitation etc. encourage the growth and vigour of the plants increasing their ability to resist attack by the insects.
- Caustic washing of the trunk (both LP and DS) of the bushes after cleaning the mosses and lichens and stirring of soil around the collar region will reduce the pest incidence significantly.
- If the scale infestation is moderate to severe (UP condition), we recommend thorough drenching of infested plants including all branches up to the collar region (such as the underside of leaves, stem) with quinalphos 25 EC @1: 400 (HV), thiamethoxam 25 WG @1:4000 and clothianidin 50 WDG @1:4500 plus sticker two round followed by COC application @1:400.
- Mixing Agro spray oil (0.51%) or Sesame oil (0.5%) or soapnut (0.05%) as an adjuvant with above mentioned insecticides can enhance their efficacy.
- Before applying insecticides, make sure the plants are receiving appropriate TRA recommended cultural care and take steps to conserve natural enemies. Use of stickers is recommended during the spraying.
- Recent studies conducted by the Entomology department TRA, revealed that Aloevera extract (5%), Himalayan salt (2%) and lime sulphur @ 1:40 + Himalayan salt (2%) and Washing soda @6 kg/drum had given promising

result in management of scale insect on tea.

- In cases of severe scale insect infestations, dimethoate (30% EC @ 750 ml/ha may be utilized for the control of scale insects since it is approved by CIB-RC as an ad hoc recommendation under national exigency. But strictly follow the pre-harvest interval with proper caution.

6. Termites :

Live wood eating: *Microcerotermes* sp.
Dead wood eating: *Odontotermes* spp.

- Bushes should be properly cleaned out at the time of pruning by removing the snags, dead and diseased branches. Any earthen materials like earth runs over the trunk and stems, earth depositions on the collar of the bushes should be wiped out/removed at the time of pruning.
- Pruning cuts should be painted with indopaste. Remains of old shade tree stumps inside the sections should also be cleaned and treated/removed permanently.
- Improve drainage condition in the termite prone fields. Improve shade status of the tea fields.
- Destroy termite mounds and queens. Remove earth runs and fork the soil around collar region of the infested tea bushes/ shade trees before application of pesticides.
- Weeds like grasses etc within radius of 30cm from the collar region of the bushesshould be cleaned.
- In tea sections where live wood eating termite is noticed, the mulching materials should also be sprayed with recommended chemicals.
- Keep the soil is in moist condition for effective spraying and control. Slight irrigation before and after spraying improves condition of the (hard and dry) soil for absorption of pesticide.
- Stems and branches should be drenched using 250-400 ml for mature tea and 60- 120 ml spray fluid for young tea. The spray fluid requirement will vary between 2000-3000 liters/ha depending on bush population/ha. The spray fluid should be preferably applied by means of plastic cans or with hand sprayer without nozzle.
- In case of termite prone garden, during initial infestation, September – October the sections due for pruning can be treated with Entomopathogenic nematodes (EPN: *Steinernema* Sp. and *Heterorhabditis* Sp. (Minimum Infective IJs 25 nos. per gm of formulation) @ 1.5-2 billion IJ /ha and during December-February, another round of spray with the same on the ground around the collar region may be given.

7. Nematodes :

Root-knot nematode, *Meloidogyne sp.*
Root-lesion nematode, *Pratylenchyus sp*:

- Soil from the nursery site should be tested for eelworm population and acidity status. If the population of eelworm is found to be 6 or above per 10g of soil tested, it is considered to be unsuitable for use.
- Preparation of the nursery bed should be done by harrowing and ploughing to expose and dry the un-decomposed weeds and roots of the plants. All sorts of mulching materials should be kept away from the seed

nursery to avoid nematode infestation.

- Plant parasitic nematodes can be killed by uniform heating (after sieving) of the soil up to 60° – 70°C for 4-5 minutes on plain tin sheets. The soil can be usedafter heat treatment.
- Removal of weed hosts from nursery beds will help in minimizing the population build-up.
- Soil sampling in the estates should be systematic following appropriate procedure to avoid errors in the assessment of eelworm.
- At present no CIB approved chemicals available for management of eelworms intea fields.

DISEASE MANAGEMENT

According to recent estimates, a total of 507 species of fungi have been recorded on tea. Like any other crop, many diseases affect the root, stem and leaf of the tea plant. The most important leaf diseases are blister blight at high elevation with cool climate and black rot, *Fusarium* die back in plains of North East India. Brown blight and grey blight affecting the mature leaves are secondary in nature and not very damaging. They affect the dry matter content of mature leaves. The blister blight disease is responsible for considerable loss of crop in Darjeeling during monsoon. In recent years intensity of *Fusarium* die back is in increasing trend in plains and also in Darjeeling on few clones. The most common primary root diseases in the plains of North East India are Charcoal stump rot and Brown root rot. Black root rot is occasionally found in Darjeeling gardens while Red root rot is a rare occurrence. The important stem diseases are *Poria* branch canker and Thorny stem blight in the plains as well as in the hills of Darjeeling.

Dense shade increases blister blight disease infection despite regular fungicideapplication. On the other hand, regulated shade reduces disease incidence by making the microclimate unfavourable for the pathogen. Black rot is also a common disease damaging the maintenance foliage under overshaded and waterlogged condition and bushes having a dense canopy. Certain cultural control measures for the control of this disease are plucking at shorter interval, removal of badly affected shoots, pruning, proper drainage system, effective shade management by pollarding, proper lane cutting and avoiding of broad-leaved Assam jats on new clearing.

Red rust, a secondary disease is caused by an alga *Cephaleuros parasiticus*. The parasite usually attacks debilitated bushes. Healthy cultural practices, proper stand of shade trees, balanced application of nitrogen and potassium fertilizers will ward off the disease.

1. Black rot: Causal organism: ***Corticium theae* and *Corticium invisum***

A. Cultural control: Prune or skiff the severely affected sections. Improve aeration by lopping side branches and 'matidals'. Thin out dense shade and improve drainage. Give alkaline wash after pruning. Shorter pruning cycle helps in minimizing infestation.

B. Chemical control: Drench thoroughly all the stems and decomposing pruning litters below the bush with Copper oxychloride (COC, 1:400) one week after the first spell of rainfall in February/March. Spray two blanket rounds of COC (1: 400) or Hexaconazole (1:1000) or Carbendazim 12 % + Mancozeb 63% WP (1:400) or Propiconazole 25 EC (1:1000) at 15 days interval during May-June. Apply two monthly rounds of COC during winter to inhibit sclerotia formation.
For effective control, spraying should be directed towards small stems and under

surface of the leaves that bear fungal pathogens.

2. **Blister Blight:** Causal organism: ***Exobasidium vexans***

A. Cultural control: Monitor thoroughly blisters prone sections to detect early symptoms. Thin out shade trees of the sections prone to blister blight incidence. Prohibit the entry of workers of the infested section into the healthy sections.

B. Chemical control:

- Apply Hexaconazole/Propiconazole @1:1000 at 15 days intervals.In case of severe infection, spray at weekly rounds of Hexaconazole/Propiconazole @1:1000 or Copper oxychloride (COC) @1:400 till the disease disappear.
- Labourers working in blister control should not be allowed to work in unaffected teas.
- Normally 4-6 rounds of recommended fungicide are necessary in Darjeeling where the disease appears regularly from July to September.
- In Assam and Dooars, the spraying can be discontinued once the damp weather condition is elapsed and it becomes hot and sunny for a few consecutive days.

3. Red Rust: Causal organism: ***Cephaleuros parasiticus*** **(Stem) and** ***Cephaleuros mycoidea*** **(Leaf)**

A. Cultural control: Identify and correct predisposing factors such as- poor drainage, low soil fertility, particularly potash, improper soil acidity, inadequate shade and continuous use of green crops like *Tephrosia candida*, *T. vogelli* etc. in addition to pruning of severely affected sections.

B. Chemical control: Spray four rounds of copper oxychloride (1:400) targeting towards the young stems and laterals bearing rusty fructifications. First two rounds at 15 days interval and the subsequent rounds at monthly interval. Paint young shade trees/ green crops in nurseries with COC. Use 2% MOP and 2% urea as rehabilitatory spray. In case of leaf red rust spray 4-6 monthly rounds of COC (1:400) targeting to the maintenance foliages.

4. **Fusarium die back:** Causal organism: ***Fusarium solani***

A. Cultural control: Remove infected portion and destroy them away from the sections. Prohibit the entry of workers of the infested section into the healthy sections. Burn or prune severely infested branches before application of chemical treatments.

B. Chemical control: Spray two rounds of or Hexaconazole (1:1000) or Carbendazim 12 % + Mancozeb 63% WP (1:400) or Propiconazole 25 EC (1:1000), at 15 days interval. In case of infection in developing fruits in seed baries, apply the above mentioned chemical in the affected seed baries in every month starting from July to December.

