Module No.

8

TEA RESEARCH

Institute of Tanzania

A tea bush affected by Mycelium of Armillaria root rot

Tea leaf Damage by Mosquito Bug

Training module on

INSECT PEST AND DISEASE CONTROL IN TEA

April 2006

FOREWORD

This is the eighth of a series of Training Modules prepared by the Tea Research Institute of Tanzania (TRIT). The first was on Rehabilitation of abandoned Tea fields, the second on Fertilizer and manure, the third on Tea plucking and Quality control, the fourth on Weed Control in Tea Bushes; the fifth on Establishment and Management of Tea Nurseries; the sixth on Tea Pruning and Tipping; and the seventh on Fuel Wood Production. Insect pests and diseases are constraints to tea production particularly in the early years of establishment of tea. Pest damage in tea often leads to a significant impact on productivity. Despite crop loss, pest infestation also affects the quality of processed tea. This module is meant to assist farmers, extension workers, estate managers and researchers in their effort to address damage caused by insect pests and diseases in tea and the appropriate control measures. TRIT welcomes suggestions from users and readers of this module and other previous modules so that improvements can be made while updating them.

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INTRODUCTION

Tea is coming among priority cash crops in Tanzania and is grown in the districts of Mufindi, Rungwe, Njombe, Muheza, Korogwe, Lushoto, Bukoba, Muleba and lately being introduced in Tarime. Tea being a long-term i.e. permanent monocultural crop can be exposed to insect pest and disease infestations. Currently, insect pests and diseases is not a serious problem in tea production in Tanzania. However, there is evidence that the pest and disease status in tea in Africa is changing, so the current situation may also change. Also, deliberate research on the prevention and control of tea pests and diseases has not been carried out in Tanzania, therefore, as a precautionary measure, there is need to study important pests and diseases in tea, assess their damage and devise appropriate control measures before they reach epidemic levels.

This training module has been prepared to expose extension staff, estate managers, scientists and farmers with important pests and diseases, damage that they cause and appropriate control methods involving recommendations from other tea growing countries. The main objectives of the training module are:

- To identify major types of insect pests and diseases found in tea fields;
- To identify symptoms of particular insect pests and diseases found in tea fields;
- To understand the effects caused by insect pests and diseases in tea production;
- To identify the appropriate control measures of insect pests and diseases; and
- To know the pesticides and the safe use of pesticides.

The module consist of 5 chapters which are Major insect pests of tea, Classification of pests, Major diseases of the Tea Plant, Methods of pest control and Recommended Pesticides

The module has been designed to support participatory learning through group discussions, first-hand identification of insects and symptoms of particular diseases by participants, plenary sessions and practical skills of pesticides in use.

Chapter

1

MAJOR INSECT PESTS OF THE TEA PLANT

Pests

In tea production, the term pest can be defined broadly as any living organism, plant or animal, which causes damage to the tea plant by feeding on it. The pest damage in tea can often lead to a significant impact on productivity, although the magnitude of pest infestation varies depending on altitude, climate and cultural practices.

Despite crop loss, pest infestation also adversely affects the quality of processed tea, for example: damage caused by sucking pests like thrips and mites leading to dull appearance of tea. Severe infestation of flushworm, thrips, mites and mosquito bug affects the flavour of made tea.

Insect Pests

About 300 species of animals, mainly insects, are known to feed on tea. Only a few of these, namely mosquito bug, tea thrips, red spider mites, cockchafer larvae and carpenter moth, normally cause sufficient damage to justify preventive control measures (*Diagram 1)*. Mites, unlike all other tea pests do not belong to the class *Insecta* but to the class *Arachnida* together with spiders and scorpions. Animals in the class *Arachnida* have 4 pairs of jointed legs, no antennae and their head and thorax are fused in such a way as to make them difficult to distinguish as separate parts.

These insect pests can be categorized as follows:

1. Leaf and shoot feeders such as mosquito bug, *thrips*, aphids, scale insects, caterpillars, weevils;
2. Stem and branch pests such as carpenter moth;
3. Soil pests such as termites, cutworms, weevils, crickets; and
4. Seed pests such as false coding moth.

Animal Pests

In some areas, rat moles and porcupines are known to cause considerable damage to tea roots and stems due to their underground habitat. Where they occur they are controlled by surveillance and trapping.