5. Poria branch canker: Causal organism: ***Poria hypobrunnea***

A. Cultural control: Use sharp knives for pruning. Remove the affected branches upto the healthy wood. Protect medium pruned cuts from sun scorch. Establish a good stand of shade trees. Improve drainage.

B. Chemical control: Protect cut surfaces within 24 hours after pruning with bitumen or COC (1:100).

6. Primary root diseases:

Charcoal stump rot - Causal organism: ***Ustulina zonata*** and

Brown root rot- Causal organism: ***Fomes lamaoensis***

A. Cultural control: Uproot diseased plant together with a ring of apparently healthy bushes surrounding the diseased one when detected. Isolate large area diseased patches by 90-100 cm deep and 30 cm wide trench surrounding the area connected to the nearest drain until uprooting can be undertaken.

B. Use *Trichoderma* amended organic matters in planting pit, minimum 250 gm/pit before planting. (@ 10 L of 2 %*Trichoderma* with 1 ton of organic matter).

Fungicide recommended in tea with dilutions

Fungicides	Dilution	
	HV	LV
Copper Oxychloride 50 WP	1: 400	1: 200
Carbendazim 12 % + Mancozeb 63% WP	1: 400	1: 200
Hexaconazole 5 EC	1: 1000	1: 500
Propiconazole 25 EC	1: 1000	1: 500
Tetraconazole 3.8% w/w (4% w/v	1: 1000	1: 500
Trifloxystrobin 25% + Tebuconazole 50% WG	1: 4000	1: 2000

WEED MANAGEMENT

Weeds compete with tea for nutrients and moisture; grasses take away large quantities of nutrients. Many of the weeds serve as alternate hosts for insect pests of tea. Weeds are problematic mainly in the new clearing, young tea and pruned fields and it is necessary to control them till the tea bushes cover the field. Certain cultural practices like mulching, raising cover crops, ideal tipping height to achieve ground cover, infilling and manual weeding are important practices.

Manual control:

- Hand removal of weeds is warranted in specific situations of thorny and hardy weeds, creeper etc. Care should be taken at the time of planting to remove all possible weed propagules present near the plantlet.
- Obnoxious weeds like fern, *Mikania* etc should be uprooted along with the roots and taken out from the tea area to the nearby roads or put in compost pits.
- Use “Cheel hoe” with a half-moon shaped blade in freshly planted areas for scraping the aboveground parts of the weeds and leveling the local depressions in the ground.
- Cut the top growth of weeds in young tea areas with sickles. But perennial grasses like *Imperata*, *Saccharum* etc. should be removed with roots.
- Since mulching cannot be done near to the collar of the plant, removal of sporadic weed growth is necessary.
- Weeds removed from the field should be taken outside the cropped area and put in compost pits. Parasitic weeds like *Cuscuta*, growing on shade trees and hedges should be removed along with the entire host branch and burnt.
- While practicing strip weeding in slopes the uncontrolled strip should be subjected

to manual slashing.

Chemical Control:

- Use of herbicides that are less mobile in soil and inside plants should be preferred. Chemicals recommended by Tea Research Institutes have undergone stringent tests and are safe to be applied.
- The herbicides are to be used judiciously and aimed at the most vulnerable, actively growing stage.
- The dosage and dilution should be at the TRA recommended rate.
- If a few species may show resistance to the recommended dose of the herbicide, these should be manually removed and destroyed.
- Rotation of available herbicides will take care of plant succession and herbicidal resistance.
- Spraying of herbicides should always be directed to the weed foliage or to the ground as necessary.
- Control of weeds at the first sighting with recommended chemical will reducethe weed flora.
- There should a minimum gap of one week after herbicide application and plucking of tea to avoid drift damage by wind.

Herbicides recommended in tea with dilutions

Herbicide	Dilution	Weed flora
Paraquat Dichloride 24 % SL/WSC a) First round b) Second round	 670 ml/200 L water 500 ml/200 L water	Grassy Weeds
Glyphosate 41 % SL *a)* On *Polygonum & Saccharum* b) On other perennials	 1500 ml/200 L water 1000 ml/200 L water	Grassy Weeds
Glyphosate 71 % SG c) On mixed weeds d) On broad leaves	 1000 g/200 L water 750 g/200 L water	Grassy andbroad leaf Weeds
Glufosinate Amonium 13.5 % SL	1500 ml/200 L water	Broad leaf andGrassy Weeds
Carfentrazone ethyl 0.43% + Glyphosate 30.82 EW	3000 ml in 500L water/ha	Mixed weeds
Indaziflam 1.65% w/w + Glyphosate isopropyl ammonium 44.63% w/w SC	2.5 L/ha in 500 L water	Predominantly monocot and Broad leaf
Triasulfuron 20% WG	125g in 500L water	
Saflufenacil 70% WG	100g in 450L water	Mixed Weeds
Glufosinate Ammonium 13.4% + Oxyfluorfen 4.8% w/w EW	3000 ml in 500L water	Mixed Weeds
2,4-D Amine salt 58% WSC	1.4 Kg/ha	Broad leaf
Oxyfluorfen 23.5 % EC	500 ml/ha	Weeds

Paraquat Dichloride 24% + Oxyfluorfen 5% SC	3000 ml/500 L	*Bidens pilosa, Cynodon dactylon, Imperata cylindrica, Ageratumconyzoides, Paspalum conjugatum,Cyperus rotundus and Commelina benghalensis*

Integration of Methods:

Integrated Weed Management (IWM) involves the use of various practices of weed suppression and control to minimize loss of crop and quality. Virgin areas opened up for plantation harbours more species till the area stabilizes to equilibrium. During winter months in N. E. India, there is no need for weed control operations.

- After tillage, the underground reproductive propagules must be collected and destroyed.
- In young teas, pre-emergent herbicides like oxyfluorfen should be used.
- Mulching with green matters or any biodegradable materials after planting and application of pre-emergent herbicides will reduce weed infestation.
- In mature tea areas, where pruning is due in the later months, winter application of herbicides should be avoided and ground should be cleaned, forked in case of heavy soil and leveled manually.
- The pruning litters should be set properly along the plucking gullies as mulch to suppress weed growth.
- Whenever possible, systemic herbicides should be preferred over contact herbicides.
- Cattle trespass and movement of workers through areas treated with pre-emergent herbicides should be prevented as far as possible.
- Use only quality herbicide formulations and use them before the date of expiry.

Preventive measures:

- During land preparation all stubs, rhizomes and other reproductive propagules should be removed. If any “difficult to control” weeds like *Imperata cylindrica* is present, those should be killed by using proper systemic herbicide.
- A ground cover by crop foliage should be established to prevent germination of new seeds. Infiling of vacancies goes a long way in creating a continuous ground cover.
- Vacant spaces inside mature tea areas should be planted with Guatemala grass (*Tripsacum laxum*) or other such rehabilitation crops.
- When compost or un-decomposed organic manures are used, weed seedlings should be immediately removed by appropriate measures.
- The weeds should be controlled before flowering. Edges of the crop field should also be kept weed free to prevent dispersal of seeds from the fringes.
- Depressions in the ground cause local water logging and water loving plants infest the area. Proper ground leveling and adequate drainage should be maintained in the cropped area.

CONTROL OF SOME MAJOR TEA PESTS IN SOUTHERN INDIA

1. TEA MOSQUITO BUG:

- It is highly essential to get an idea on the severity of tea mosquito infestation in the infested fields. Randomly collect 100 shoots (three leaves and a bud) at random from the plucking gang of each field. Count the infested shoots from them. Even a single new puncture should be included as infested. Old punctures should not be included as infested. Calculate the percentage of the infestation. If the average infestation is above 5%, immediate spraying should be done soon after plucking with a follow up round at 7–9 days interval.
- The small, scattered pockets from where infestation starts must be identifiedandalleffortsmadetokeepthesareasfreefromattack.Thiswillhelpinreducing the intensity of damage in the other areas. The fields are to be kept free from weeds which offer excellent hiding places for the pest.
- Weeds like *Maesaindica*, *Mikania cordata, Biden sbiternata, Emillia* sp., *Polygonum chinense and Lantana camara* offer excellent hiding places and serves alternate hosts for the tea mosquito bug. Growth of weeds and wild host plants in and around tea fields should be controlled and this will help to reduce the growth of tea mosquito bug population.
- Regular removal of stubs (bare stalks) and hard plucking/shearing without any selectivity will remove eggs and thereby one generation of pest.
- When an attack by *Helopeltis* becomes unmanageable the affected bushes maybe skiffed to reduce the damage. However, special care should be taken to protect such fields in October-November when a second peak of pest attack may occur.
- In the present context, *Helopeltis* cannot be satisfactorily controlled without the help of insecticides. They may be applied at an interval of seven to ten days, when the infestation is severe; the interval may be extended to 15 days if the attack is mild.
- The quality of the insecticides must be ensured before their usage. The quality parameters, laid down by the UPASI Scientific Department for the insecticides must been ensured for achieving the desired pest control.
- Use only the recommended pesticides and buy them only from authorized sources.
- The recommended chemicals for the control of this pest are Quinalphos @ 1000ml/ha or Thiamethoxam @ 100 g to 125 g/ha. Judicious use of Deltamethrin 2.8EC @ 500 ml/ha or Bifenthrin 8 SC @ 750 ml/ha or Thiacloprid 240 SC @ 500ml/ha or Clothianidin 50 WDG @80g/ha is also suggested if the infestation is on the increase (Table1 & 2). Dimethoate @ 750 ml/ha is also recommended for the control of Tea mosquito bug under national exigency.
- Insecticides belonging to different chemical groups with different modes of action are to be alternated for satisfactory control.
- For quick coverage of large areas, motorized air blast sprayers/High Volume Sprayers are to be used. The volume of spray fluid may range from 300 to 600 litres per hectare depending on the spraying machines used, slope and age of the field.
- While spraying, about ten rows of bushes, bordering the infested areas may be covered first and then the workers may approach the centre of the field.
- Insecticides are to be applied during early morning or late evening when the pest is active.
- The maintenance foliage may be covered thoroughly.