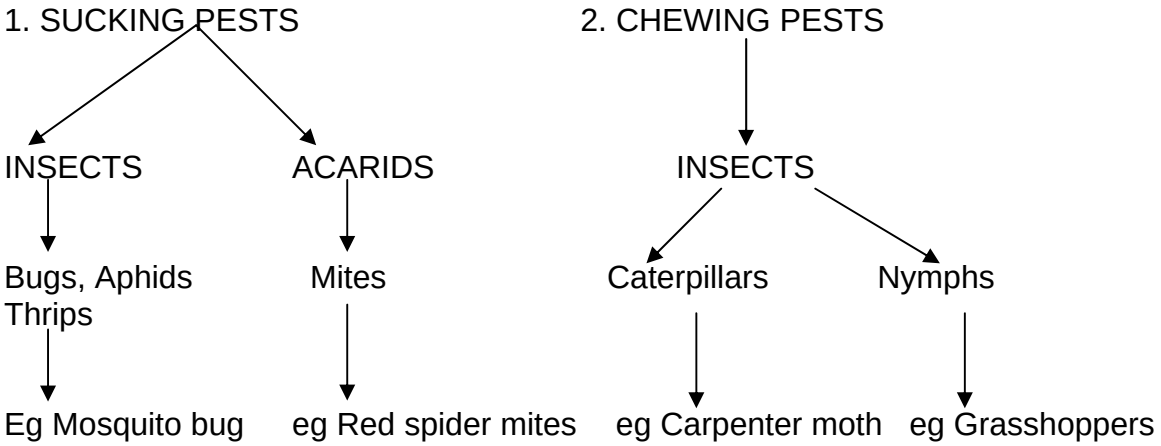
Chapter

2

CLASSIFICATION OF PESTS

Insect pests are classified according to the way of feeding on the tea plant. They can be grouped into sucking and chewing pests.

Diagram 1: Major sucking and chewing pests in tea.



Piercing and sucking pests in tea

The mosquito bug (Helopeltis schoutedeni Reut)

This is a slender bug up to 10 mm in length and belongs to the order *Hemiptera.* The females are crimson-red and the males orange or yellow though the head, antennae and thorax are black. They have a thin projection, about 2 mm long, growing out from the back of the thorax, rather like a wireless aerial. It has been observed in some parts of Tanzania, particularly, in the East and West Usambara Mountains as a minor pest.

The life cycle of the mosquito bug: Life cycle from egg to adult is completed in 5-11 weeks, depending on the season. Eggs are laid on tissue of tender stem, mid-rib and petiole of leaves. It breeds all the year round; however, their number fluctuates during the year. Overcast skies, high rainfall and low temperatures are very favourable for the development and survival of the pest whereas dry hot weather affects it adversely. Nymphs (instars) and adults feed on the tea bush during early morning hours, late afternoon and at night. They hide in the lower foliage during the day.

Damage

Both nymphs and adults of the mosquito bug prefer to feed on young plant tissue of leaves, tender stems, shoots, petioles and buds by piercing and sucking the plant sap with their proboscis. They are thereby injecting toxic saliva into the plant tissue causing it to break down into papery, pale brown necrotic patches. Feeding on the leaf results in water-soaked spot, which is at first circular and pale green turning dark brown after a few hours. When the petiole and the mid rib are attacked they cause the curling of the leaf and it becomes distorted, blackens and finally dies. Feeding on the green shoot and its tip may result in the death of the shoot. In severe cases, the whole of the tea bush is blackened as if scorched by fire and there is virtually a total loss of crop. Damaged shoots are easily recognizable as the sucking ability of the pest produces characteristic spots on the leaves (Plate 1b).

Plate 1(a): Adult female mosquito bug *(b): Leaf damage by adult mosquito bug*

Control of mosquito bug

Biological control-Spiders and praying mantis have been seen to catch and eat mosquito bugs but their influence on the pest population is not significant.

***Cultural contro*l**

Weeds serve as alternate hosts for many tea pests. Effective weed control assumes greater significance in the management of tea mosquitoes. The heavily shaded and moist areas will be damaged more by tea mosquito bug, therefore regulation of shade is important.