- The predator Reduviid bug (*Sycanus collaris*) can be released to the tea field @1000 nymphal instars / ha for the control of Tea mosquito bug. The reduviid bug species *Sycanus collaris* is mass cultured and available for large scale use.

Table.1.Insecticides recommended for the control of *H. theivora*

Months	Chemical	Dosage/ha
June (1ROUND)	Dimethoate/ *Quinalphos/ Deltamethrin2.8EC	750ml/1000ml/500ml
July (2 ROUNDS)	*Bifenthrin/Deltamethrin	750ml/500ml
August (2 ROUNDS)	Dimethoate/Quinalphos/ Thiamethoxam	750/ml1000ml/100to 125g
September (2 ROUNDS)	Thiamethoxam/Quinalphos	100gto125g/1000ml
October (2 ROUNDS)	Dimethoate/Quinalphos/ Thiacloprid 240SC	750/ml1000ml/500ml

- Add wetting agent for better control during severe incidence. Apply Insecticides only after plucking.
- Integrated Pest Management Strategy is the best for controlling this dreadful pest.

Table.2. Spraying Schedule for TMB (Need based)

Chemical	Dosage per ha
Quinalphos 25 EC	1000 ml
Dimethoate 30% EC	750 ml
Thiacloprid 240 SC	500 ml
Bifenthrin 8 SC	750 ml
Thiamethoxam 25 WDG	100 to 125 g/ha
Deltamethrin 2.8 EC	500ml
Clothianidin 50 WDG	80g
Flupyradifurone 17.09% w/w SL	750 ml

Spray interval: 7 to 10 days during high incidence and two weeks during low incidence

2. SHOT HOLE BORER (SHB)

- Pruning height & Selective Surgery: The SHB infested fields are to be pruned at a height of 60 to 75 cm. This type of medium pruning is best suited for borer infested fields, except when other factors demand a different height of pruning.
- The branches which are very badly affected by shot hole borer may be cut to sound wood by selective surgery. This special task, to be carried out just after pruning, may be assigned only to experienced workers.
- Post-prune spray: Immediately after pruning, the infested field has to be sprayed with any one of the following insecticides to prevent the migration of beetles to adjacent fields. Deltamethrin 2.8 EC @ 500ml/ha or Quinalphos 25 EC @ 1000ml/ha. If hand operated knapsack sprayers are used, a spray volume of 675 liters of water will be required to cover one hectare. The volume of spray fluid may be reduced to 450-500 L/ha, if motorized sprayers are used. Care must be taken to drench the frames and prunings and also to prevent the removal of unsprayed prunings.
- Manuring of pruned (infested) field: It is desirable to apply high level of potassium fertilizer in the pruned year. It is suggested to use N and K2O at 1:2 ratio. This will

help in the development of healthy frames and prevent the build- up of borer population. Potassium is known to impart physiological resistance to plants against many pests. From the 2nd year of the pruning cycle, fertilizers may be applied at the normal rate.

- Infestation trend in the pruning cycle: In the pruned year as well as in the second year, bushes will be comparatively free from borer infestation. An increase in infestation is seen by the end of the second year after pruning. The new branches formed after pruning is more susceptible than the old wood, to borer attack.
- Assessment of infestation in the second year: The level of borer attack will have to be assessed in the 24th month after pruning. For this, the field may be divided into two ha blocks and from each block, 200 stem (new branches) cuttings, each of 20 cm long and 1 to 1. 5 cm diameter is to be collected at random. Any bias towards the collection of infested branches will lead to a wrong conclusion. Each collection may be examined for borer attack and the percentage of infestation in each block and the average percentage of attack for the whole field may be calculated. If the mean percentage of infestation is below 15, the assessment may be repeated in the 30th month.
- **Montanoa cut stems:** Placing of partly dried Montanoa cut stems (25-30 cm thickness and 90 cm long) in the SHB infested third and fourth year fields during May end to October end will attract the SHB beetles to these stems and lead to reduction in the incidence. An average of 4 cut stems are required for 100 sq. m or 400 cut stems per ha. After 20 days, the level of attraction to the stems comes down and the stems will have to be replaced. The attracted beetles may be killed by burning the stems. A Kairomone trap (based on the above) developed by UPASI is also being field tested for the management of SHB in the organic fields.
- Kairomone traps can be used @ 25 traps/ha at a spacing of 20x20 m for the capture of Shot hole borer. The traps can be tied at 0.5 m height from the ground level at a density of one trap / tea bush. The vials should be filled with Kairomone and plugged with cotton dispenser.

Table.3.Schedule for mid cycle control of shot hole borer

Month	Chemical	Dose/Ha
April	Deltamethrin/Quinalphos	500ml/1000ml
October	Quinalphos	1000ml
December	Deltamethrin/Quinalphos	500 ml/1000ml

Schedule for spraying: Based on infestation percentage, mid cycle control may be adopted from the end of second year or early third year and continued till the field is pruned. As mentioned earlier, entomopathogen/insecticides are to be applied in April, May, October and December.

Protection of new clearings: Young plants, planted near borer infested fields are more vulnerable to the attack of this pest. For the protection of plants in the new clearings, insecticides should be sprayed onto the branches in April, May, October and December, till they are subjected to formative pruning.

3. RED SPIDER MITES (RSM)

The population of red spider mite must be monitored regularly and control measures must be initiated when mites begin to appear. The plucking supervisors may be trained

to identify the infested bushes and mark the same. Control measures may be initiated when mites begin to appear. Any delay in tackling the initial population will lead to significant increase in the intensity of attack and spread of the pest.

The following chemicals are recommended for the control of RSM

1) Propargite 57 EC @ 500 ml/ha
2) Fenpyroximate 5 EC / SC @ 300 ml/ha
3) Hexythioxox 5.45 EC @ 400ml/ha
4) Spiromesifen 240 SC @ 300ml/ha
5) Lime sulphur - Polysulphide content 13-15 % @ 1:40, 10-12 % @ 1:30; 7- 9 % @ 1:25 and 5-7 % @ 1:20. It is suggested that lime sulphur preparation with less than 5% polysulphide content should not be used. Lime sulphur has been found to be quite effective in the control of this pest. It has poor acaricidal action and therefore it must be followed by application of propargite at 7 days interval.

- It is suggested to use a spray volume of 350 to 400 litres per hectare with power sprayers, 500 litres per hectare with hand operated sprayers and 500 to 600 litres per hectare with high volume sprayers.
- The entire maintenance foliage must be drenched thoroughly.
- The first two applications must be given at 7 day interval.
- Lanes in alternate rows will be very useful in proper spraying.
- Addition of wetting agent @ 50 ml for every 100 litres of spray fluid will aid in better control.
- The fields must be kept free of weeds as many common weeds are alternate hosts for this pest.
- Avoid cattle grazing inside tea fields.
- The predator green lacewing (*Chrysoperla sp* & *Mallada sp*) can be used for the control of RSM.

4. TEA THRIPS

Following measures are highly essential for successful management of tea thrips.

- The density of thrips population in each field has to be assessed regularly during the pest season to take up appropriate and timely control measures. One hundred shoots should be collected (three leaves and a bud) at random from the infested fields. The number of thrips in each shoot should be counted. If the average thrips population exceeds three /shoot, immediate spraying should be done soon after plucking with a follow up round at 7 – 9 days interval.
- All the small scattered pockets of infestation may be identified and the population must be monitored periodically.
- The control measures must be initiated when thrips begin to appear and not after seeing the symptoms of damage.
- Chemical pesticides like Quinalphos 25 EC @ 750 ml/ha or Thiamethoxam 25 WG @ 100 g/ha recommended to contain the thrips population.
- Usage of correct nozzle and spray volume is also equally important. The optimum spray volume for mist blower (power sprayer) is 300-350 litres/ha. No. III nozzle with discharge rate of 1.5 l/minute is suggested. In hand operated knapsack sprayers, the spray volume may be enhanced to 400-450 l/ha according to the age of the field. Duro mist nozzle (NMD) has to be fitted to these sprayers for applying insecticides. For high volume sprayers the spray volume should be 500 to 600 l/ha.
- One row of bushes on either side of the operator ha to be covered.
- While spraying against thrips, complete coverage of the top hamper is necessary to obtain good control.