Chemical control

The use of chemicals to control mosquito bug should be based on the assessment of the pest and the damage, also known as scouting. Spraying without scouting will result in unnecessary over or under application and will be inefficient and uneconomical. Spraying should be done when the average Damage Index reaches threshold levels,

which vary according to the time of the year and age of the tea. Recommended chemicals for use include: Thiodan (Endosulfan) 35% EC and Actellic 50% EC. Based on results of trials carried out by TRF(CA) in 1987, Thiodan was more effective than synthetic pyrethroid insecticides as reflected by increase in crop. Minimum number of days between spraying and plucking is not less than 5 days to avoid taint. Spraying is done early in the morning and late afternoon when they are active. Spraying should be done after removing the infested leaves from the table by skiffing or by black plucking.

Botanical insecticides

These are derived from extractions, pressing, infusions, pulverizing, etc and they come from any plant part. The fact that they are plant derived, however, does not distinguish them from other pesticides by virtue of their use, mode of action, chemistry, formulation toxicity safety, efficacy, marketability, or overal utility. Neem has been found to have multifarious properties like antifeedant, repellent, toxicant, growth inhibitor, antiovipository etc. The bio-efficacy of neem oil (NO) and neem seed kernel powder (NSKP) against sucking pests have been observed in a field trial conducted in Darjeeling. Neem oil and liquid soap at 1% concentration offered best control followed by NSKP 100gm treatment.

Biting and chewing pests in tea

The carpenter moth (*Teragra quadrangula*)

This insect belongs to the order Lepidoptera that includes moths and butterflies. Adult carpenter moth has two pairs of wings that are covered with scales, and a sucking proboscis. It is nocturnal and therefore rarely seen. The moth itself does little or no damage, as it feeds on nectar from flowers and other liquid foods. Its larva, a caterpillar, however, has biting and chewing mouth parts with which it feeds on the bark of tea stems and branches. In Tanzania, the pest infestation has been recently observed in some villages of Mufindi District causing less damage.

Life cycle

Eggs are laid individually in cracks on the bark or on old pruning litter on the ground and hatch in fifteen to twenty days. The presence of the hatched caterpillar becomes noticeable by a web which each caterpillar spins over the area it inhabits.

Damage caused

The damage to tea is caused by caterpillar feeding on the bark and leave ring barking stems and branches with young plants being more affected than mature tea. Ring barking causes the transport system (phloem and xylem) to be destroyed and this prevents the movement of water and it's dissolved contents from the roots of the tea plant and the conducting of food from the leaves. The leaves turn chlorotic; the plant withers even when well watered and dies (*Plate 2*). An outbreak of the pest in young tea can cause a loss of up to 50% of the young plants especially in the dry season. In

tea over five years old the carpenter moth usually feeds on branches also by ring barking making a hole within the feeding area into the wood, which appears to be largely for shelter. The ring barked branches manifest no visible sign of stress and usually remain less productive. Just before adult emergence, the pupae wriggle out of their holes until most of the body is jutting out, and then the adult moth emerges emptying the pupal shell hanging out of the web. Feeding stops after the emergence of adult.

Plate 2: Symptoms of carpenter moth damage

Control of carpenter moth

Biological control: little is known about natural enemies, but there indications that the carpenter moth population is kept low by predators as well as parasitizing wasps and other feeding on the pupae.

Chemical control: The caterpillar is most vulnerable to insecticide spray before it has made the protective web and bored the retreat hole. Spraying young plants once or twice, just before the start of the dry months helps control the pest. The spray should normally be directed to the frame of the plant. If infested fields of mature tea are adjacent to young tea field and field with infills should be sprayed to prevent migration into young tea. Lambdacyhalothrin (Karate 5% EC) at the rate of 100 ml per hectare applied after pruning is recommended for the control of carpenter moth. The use of endolsulfan chemicals is also recommended.

TERMITES

Termites are important pests in tea where they limit the establishment of newly planted young tea and reduce the stand of mature tea by killing bushes. Termites are soft-bodied, pale-coloured insects with biting mouthparts and live in colonies. Colonies of some species have been estimated to remain active for over a hundred years. Termite infestations have been noticed in some parts of Kagera, Tanga and Mbeya regions; notably where tea growing conditions are marginal due to less rainfall.