- The number of spraying rounds necessary for the control of thrips depends on the severity of infestation.
- A change of insecticide during the alternate rounds of treatments is always advocated to reduce the chances of thrips developing resistance to any of these chemicals.
- It is necessary to maintain 7 to 10 days interval for spraying. The first two applications must be given at 7 day interval.
- Polymer frill yellow sheets (30 cm x 30 cm) are an efficient tool to monitor and control thrips population in tea fields. The surface of the trap should be coated with a thin film of inert pertroleum jelly as a sticky material. Twenty traps/ha is required for this purpose. It can be placed in Grevillea trees at a distance of 20 m distance on the bush canopy level at an angle of 40º facing against the wind.
- Thrips population can be counted weekly interval.
- Lanes in alternate rows will be very useful in proper spraying.
- Addition of wetting agent @ 50 ml for every 100 litres of spray fluid will aid in better control
- The fields must be kept free of weeds as many common weeds are alternate hosts for this pest. Integrated Pest Management Strategy is the best for controlling this dreaded pest.
- The predator green lacewing (*Chrysoperla sp* & *Mallada sp*) can be used for the control of Tea Thrips.

5. BLISTER BLIGHT AND GREY BLIGHT DISEASES

Name of the disease	: Blister blight
Category	: Leaf disease
Causal organism	: *Exobasidium vexans* (Fungus)
Disease season	: June to November
Ideal conditions	: Temperature- 17° C to 22° C. Relative humidity- above 60%

Cultural Practices

Fine-tuning of the following cultural practices would bring down the infection pressure, which would reduce the cost of blister blight control.

Shade regulation: Thickly shaded areas are highly prone to disease and it would be beneficial if pollarding of shade trees at 9.1 meters high followed by lopping is done just before monsoon.

Weed control: Presence of weeds in tea fields provides a microclimate, which favors disease development. Weeds should be removed from the fields during disease season especially in the fields recovering from pruning, which are highly vulnerable to the disease.

Lane cutting: Spraying lanes should be cut every four rows apart to facilitate the free movement of the spraying persons.

Plucking: Closer rounds of plucking interfere with the life cycle of the pathogen, which in turn reduce disease incidence. Over grown shoots should not be left on the plucking table. It is equally important that the banjies have to be removed at the time of plucking.

Disease Assessment

- Assessment of infection should be made field wise at the time of plucking. Two to three handfuls of shoots may be drawn from the harvest of each plucker and bulked to prepare a composite sample.
- 50 to 100 shoots may be drawn at random from this lot. The shoots must be uniform, comprising either three leaves and bud or two leaves and a bud and not a mixture of shoots at various growth stages.

- Each shoot has to be examined for incidence of the disease. A shoot is counted as infected even if a single lesion is noticed. Right from oil spots to mature sporulating lesions will have to be taken into account. Fully necrotized lesions have to be considered as controlled, while partly necrotized ones as infected. From the total number of infected shoots, the percentage of infection may be worked out.

Control Measures

Table 4. Nursery (June to November)

Schedule	Fungicides*& Dosage in 10 litres of water	Spray interval (days)
Hexaconazole	Hexaconazole 10ml+ Copper oxychloride 10g	7
Propiconazole	Propiconazole 7ml+ Copper oxychloride 10g	7

Table 5. Young tea and Tea under plucking (June to November)

Schedule	Fungicides*& Dosage/ha	Spray interval (days)
Hexaconazole	Hexaconazole 200ml + Copper oxychloride 210g	7
Propiconazole	Propiconazole 125ml+ Copper oxychloride 210g	7
Tebuconazole 50% + Trifloxystrobin 25%	125 g	7

* Add non ionic wetting agent to the spray fluid @ 0.05 % during wet weather

Table 6. Tea recovering from pruning

Schedule	Fungicides*& Dosage/ha	Spray interval (days)
Hexaconazole	Hexaconazole 200 ml+ Copper oxychloride 210g	5
Propiconazole	Propiconazole 125 ml+ Copper oxychloride 210g	5
Tebuconazole 50% + Trifloxystrobin 25%	125 g	5

* Add non ionic wetting agent to the spray fluid @ 0.05 % during wet weather

- The fields pruned in April/May recover during the peak monsoon months and highly prone to the disease. Control measures should be undertaken right from June to till the tipping is over. After tipping, the control measures recommended for tea under plucking may be continued.
- In July/August pruned fields, spraying should be commenced without waiting for the bud break to protect the susceptible shoots left during pruning and continued till tipping is over.

Table 7. Organic Tea

Fungicide	Dosage/ha	Maximum no. of rounds
Copper oxychloride	420g	14
Copper oxychloride	350g	17

Table 8. Sprayers and spraying techniques

Sprayer	Nozzle	Discharge rate (L/min)	Spray volume* (L/ha) Plucking	Pruning	Walking speed (ft./min) Plucking	Pruning	Coverage (Rows on either side)
Knapsack (indigenous)	NMD (0.45)	0.45	150-175	175-250	40	30	1+1
Knapsack (imported)	NMD	0.55	120-150	150-170	50	40	1+1
Mist blower (indigenous)	Rotatory 2	1.0	60-90	70-90	90	80	2+2
Mist blower (indigenous)	AMN disc 1.0	1.0	60-90	70-90	90	80	2+2
Cifarelli (imported)	Position 4	1.5	50-60	50-70	90	80	4+4

Disease season: Throughout the year, Peak season-July to December.

Grey blight/die-back of shoots will result in severe crop loss if proper control measures are not adopted.

Disease Assessment

Disease assessment has to be made straight on bush canopy by using a quadrat of one square foot size. Keep a quadrat (one sq. foot) on the plucking table of the randomly selected bushes and assess the infected and uninfected leaves (IL), cut leaves (CL), bare stalks (BS) and young shoots (YS) inside the quadrat and individually calculate the per cent infection. The percent disease incidence (PDI) may be calculated by the formula:

% Disease Incidence = (IL + CL + BS + YS)/4 IL = disease incidence on intact leaves; CL – disease incidence on cut leaves, BS – disease incidence on bare stalks, YS – Disease incidence on young shoots (all on per cent basis).

Table 9. Control Measures

Fungicide	Dosage in 10 L of water	Spray interval (days)
Carbendazim 12% + Mancozeb 63%	20g	10-15
Copper Oxychloride	30g	10-15

Points to Remember

- Bare stalk plucking and stripping should be completely avoided. Knapsack sprayers are recommended to carry out the spraying operations with a spray volume ranging from 175 to 300 litres per hectare depending on the extent of disease severity.
- The bushes have to be thoroughly drenched with the spray fluid to get complete control. A prophylactic spray just before the onset of monsoon would help in reducing the disease pressure. Afterwards, the spraying may be taken up when the disease incidence crosses 15%.
- Two successive fungicide applications at an interval of 15 days are necessary to bring the situation under control. After the commencement of fungicide application, periodical observations should be made to assess the presence of spores on the affected portions.
- The recommended fungicides should not be combined with the fungicides used for blister blight control.

Weed Management

- Weeds compete with tea for nutrients and moisture; grasses take away large quantities of potassium and deprive the tea plants of his major nutrient. Many of the weeds serve as alternate hosts for insect pests of tea. Weeds are problematic mainly in the new clearing and pruned fields and it is necessary to control them till the tea bushes cover the field. Certain cultural practices like mulching, raising cover crops, closer planting higher pruning and tipping practices, infilling and manual weeding are important practices.
- Adopting the schedule of herbicide applications as recommended by UPASI Tea Research Foundation can effectively control weeds.

Chemical weed control in tea fields

1.	Paraquat dichloride 24% SL*	2.25 L/ha
2.	Glyphosate 41% SL	3.00 L/ha
3.	Glyphosate 41% SL+Kaolin#	2.0 L+ 2.0 Kg/ha
4.	Ammonium salt of Glyphosate 71% SG	2.250 kg/ha
5.	2,4-D amine salt 58% WSC	1.935 kg/ha

Approved for use in RF certified gardens
*Banned by Government of Kerala
In 450 litres of water per ha for blanket applications.