Damage caused

Termites feed only on plant material. Those feeding on dead wood are to be considered only as secondary pests, whereas those feeding on live wood may cause considerable damage to the tea bush. Termite tunnel, ring bark or sever young plants, causing them to wilt and die. Ring barking can also be caused by cockchafer or white

grub (*Plate 3*). In contrast to termites, a white grub attack produces a heavy callus around the ring. They also destroy the root system as well as the heartwood. Termites girdle the branches and attack the bush frame at any time of the year. The first sign of attack is a loss of vigour, followed by chlorosis, incipient wilting, moribund and death.

The main species of termites causing damage on tea

***Ancistrotermes spp*.** (including ***A.latinotus*)**. These feed on crop debris and woody litter. The termites enter the roots or the collar at bellow ground level, and often penetrate stems and branches. Roots are completely eaten out or tunnels are made into the stem.

***Microtermes spp*.** These feed mainly on woody litter and roots and they damage tea by boring into the stem and ring bark below the soil surface.

Pseudacanthotermes spp. (including ***P. militaris***) is a wide spread dark coloured litter feeder, occasionally damaging tea and Eucalyptus.

Control and prevention:

Termites are difficult to control because they live underground, so preventive rather than curative measures should be taken. Cultural practices such as correct mulching, timely pruning, and protection from sun scorch damage, or shading and irrigating help to alleviate stress and thus reduce the likelihood of termite damage to the tea plant. The options for chemical control are limited, expensive and less effective.

BEETLES

Cockchafer larvae - Schizonycha spp*.*

Cockchafers or white grubs are found in moist soils; the larvae feed on grass roots and dead material and occasionally may feed on the root of the tea plant. They attack in the nursery or in newly planted field (up to two years) especially during dry period. The grubs are white and C-shaped (*Plate 3*) and live in soils at a depth of 5 to 20 cm. The adult beetle emerges at the beginning of the rains and feeds on leaves of other plants. In Tanzania, it has been observed in Mkonge village-based tea nursery.

Plate 3: Cockchafer larvae - Schizonychasspp

Damage caused
The roots are eaten away and the stem is often ring barked at the soil level. The damage is frequently followed by extensive callus growth and swelling around and below the collar. The leaves of the affected plants turn yellow, wilt and defoliate and plants often die. Sometimes, the cockchafer grub damage is often confused with injury caused by chemical fertilizer coming into contact with the collar of the young plants.

Control:
The damage is very sporadic and thus no routine insecticide treatment of the soil before or after planting is recommended. Infilling should be done as soon as convenient. Keeping mulch 15-20 cm away from the collar of young plants will help to prevent damage occurring.

When tea nurseries are affected by chafer grub, it is advisable to treat the soil by incorporating endosulfan with the top 10 cm of soil of new nurseries) which are to be established in the vicinity before the cuttings/seeds are propagated or planted respectively. For the affected plants, loosen the soil around the bush and spray with endosulfan 35% EC at 3 ml/litre of water. Spraying in the planting holes before planting has also been found to be beneficial.

THRIPS

Black tea thrips (Hellothrips haemorrhoidalis**)**

The insect has polyphagous feeding habits and has also been recorded in citrus, pine, coffee and many other crops. Infestations occur during dry season but heavy rain and cold weather reduce the population. In Tanzania, it has been observed in most tea growing areas, particularly in Mufindi district.

Damage caused:
Outbreak of black tea thrips are associated with prolonged drought, they suck the cell sap of mature and young leaves. The new leaves remain small, become cupped and the margins are brown and cracked. The growing shoots are stunted with shortened internodes and defoliation often occurs (*Plate 4*). The underside of the affected leaves become silvery with black spots, the excreta of the insect.

Control
The pest can be controlled by timing the prune so that the tea is fully recovered by the beginning of the thrip season. Spray the foliage with Fenitrothion 50% EC at the rate of 2ml per litre of water or spray with Karate 1.75% EC at the rate of 4ml per litre of water.

Plate 4: Flush damage by thrips

GRASSHOPPERS

Species of grasshoppers (*Plate 5*), crickets and locusts are found in tea but they usually feed on other plants. They do localized damage in the early rains by biting and chewing leaves. The very young nymphs characteristically skeletonise leaves.

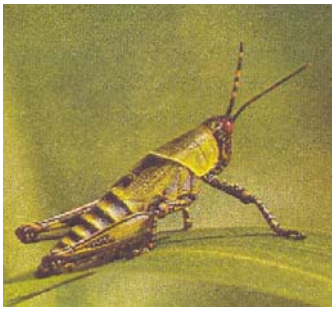


Plate 5: Elegant grasshopper

Control
Hand collection is recommended before insecticides can be used.