CHAPTER 3

HAZARD CATEGORIZATION OF PESTICIDES

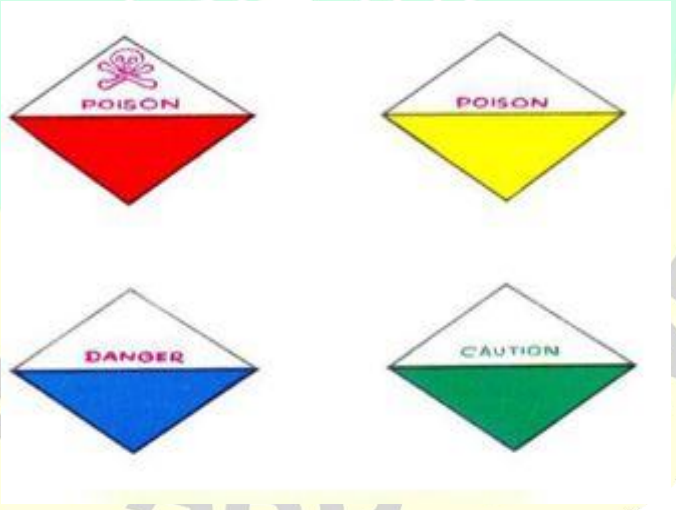
Pesticides are poisonous substances and they are to be handled with extreme care. On the basis of 'acute toxicity', pesticides are grouped into four 'hazard categories'. The hazard categorization of the pesticide should be indicated in the label on the pesticide container. The label shows a square (set at an angle of 45°) divided into two triangles. The lower triangle will be coloured according to the hazard category and the upper triangle will show the symbols of toxicity (Plate I). Following table gives the details of hazard categorization of pesticides in India (Table 1).

Table 1. Hazard categorization of PPFs

Classification of pesticides	Colour of the lower triangle	Symbol and signal word* on upper triangle
Extremely toxic	Bright Red	Skull and cross bones 'POISON' in red
Highly toxic	Bright Yellow	'POISON' in red
Moderately toxic	Bright Blue	DANGER
Slightly toxic	Bright Green	CAUTION

* Signal words in Indian languages may also be given in addition to those in English

Plate I: Hazard categorization of pesticides



SAFETY PRECAUTIONS

The responsibility for the safe and effective use of pesticides rests with the government, industry, extension agencies, farmers and workers themselves (**GIFAP. 1983). The improper use of pesticides is a major cause of concern in all the developing countries and this highlights the need for educating the people engaged in the storage, handling and application of these poisonous chemicals. It is the responsibility of all concerned with the use of pesticides to ensure that the workers involved in the application are properly educated and trained.

(** Groupment International des Associatione Nationales des Fabricants de Produits agrochimiques.)

CHAPTER 4

DO'S AND DON'TS IN TEA PEST MANAGEMENT

- Monitor the incidence of pests by assessing their populations in the field.
- Mark the areas from where the pest attack starts
- Start appropriate control measures in the beginning of the season
- Integrate cultural control methods with biological and chemical control measures.
- Use pesticides only when it is absolutely essential
- Do not allow the pests to cross the ETL
- Do not reduce the recommended concentration of pesticides
- Do not mix two or more pesticides.
- Do not unduly drench soil.
- Do not add wetting agents unless recommended
- Do not allow the growth of weeds in ravines, along drains, foot-paths and vacant patches.
- Do not allow cattle inside the tea field

Guidelines for safe and effective use of pesticides

- Read carefully the label on the pesticide container
- Use the pesticide only when it is essential
- Use only the recommended pesticide and buy them only from standard sources.
- Apply pesticides at the correct dosage and by the recommended method
- Use protective clothing like overalls, gloves, goggles, rubber gum-boots and wide-rimmed hats.
- Do not wear clothes contaminated with pesticides
- Clean the protective clothing by washing with soap and water
- Do not allow children, sick persons and pregnant and nursing mothers to handle pesticides
- Never blow out clogged nozzles with mouth
- Do not use leaking sprayers. Avoid contamination of skin, mouth and eyes.
- Do not inhale the pesticide while mixing
- Never spray against the wind
- Do not leave pesticides uncared for in the fields
- Do not allow humans and livestock to enter the pesticide sprayed fields for a safe period.
- Do not wash pesticide containers near wells or running streams
- Keep clean water, soaps and towels ready for use.
- Wash hands and exposed skin thoroughly with soap and water before eating, drinking, smoking or chewing and after work

- Keep the pesticides locked in store room and out of reach of children and other unauthorized persons
- Do not enter sprayed field. Follow the re-entry periods for all pesticides including herbicides, as suggested by the manufactures.
- Keep pesticides in their original labeled containers.
- Do not decant pesticides into unlabelled containers, except for immediate use.
- Dispose the containers safely after thoroughly emptying and washing. They may be buried in a place away from wells or water sources.
- Never reuse the container for any other purposes: it is impossible to remove the traces of pesticides from the containers.
- Make sure that those who handle and apply pesticides understand and follow the safety precautions.
- In any case of pesticide poisoning, the affected person should be taken to the nearest hospital or a doctor called in as soon as possible. Before medical assistance reaches the spot, first-aid may be given to the patient.

CHAPTER 5

SAFE DISPOSAL OF PESTICIDE CONTAINERS

1. Unwanted pesticides and pesticide containers are serious hazards in the tea gardens if not disposed off properly.
2. Pesticide containers should not be used for any other purposes like storage tanks, live stock feeding trough etc.
3. Pesticide containers can never be properly cleaned or decontaminated at garden level.
4. It is hazardous to leave the empty containers as such. These should be appropriately disposed off.
5. Combustible containers can be burnt unless the container label warns against burning. Containers made of paper, cardboard & plant materials can be disposed off by burning.
6. It is important to note that herbicide containers, pressure cans & aerosol containers should not be burned and must be buried in the designated area.
7. Non combustible containers should be broken or deformed by punching holes at several places to prevent reuse. They have to be disposed off by burying them in the soil.
8. The spilled pesticides should be absorbed with cloth, cotton or saw dust and disposed off safely in the designated area by burning or burying, depending on the nature of pesticide.
9. Containers containing unwanted pesticide should be buried at a depth of 50 cm in the designated area.
10. The excess or left over pesticide spray fluid should also be disposed off in the designated pesticide disposal area.
11. The pesticide waste disposal area in the garden should be on a relatively higher ground, flat or gently sloping, away from any water source. The soil should be deep.
12. The pesticide waste disposal area should not be used for growing crops or for constructing buildings, wells or ponds.
13. The disposal site in the garden should be fenced and appropriately identified with clear sign boards.
14. The disposal area should be easily accessible for disposal of containers, and left over pesticides.

CHAPTER 6

TRANSPORTATION OF PLANT PROTECTION FORMULATIONS

Pesticides are toxic materials and accidents can occur at any time. The person undertaking transportation of the materials is responsible for taking preventive measures to reduce hazards during transportation.

Several precautions need to be taken to ensure safe transportation. Safety of the labourers loading and unloading the material, and safety of transporter, is equally important.

The following guideline should be helpful in the safe handling and transportation of pesticides:

1. The safest means of transporting pesticides by road is an open-type truck. Closed trucks do not offer good ventilation, and materials which give off noxious fumes can be hazardous.
2. Ensure that the good are protected against rain during transportation.
3. Load and unload the materials with care.
4. Do not throw pesticide packages, or allow them to drop from a height.
5. Do not use hooks in loading bags.
6. Never place pesticide packages under heavy loads of other items.
7. Whenever possible, do not load pesticides in passenger vehicles.
8. Do not carry foodstuff, animal feed etc., on the same truck as pesticides.
9. Do not transport livestock or domestic animals with pesticides.
10. Avoid puncturing paper containers when handling them.
11. Load only tightly closed and sealed containers.
12. When loading, check that the outside of the package is not contaminated with pesticide.
13. Load the pesticides on the vehicles in such a way that it does not roll or side from place to place.
14. Do not transport herbicides with other pesticides and fertilizers.
15. Do not allow children to ride on the vehicle.
16. Place boxes with the right side up.
17. Load one container or package at a time.
18. Do not permit handling labour to smoke or prepare and chew tobacco during loading and unloading.
19. Load carefully within the weight limitation of the vehicle. Ensure that containers do not fall on the vehicle.
20. Inform the truck driver of the potential hazards of the pesticide.
21. When transporting any hazardous substance, it is desirable that the carrier should have a Transport Emergency Card (TREMCARD) inside the vehicle.
22. Material Safety Data Sheet (MSDS) should be made available.
23. Do not leave a loaded vehicle unattended. Such vehicles may attract the attention of inquisitive children or livestock.

24. Always send a detailed inventory of the material loaded in the truck with the driver.
25. After unloading the truck inspect the body of the vehicle, the tarpaulin used to cover the material and other parts of the truck for evidence of leaks or spills. If found, treat spill properly.
26. Before loading check the truck body for protruding nails, metal strips or other sharp objects which could puncture containers. Hammer them flat if found.
27. Do not permit passengers to ride in the back of the truck, or sleep on top of the loaded truck.
28. Clean vehicle after unloading.

CHAPTER 7

STORAGE OF PLANT PROTECTION FORMULATIONS

The farmer/consumer normally handles much smaller quantities compared to the retailers. However, the fundamental principles of good storage practice remain the same.

1. Never store pesticides in living quarters, or in the kitchen.
2. Always keep pesticides in their original containers. Do not transfer to food or water containers.
3. Store away from children and fires.
4. Store in a locked cupboard or box meant exclusively for pesticides. There should be designated in-charge for keys to storage for PPFSs.
5. Store in shaded area.
6. Keep storage quantity to a minimum.
7. Buy only when needed and consume quickly.
8. Store in a ventilated area.
9. Do not store animal feed or other food stuff with pesticides.
10. Inform all family members of the location of the store and warm them.
11. Inspect periodically for signs of damage or leaks. The storage areas should have sand pits and the floor should be concrete.
12. Use the oldest stock first.
13. Ensure that a partly left over product is kept in its original container only, and the container is tightly closed.
14. Never store garden chemicals in soft drink bottles, or any other container that could lead to anyone, especially a child, to mistake the contents for food or drink.
15. Follow the FIFO (First In First Out) principle while storing the PPFs.

CHAPTER 8

APPLICATION OF PLANT PROTECTION FORMULATIONS

Spraying equipment and tips for successful spraying:

Spraying is an important operation in tea agro practices and considerable manpower and financial inputs are involved in the operation. Spraying machines are used for the application of pesticides, herbicides and nutrient formulations on target sites. The job of spraying machine is to break down the spray fluid into tiny droplets under pressure for uniform coverage of the area sprayed. The main difference in application of all these materials lies in the variable requirement of droplet sizes, accompanying spray pressure and targeting the spray towards different parts of the plant body. While herbicides require bigger droplets, insecticides require finer spray, and nutrient solutions require thorough wetting of foliage for better absorption. Generally, in a tea plantation, the following types are commonly used.

Knapsack sprayers & backpack sprayers (Hand sprayers):

Hand sprayers are generally high volume sprayers used for spraying insecticides, acaricides, fungicides, herbicides and nutrient formulations with different nozzles. They are sub divided into:

Back pack sprayer for herbicide spraying:

For herbicide spray, Floodjet nozzle is fitted to the spraying machine and the operating pressure is maintained between 10-15 psi. Recommended nozzles: WFN24, WFN40, WFN62.

Knapsack sprayer for pesticide, fungicide and nutrient spraying:

For spraying pesticide, fungicide and nutrients, the spraying machine needs to be fitted with Hollow cone nozzle, which normally discharges 450cc fluid per minute under an operating pressure of 40 psi. Recommended nozzles: NMD 60/450, NMD 80/450, HCN 100/700, BAN 75/450. For efficient operation of hand sprayers, continuous pumping is necessary.

Power sprayers:

These are motorized air blast sprayers which use low volume of water. They are also called mist blowers. They atomize the spray fluid into extremely fine droplets with a throw of 14-20 ft (4.5-6 m). Recommended nozzles: AMN nozzles.

High tree sprayers:

These are foot operated sprayers used for spraying pesticides and fungicides on shade trees and tea plants in seed baris.

Spray fluid:

The volume of spray fluid required for spraying varies according to the type of equipments used, types of pruning, kinds of pests and diseases, their intensity of incidence and in case of weed control, type of herbicide used. Spray fluid requirement (l/ha) for different situations is given below:

Type of tea field	Spray volume (L/ha)		
	Hand Sprayer		Power sprayer
	Pest	Disease	
Pruned	200-350	400-600	100-150
Skiffed	350-500	500-600	200-250
Unpruned	500-700	600-700	250-300

CHAPTER 9

PRE-HARVEST INTERVAL

The safe pre-harvest intervals for the PPFs in tea plantations

Type of PPFs	Sl. No.	Name of PPFs	Pre harvest interval (PHI) in days*
Acaricides	1	Cyflumetofen 20 SC	5
	2	Ethion 50 EC	3
	3	Etoxazole 10 SC	5
	4	Etoxazole 6% + Abamectin 1.5% SC	3
	5	Fenazaquin 10 EC	7
	6	Fenazaquin 18.3% SC	
	7	Fenpyroximate 5 EC/SC	7
	8	Flufenzine 20 SC	7
	9	Fenazaquin 10% + Bifenthrin 4% EC	7
	10	Hexythiazox 5.45 EC	5
	11	Propargite 57 EC	7
	12	Propergite 42% +Hexythiazox 2%EC	7
	13	Pyridaben 20% WP	7
	14	Spiromesifen 22.9 SC	7
Insecticides	15	Bifenthrin 8 SC	11
	16	Clothianidin 50 WDG	5
	17	Deltamethrin 2.8 EC	3
	18	Deltamethrin 11 EC	15
	19	Emamectin Benzoate 5 SG	1
	20	Emamectin Benzoate 3% + Thiamethoxam 12% WG	7
	21	Fenpropathrin 30 EC	7
	22	Flubendiamide 20 WG	7
	23	Flubendiamide 19.92% w/w + Thiacloprid 19.92% w/w SC	7
	24	Flupyradifurone 17.09% w/w SL	7
	25	Quinalphos 25 EC	7
	26	Spirotetramat 15.31% w/w OD	7
	27	Thiacloprid 21.7 SC	7
	28	Thiamethoxam 25 WG	7
	29	Thiamethoxam 12.6% + L-Cyhalothrin 9.5%	7
	30	Carbendazim 12% + Mancozeb 63% WP	7
Fungicides	31	Hexaconazole 4% + Zineb 68% WP	7
	32	Hexaconazole 5 EC	7
	33	Propiconazole 25 EC	7

	34	Tetraconazole 3.8% w/w (4% w/v)	7
	35	Trifloxystrobin 25% + Tebuconazole 50% WG	7
	36	Glyphosate 41 SL	21
	37	Glyphosate 71 SG	7
Herbicides	38	Glyphosate Ammonium Salt 5 SL	7
	39	Glufosinate Amonium13.5 SL	15
	40	Oxyfluorfen 23.5 EC	15
	41	Paraquat Dichloride 24% + Oxyfluorfen 5% SC	15
	42	Carfentrazone Ethyl 0.43% + Glyphosate 30.82% EW	7
	43	Indaziflam 1.65% w/w + Glyphosate-isopropyl ammonium 44.63% w/w SC	14
	44	Saflufenacil 70 % WG	7
	45	Triasulfuron 20% WG	7
	46	Glufosinate Ammonium 13.4% + Oxyfluorfen 4.8% w/w	10

*As per CIB guidelines on major usage of pesticides dated 01.06.2023

CHAPTER 10

SPRAYING INSTRUCTIONS AND PROPER MAINTENANCE OF SPRAYING EQUIPMENTS

The person spraying the pesticide can be exposed to it during his work. If he is careless, he may also expose other people or farm animals to the pesticide. It is therefore essential to use safe working practices in the application of the pesticide.

1. Read carefully the label on the pesticide containers
2. Wear personal protective equipment as recommended.
3. Spray crops with the wind and gradient. In other words, spray with the wind coming from the back.
4. Ensure that there are no animals, people, food or animal feed downwind, i.e. in the direction in which the wind is blowing.
5. Check sprayer and equipment for leaks. Leaking spray equipment can seriously contaminate the person. Avoid contamination of the skin, mouth and eyes.
6. Do not walk with running sprayer on roads, pathways.
7. Apply at the correct dosage and by the recommended method.
8. Never blow out clogged nozzles with mouth.
9. Do not wash pesticide containers near a well or running stream.
10. Dispose the containers safely after thoroughly emptying and washing. They may be buried in a place away from wells or water sources.

Before spraying

1. Identify the pest and ascertain the damage done. Use only recommended pesticide which is least, if the pest populations exceed the economic injury Level.
2. Read instructions manual of the pesticide and equipment.
3. Check the spraying equipment and accessories which are to be used.
4. Ascertain that all components are clean, especially filling and suction strainer, sprayer tank, cut- off device and nozzle.
5. Replace worn out parts such as 'O' ring, seal, gasket, worn out nozzle tip, hose clamps and valves.
6. Test the sprayer and ascertain whether it pumps the required output at rated pressure.
7. Check the nozzle spray pattern and discharge rate.
8. Calibrate the sprayer, by set spraying speed and nozzle swath by adjusting spray height and nozzle spacing.
9. Make sure that appropriate protective clothing is available and is used.
10. Train all concerned with application and also understands the recommendations.
11. Ensure that soap, towel and plenty of water is available.

During Spraying

1. Take only sufficient pesticide for the day's application from the store to the site.
2. Do not transfer pesticides from original container and packing into the containers.