TEA MITES

Red spider mite (*Oligonychus coffeae*)
One type of the many mites that attack tea is the red spider mite which is present on tea all year round, although numbers vary depending on season. Their number increases as the weather warms up and decreases markedly once rains set in. In Tanzania, this pest is prevalent in Kagera and in the Usambara Mountains.

Damage caused:
Tea of all ages is attacked, the upper surface of the mature leaves darken and turn brown (*Plate 6*). The leaves then dry up and drop off, reducing the maintenance foliage. The mites and their egg shells can be seen on the upper surface of the leaves with a naked eye but more visibly if magnified, the front part of their bodies is red and hind part is purple. Signs and symptoms of red spider infestations show up early in unpruned than in pruned tea, because the pest survives on the old leaves in the canopy.

Plate 6: Leaf damage by red spider mite

Control
Good management practices, in particular weed control, planting resistant clones, mulching and adequate levels of fertilizer should be maintained to reduce red spider infestations.

Chemical control is essential when outbreaks exceed threshold levels. A spray of omite 57% at 3ml/litre of water is recommended. Use enough water to wet the bushes thoroughly. However, there has been no increase in yield in experiments done by TRF(CA) controlling red spider and other mites by use of chemicals.

SCALES

Soft white scales

Scale infestation is usually localized; they tend to remain confined to the individual bush. Scales have sucking mouth parts; they insert their mouth parts and start feeding by sucking. The effects may not be very serious in mature tea, but on young tea may lead to severe defoliation, stunting and dieback. Soft scales have been reported in Kagera at Maruku tea estate.

Damage
Soft scales feed on green stem or on the underside of the leaves mainly along the midrib, and produce large amounts of honeydew. Yellow feeding spots appear on the upper side of the leaves, the damaged leaves eventually drop off. The ants feeding on honeydew are sometimes the only sign of their presence. Often, however, sooty mould grows on the honeydew so that some portion of a bush appears black. Soft scales are known to kill small branches

Control
Scales insects are some of the most difficult pests to control because their mouth parts are more or less permanently inserted in the plant tissue and their scales protect them from contact with chemicals. It is important to follow good hygiene when taking cuttings from mother bushes. Spray with Karate at 4ml per litre of water and if necessary re-spray after two weeks. Allow a minimum interval of one week between praying and plucking. Ants that may spread the attack can be controlled by spraying with Dursban 48% EC at 1.5 ml per litre of water around the affected leaves.

NEMATODES

There are various types of nematodes which attack tea particularly in nurseries where propagation of cuttings take place continuously. Some nematodes may also attack tea in the field. Attacks of nematodes to tea are reported from other countries. In Tanzania, nematodes have not come to be noticed perhaps due to lack of methods of identification including a nematologist.

Chapter

3

DISEASES OF THE TEA PLANT

Disease

Tea like other agricultural crops is prone to attack by diseases. Disease can be explained as a condition of the plant involving abnormalities of growth or structure. The symptoms, or visible signs, of a disease can vary between minute changes in appearance to death of the whole plant. Disease causing pathogens are parasitic organisms that live in or on the host plant and cause the appearance of disease symptoms, a process called pathogenesis. Parasitic diseases are important because they are infectious. They can spread between plants, often rapidly and extensively and may produce epidemics. The severity of symptoms when judged visually is not a good indication of the importance of the disease. Some diseases may produce no immediately obvious symptoms in the field but cause substantial reduction in yield, whereas others produce very obvious symptoms, which have little effect on the productivity of the plant.

The diseases can be categorized as follows

1. Leaf diseases such as brown and grey blights, eye spot;
2. Stem diseases such as stem and branch canker (*Phomopsis theae),* wood rot disease *(Hypoxylon serpens and H. investiens); and*
3. Root diseases such as *Armillaria root rot,* charcoal stump rot *(Ustulina deusta).*

The damage done depends on the part of the plant attacked, the part harvested, and the stage of development of the plant. There are only a few economically important diseases affecting tea in East Africa. These include Armillaria root rot, stem and branch canker and wood rot.

Causes of plant disease

Plant disease may be caused by pathogens such as fungi, bacteria, viruses or nematodes. Parasite causing plant diseases can be classified as obligate or facultative, according to their dependence on the host plant.