3. Recheck the use instructions of pesticide and equipment.
4. Make sure pesticides are mixed in the correct quantities.
5. Wear appropriate clothing. Avoid contamination of the skin especially eyes and mouth.
6. Liquid for formulation should be poured carefully to avoid splashing.
7. Do not spray in high wind, high temperature and rain.
8. Avoid drift by selecting proper direction of spraying and also holding nozzle and boom at a proper height.
9. Start spraying near the downwind edge of the field and proceed upwind so that operator upwind so that operator moves into unsprayed area.
10. Never eat, drink or some when mixing or applying pesticides.
11. Never blow our clogged nozzles or hoes with your mouth.
12. Follow correct spray technique. Spray plant crop thoroughly by operating sprayer at correct speed and correct pressure.
13. Never allow children or other unauthorized persons to be nearby during mixing.
14. Never leave pesticides unattended in the field.
15. Never spray if the wind is blowing towards grazing live stock or pastures regularly used.
16. Do not tamper with the spraying nozzle.

After Spraying

1. Remaining pesticide left in the tank after spraying should be emptied and disposed off in pits dug on wasteland.
2. Never empty the tank into irrigation canals or ponds.
3. Never leave unused pesticides in sprayers. Always clean equipment properly. After use, oil it and then keep away in store room.
4. Do not use empty pesticide containers for any purpose. Crush and bury the containers preferably in a land-filled dump.
5. Clean buckets, sticks, measuring jars, etc. used in preparing the spray solution.
6. Remove and wash protective clothing and footwear. Wash yourself well and put on clean clothing.
7. Keep an accurate record of pesticide usage.
8. Prevent persons from entering treated areas until it is safe to do so. Mark the sprayed plots with a flag.

Maintenance

1. Checking and preparation should commence well before the beginning of the season. Sprayer should be well maintained during the spraying season.
2. Clean both inside and outside of sprayer after each day's work, even if the same chemical is being used the next day.
3. Sprayer should be lubricated thoroughly and regularly, especially all moving parts, before starting the work.
4. While inspect the parts of sprayer, worn out, broken and damaged parts should be replaced.
5. To avoid guess work and waste of time it is necessary to specify correct name and code number of the part specified in the manual.
6. Parts that are likely to be needed should be kept in stock.

7. Filters and nozzles should be cleaned thoroughly It is of paramount importance

Maintenance of High volume sprayer

1. Use clean fuel (high speed diesel)
2. Keep fuel tank, fuel filter and fuel pipes clean
3. Daily, before starting the engine check up oil level in the pump with the correct grade of oil.
4. Install the engine in an airy space and ensure that engine breathes clean air.
5. Keep air cleaner and exhaust silencer clean.

CHAPTER 11

QUALITY OF WATER FOR SPRAYING

The quality of water used to mix with agricultural chemicals can reduce the effectiveness of the Chemical applications.

Poor quality water can reduce spray efficacy. Use cleanest water possible for spray applications. Test water for turbidity, hardness, pH and EC

Poor quality water can:

- Reduce activity of agricultural chemicals
- Block spray lines or nozzles, reducing chemical application uniformity
- Increase wear of nozzles also causing reduced chemical application uniformity
- Increase wear on spray rigs.
- Water quality is variable and is dependent on the source of the water (e.g. rainwater, farm dams, river, bore, town reservoir). Water quality can also vary throughout the year and after periods of high rainfall or drought. Use the cleanest water possible when preparing agricultural chemicals for application. Where clean rain water is not available use the following guidelines to minimise spray failure due to poor quality water. Note that some agricultural chemicals are more sensitive than others to poor water quality; check the specific instructions on pesticide labels.

Guideline to minimize spray failure

Turbidity

Dam or river water often contains suspended particles of clay, silt and fine organic matter, giving the water a “muddy” appearance. Transfer muddy water to a settling tank where heavier particles will sink to bottom. Use a “flocculent” such as Alum (aluminium sulphate) to settle out the very light particles. However DO NOT use water treated with Alum to spray amine formulation chemicals. Filter the water before filling the spray tank. Alum is most effective at pH 6.8 - 7.5 and should not be used if water pH is less than 5.5.

Hardness

Water hardness is caused by high levels of calcium and/or magnesium and is common for bore water. Chemicals with amine formulations, which include the herbicides: glyphosate, 2,4-D amine, and dicamba are adversely affected by hard water. Hard water can cause some chemicals to precipitate and can affect the properties of surfactants, emulsifiers and wetting agents. Precipitates can block nozzles and pre-filters and cause additional wear of spray rigs.

To “soften” hard water use softening agents, adjust pH and use water that is neither very hot nor very cold temperatures. Add Ammonium sulphate to hard water in spray tank before adding amine formulation herbicides. This will improve efficacy.

pH

The pH of water indicates its acidity or alkalinity and is measured on a scale of 1 to 14. A neutral pH is 7. Most water has a pH between 6.5 and 8. Water above 8 is alkaline and water below 6.5 is acidic. pH >8.5 or <6, can affect spray mixes. pH >8 can cause deposits in pipes and blockage of equipment. pH <6, can cause corrosion of metal pipes and fittings. Alkaline water (>pH 8) can break down some chemicals through a process called alkali hydrolysis. In the case of some herbicides this actually improves efficacy, but it is likely to reduce the efficacy of many other agricultural chemicals. The longer a mixed chemical is left in the tank prior to spraying, the greater the breakdown; it is not recommended to leave spray mixes overnight. Acidic water can affect the stability and physical properties of some chemical formulations. Critical pH levels at which chemical efficacy is compromised should be included on pesticide labels. Water pH can be changed by adding an acid or alkaline to the water tank. Using an acid such as sulphuric or phosphoric acid will lower pH while addition of an alkaline such as potassium hydroxide will increase pH. This has to be done precisely using calculated amounts depending on the pH change required. Do not guess.

Salinity

Salinity is the concentration of all soluble salts in water. The amount of mineral salts dissolved in water is measured by its electrical conductivity (EC). The type of local rock and soil can influence the saltiness of water, but high EC is usually caused by runoff containing fertilizer salts getting into the water source. Salty water can cause blockages and corrode the metal parts of spray rigs. High salt levels, particularly chloride, can lead to burning of crop foliage. Sensitivity to salts varies between crops. It is important to know the concentration of chloride that will cause foliar damage to crops grown. Most agricultural chemicals are not adversely affected by low to moderate salt levels. Salty water can be mixed with fresh water to reduce EC levels to more suitable levels for spraying.

Organic matter

Water containing a lot of organic matter (e.g. algae or leaves) can block nozzles and pre-filters. High levels of algae can also increase the alkalinity of water and will reduce the efficacy of some agricultural chemicals. Filter water before filling spray tanks. The best filters to remove organic matter are media filters with 1 mm crushed basalt. Disc filters with 60-micron openings can also be used.

Iron

Iron-loving bacteria can grow in water where the concentration of iron is 0.3 to 1.5 mg/L (0.3 to 1.5 parts per million, ppm). This can cause blockages in equipment such as pressure gauges. Iron is soluble in water where there is little or no oxygen, as can occur in deep bores and dams. Iron concentrations above 1.5 mg/L (1.5 ppm) can cause iron deposits in water, pipes and equipment.

Aeration oxidises iron, which makes it form solid particles that can be filtered or settled out of solution. Procedures used include aeration, settling, chlorination and use of potassium permanganate.

Temperature

Very cold water can cause some chemicals to gel and reduces the solubility of wettable granule formulations. Hot water can reduce the stability of chemical mixtures. Water temperatures extremes can increase accentuate the effects of other water quality factors. Avoid mixing sprays during extreme weather. On a hot day let the hose flow for time enough to become cool.

CHAPTER 12

SAFETY MEASURES FOR SPRAYING SQUAD

The following type of protective equipment can be used:

Overalls:

For almost all conditions, a light cotton overall is the best. The overalls must cover as much of the body as possible. Long sleeves with cuff-buttons, trouser buttons which are laceable at the bottom offer good protection. A high collar with the upper-most button closed offers good protection of most of the body areas. Avoiding pockets, remove areas where pesticide dust can accumulate.

It is better to separate one set of clothes for use with pesticides. Choice of clothing should be such that it can cover the greatest possible body area. In no case should a pesticide be applied or mixed without adequate protective gear.

Aprons:

When mixing highly toxic pesticides and/or spraying them in uncertain win conditions, water proof aprons made of rubber or plastic are very effective, Aprons should reach from the top of the chest to below the knees. A good idea under such circumstances is to use a plastic or rubber rain-coat. Another locally available apron is a large sized plastic bag with three holes cut on it's seamed bottom for the head and two hands, In this case the apron does not protect the sleeves and shoulder but offers good protection to the body.

Gloves:

Gloves are the single most important item for use. Dermal exposure is maximum in this area. Using the gloves greatly reduces this risk. The gloves used should have a length upto 2-3" below the elbow. The glove should be worn outside the shirt sleeves so that any liquid does not wet the shirt.