Obligate parasites depend upon the existence of the host. They grow directly upon the host plant and are usually not able to grow on non-living organic matter. Their survival in the absence of a suitable host depends upon dormant resting stages in the life cycle such as spores. This is why they may cause only fairly mild symptoms such as growth malformation, stunting and discoloration. Although they may not kill the host,

its steady debilitation leads eventually to loss of yield. Examples are powdery mildews and rusts, as well as smuts on maize and soot mould on tea. Viruses are highly specialized obligate parasites that can only exist within the living plant cells. Facultative parasites are adapted to a saprophytic existence and can survive long periods in active stage in the absence of a suitable host e.g. *Armillaria heimii*. Because destruction of their host is of less consequence to the survival of facultative parasites, they cause more immediate and drastic damage such as necrosis and wilting. They produce a variety of toxins and enzymes which kill the plant tissues as they are penetrated. Both parasites produce chemical substances known as auxins which interfere with the growth-regulating mechanisms of the host. Many disease symptoms are the result of the defense reactions of the host and include, for example production of corky tissue or scab as well as blocking of xylem vessels by swelling of cell walls. This difference in the parasites' dependence upon the host plant underlies the choice of control measures.

Fungi

Fungi are plants that lack chlorophyll and are unable to synthesize food from the sun's energy as green plants do. Consequently, they are parasitic or saprophytic. Parasites penetrate growing plants by their fine-branching mycelial growth through natural openings such as stomata, air pores or wounds. Most parasitic fungi are facultative although some are specialized obligate parasites such as powdery mildew and rusts. Fungi produce spores, which are microscopic seed-like structures of different sizes and shapes, methods of dispersal that enable the fungi to spread between plants. Fungicides are rarely used in the field to control fungi except in India where blister blight *Exobasidium vexans* is prevalent. To control diseases in the nursery, however, Copper oxychloride, Dithane, Ridomil or other brands are commonly used.

Bacteria

Bacteria cause a number of important plant diseases, but many fewer than those caused by fungi. Bacteria are microscopic plants that lack the primary photosynthetic pigment of all green plants. They are all facultative and often work together with fungi. Plant parasitic bacteria use sugar as their main source of energy but some are capable of using cellulose which is the main material of the cell walls of plants. As a result spots develop which may be surrounded by special plant secretions forming scabs and cankers as is the case with fungal diseases.

Viruses

Plant diseases caused by viruses are among the most difficult to control. Viruses are intracellular parasites and can multiply only inside living host cells. This means that they are incapable of reproducing themselves and induce their hosts to make copies of themselves. They are so small and can only be seen with electron microscope. Their effect is systemic and leads to such symptoms as yellowing, mottling, leaf curl, excessive branching or stunting in infected crops, all of which can reduce yield; severe infection can lead to death. Viruses are mostly transmitted by piercing and sucking

insects (vectors) but may also be transmitted mechanically with working tools or by nematodes, fungi or through seeds. The disease itself cannot be controlled but the means of spread can.

Nematodes

Nematodes or eelworms are microscopic non-segmented roundworms, which are common inhabitants of the soil. Some of these are plant parasites feeding on or in the roots of plants, causing diseases such as root knots. They may also transmit virus diseases, by damaging the root system which can seriously affect yield e.g. in tobacco.

Root diseases

Root rot or Collar crack (Armillaria heimii Pegler)

The disease is caused by a fungus, *Armillaria heimii***.** This fungus is closely related to ***Armillaria mellea*** which exists in natural tropical forests as a saprophyte and a mild parasite on the roots of many types of trees. Armillaria is rarely seen on crops (E.A) as no more forest land is being cleared for planting tea, but becomes apparent where normal precautions, such as removal of shade trees without first ringbarking them are ignored.

Symptoms: Tea plants of all ages are susceptible to this disease. Affected bushes occur in patches, usually around old tree stumps, but sometimes isolated bushes are affected. Plants become weaker and their leaves begin to turn yellow and finally wilt and defoliate, eventually leading to death of the plant. Longitudinal cracks are usually present on the collar above the soil level but also on the tap root and lateral roots (*Plate 7*). Scrapping of the bark at the collar region reveals sheets of creamy white mycelia and the wood has a strong mushroom like-smell. This has been observed at Kyimbila Estate in Rungwe District in 2005.