Rubber gloves are clean and easily available. Other durable gloves include cloth-backed PVC gloves which are also quite effective. When using gloves, there is a slight loss of dexterity in using the fingers and hands. However, by working slowly and patiently with gloves almost all jobs related to pesticide mixing and application can be done. Emulsion concentrate formulations can quickly penetrate the gloves, especially in case of heavy spill. Such spills must be cleaned quickly.

Gloves should be decontaminated and tested for leaks. Leaking and damaged gloves should be destroyed since they can cause greater damage than using no gloves at all.

Shoes:

A operations related to pesticides should be done while wearing shoes. However work such as that related to puddle paddy fields, which necessarily requires working

bare-foot, are exceptions. Shoes made of rubber or plastic are easily available. The large gum boots offer the best protection. However even ordinary shoes offer good protection. Shoes should be regularly inspected for damage and possible leaks. Using shoes greatly reduces chances of dermal exposure.

Head Protection:

Hair presents an excellent place for dust or liquid mist to accumulate. It is also difficult to wash. It is therefore important to protect this area, A rain coat cap or hat with a wide brim offers a reasonable amount of protection.

In many areas turbans are used. This long piece of cloth can be effectively used to cover the head, It is preferable to identify one such turban for pesticide application and decontaminate it like other pieces of clothing.

A cotton balaclava cap is cheap and offers a reasonable degree of protection.

Pesticides should never be handled without proper head gear.

Goggles:

Goggles, face shields and spectacles primarily protect the eyes and the face. Apart from protecting against splashes and spills, tight fitting goggles offer good protection against irritating fumes on the eyes. Goggles, however do not protect the face. A properly fitting set of goggles will be found uncomfortable.

A cheap and fairly efficient method of protection against mists, small droplets and splashes reaching the eye is achieved by wearing ordinary spectacles, These are quite comfortable to use and can be used for prolonged use, goggles will be found uncomfortable.

A face shield is a piece of transparent acetate or acrylic sheet which covers the whole face. It is good to prevent a spill or splash from reaching the face. However, it does not protect against fumes irritating the eyes.

Respiratory equipment:

This is the most difficult and yet the most important form of protection. Respiratory equipment is by nature uncomfortable to use. It is difficult to talk with the respirator on. A respirator is also bulky and expensive.

Respiratory equipment is of different types. These different types of respiratory equipment perform different functions. They have different limitations of use. They are: nose filters, cartridge type respirators, canister type respirators, positive pressure breathing apparatus and self contained breathing apparatus.

Nose filters are simple devices available in 2-3 different designs. The simplest one is a piece of soft cloth tied across nose and mouth by means of wither a cloth band or an elastic one. Disposable designs using filter paper or pressed synthetic fibres are also available. Nose filters are mainly used for filtering airborne particulate solids. The best designs are normally limited to a filtration efficiency of 99% for 5-micron sixe particles. Nose filters are the cheapest of all respiratory protective equipment.

Cartridge type respirators are made of synthetic washable plastic and cover the mouth and nose. These are held in place by an elastic or rubber head band. The air valves inflow and outflow through these filters is regulated by means of small rubber

non-return valves. Air enters the respirator through a cartridge. This cartridge contains different layers of filters and adsorbent materials. Contaminated air is filtered at the first stage of activated clay where organic vapours are removed. The clean air then passes into the respirator and this air is breathed by the user.

The cartridges are produced by the respirator manufacturer and have to be destroyed after use.

Cartridges are produced by the respirator manufacturer and have to be destroyed after use.

Cartridge type respirators are good only for intermittent exposure to chemicals. With continued use the absorbent layer becomes ineffective and no cleaning takes place.

These respirators are more expensive than nose filters. The maintenance cost are also high because of the replacement cartridges. However, a combination of intermittent use of cartridge type respirator with regular use of dust filter can provide an excellent degree of protection.

Canister type respirators area also known as “gas masks”. They comprise of two basic designs. In the first case the breathing end is built like a cartridge type respirator with the filters replaced by a tube. The second design has a full face visor with a rubber face piece. The design covers the entire face head till below the chin. The face piece is held in place by means of rubber head bands. The design also has a rubber tube inlet. In both cases the rubber tube is connected to a canister. The canister contains air and chemical filters. Specific canisters are available for specific gas hazards. Since the canisters can contain larger quantities of adsorbent, they can be used for longer periods. These types of respirators are more expensive and are useful only in operations where continuous exposure to high concentration is involved, such as fumigation of godowns or ship holds.

Positive pressure air breathing apparatus type of equipment comes in two designs. The first design comprises of a rubber face piece with a face visor. The second design comprises a helmet like head piece and face visor and both these are held in place by a plastic cloth. The assembly is worn on the head and strapped under the shoulders and across the chest.

Air for breathing in both designs is supplied from an external source, may be an air compressor or an air cylinder. This compressed air provides the area near the nose and mouth with a pressure higher than that in the atmosphere and thereby does not allow outside air to enter.

Success in the use of these of respirators needs a good supply of compressed air. The compressor therefore must be located in an area where there is no pesticide contamination. Air from a compressed air cylinder may also be used. However, packed air cylinders have no moisture and therefore this air humidifier in the air supply circuit. In the absence of such a humidifier, problems related to excessive dryness or even desiccation of the external and internal respiratory organs may occur.

This type of equipment is useful when working in areas where a high concentration of pesticides may be encountered. It also supports life in an area where there is a depletion of oxygen. The operator using this type of device is restricted in his movement to the extent of the air life line length.

Self contained breathing apparatus:

The construction of the self contained breathing apparatus is the same as that for positive pressure breathing apparatus. The exception is that the operator carries his own supply of compressed air on his back. The mobility with this equipment is greater. The areas of use are the same as those for positive pressure breathing apparatus. However, this equipment is very expensive and is rarely used.

CHAPTER 13

END PRODUCT TESTING

Tea is covered under the FSSAI Regulations defining several quality attributes which are at par with the international standard ISO-3720. Residues are the remnants of the applied chemical substances (plant protection products) which remain in or on food commodities or feed at a given time following their use. For regulatory purposes it includes the parent compound and any specified derivatives such conversion products, metabolites and impurities considered to be of toxicological significance.

MRL is the maximum concentration (mg/kg) of a pesticide residue legally permitted in or on food commodities and animal feeds MRL is intended primarily as a check that GAP is being followed and to assist national and international trade in produce treated with pesticides.

As per the FSS (Licensing and Registration of food business) Regulations 2011, all the manufacturers [including repackers & relabellers] need to conduct mandatory product testing twice in a financial year on a half-yearly basis as per FSSAI order, dated 13th January 2023. Accordingly, all manufacturers of tea are required to test their products as per FSSR 2011 standards for tea twice a year in 6 months interval from a NABL accredited laboratory and upload the report on the FSSAI portal as per followings:

Period	Testing Period for F.Y 2023-24	Report upload
1st half	April 2023 - September 2023	Within 31st October 2023
2nd half	October 2023 - March 2024	Within 30th April 2024

CHAPTER 14

MEASURES TO KEEP THE RESIDUES IN TEA BELOW THE MAXIMUM LIMIT

1. Monitor for early detection of pests
2. Adopt integrated pest management techniques
3. Use only recommended safer pesticides,
4. Avoid repeated spraying of same pesticides
5. Allow sufficient waiting period between spraying and plucking
6. Avoid blanket sprays as far as possible
7. Resort to spot treatment
8. Use pesticides only at recommended rate and method.
9. Check pesticide formulations for active ingredient and impurities
10. Monitor other inputs used in the plantations.
11. Maintaining hygienic conditions both in field and factory
12. Ensure proper disposal of excess spray fluid, empty containers & old stocks.
13. Regularly monitor invoice tea samples for residues.

Use of sub-standard or non-approved product or non-compliance of recommended method and dosages or over-uses amount to abuse of pesticides. This will aggravate the residue and other problems mentioned earlier and may lead to leakage of residual pesticides drained from tea gardens into nearby areas inviting social and ecological problems as well.

Therefore, in addition to the above measures, the following points are very important and needs to be ensured:

1. Use the chemicals in rotation - application should be need - based.
2. Spray only after plucking.
3. Do not use pesticides, which have crossed shelf life.
4. Use only conventional sprayers.
5. Do not use banned pesticides in tea.

NOTES

MAXIMUM RESIDUE LIMITS (MRLs)

In India, generally tea companies have been following the residue tolerance limits prescribed by the Environmental Protection Agency of USA. Now, concerted efforts are being made by tea companies to adhere to the standards prescribed by various other countries, especially those set by the EU/EEC. Tea industry in India has been holding continuous dialogue with the tea importing countries in the matter of evolving standards.

Indian tea industry realizes that though the task may be difficult, it would be necessary to adhere to pesticide residue limits prescribed by various countries. The industry is also in close liaison with the BIS for establishing the standards.

The Central Insecticides Board and Registration Committee, Government of India, constantly review the usage of pesticides in this country and up-date information with the help of pesticide industry on the safety of chemicals and those which pose a health hazard.

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