Control: Removal of stumps left in the soil would certainly eliminate the food base of secondary root rot pathogens. The operation of ring-barking carried out before felling the tree will deplete the starch reserves in the stump, thus making it unsuitable for the root rot pathogens. When disease noticed, immediate uprooting all roots of the diseased bush (es). Then the area should be kept under thorough soil rehabilitation with quatemala grass *Tripsacum laxum* (or other types of heavy feeder grasses) at least for two years before replanting or refilling.

Plate 7: ***Mycelium of Armillaria root rot under the bark***

STEM DISEASES

Stem and branch canker (Phomopsis theae*)*

Stem and branch canker of tea is caused by the fungus *Phomopsis theae* which primarily affects susceptible clonal plants, but rarely present in tea above eight years old. Its development is influenced by availability of moisture and worst attacks occur soon after prolonged drought. The disease is of little importance in Tanzania as only few cases have been reported. In drought, pegged bushes are more susceptible.

Damage caused

The disease appears initially as a small dark brown lesion on the bark. As the lesion develops and enlarges in size, the bark and cambium are killed, and the necrotic area becomes slightly depressed. The canker lesions develop on the stem at the collar region or on the branches (*Plate 8*). Upper edges of the lesions are usually heavily callused, leaves on the branches girdled by the lesions turn yellow and ultimately the branches die. Infection of the bush, especially of the collar, leads to secondary attack by scavenging termites which causes further damage and sometimes results in plant death.

Control: Cultural practices can reduce water stress and thus limit the development of the disease and minimize losses. As the disease is sporadic, the control is based on taking the following preventive measures: avoid planting tea in drier areas, planting plants with a well developed root system, irrigation, mulching, avoid injury to the plant when weeding or pegging, collar prune and removal of damaged branches and burning them is recommended.

Plate 8: Stem damaged by Phomopsis theae

Wood rot disease (Hypoxylon spp)

Wood rot disease affects stems and branches of older tea, the affected parts become dry, light, brittle and non-functional. The death of lateral branches causes a gradual decline in vigour and in some cases, the whole bush dies out.

Damage caused

The disease is easily recognized by the typical structures of fungus which forms characteristic fructifications on the affected wood; these are irregular, slightly raised and whitish-grey to dark patches (*Plate 9*).

Control No control measures are suggested at present, however, selective pruning of the dead and dying branches and painting of the large prune cuts with a paste of copper oxychloride in raw linseed oil can be effective.

Plate 9: Fructifications of Hypoxylon spp on the stem

LEAF DISEASES

Brown and grey blights

Brown blight (*Colletotrichum camelliae)* and grey blight (*Pestalotiopsis theae)* are very common leaf diseases and usually occur together. However, they do not cause economic loss. They appear in weakened or injured bushes, e.g. bushes affected by an excessive dose of fertilizer, herbicide injury, lack of nitrogen, hail, frost, sunscorch, waterlogging, hard plucking and bushes affected by stem and root diseases or attacked by pests.

Damage

Brown blight occurs on old and young leaves and can cause defoliation and death of young plants. Grey blight flourishes as a saprophyte on the dead tissue of the bush, and may cause sporadic attacks on seedlings and vegetative propagated cuttings.

Control

Underlying causes should be ascertained and corrective measures taken. Spraying with fungicide is unnecessary.

Eye spot (Pseudocercospora ocellata)

Eye spot is common fungus on semi mature leaves but occasionally young leaves and stems are also affected. It develops slowly and its appearance is governed by weather conditions, it usually appears in the rain season.

Damage caused

The fungus causes minute more or less circular, brown to dark brown spots on young and semi-mature leaves. The spots have swollen purplish brown margins surrounded by a light coloured halo (*Plate 10*). The spots are visible on both surfaces of the leaf and should not be confused with mosquito bug attack.

Control

Infection on leaves of mature bushes is not serious and thus no control measures are necessary. Badly infected young tea under two years may need spraying every two weeks. Spray both sides of the leaf to run off with Copper oxychloride 50% WP 2-5g per litre of water after plucking.

Plate 10: Eye spot caused by Pseudocercospora ocellata

Damping off (Pythium spp.)

The damping off disease is caused by the fungus *Pythium spp.,* a soil borne fungus attacking the main stem of young plant near the soil surface and causes to rot especially where the soil remains unduly wet for long periods

Damage

The leaves of affected plant may turn yellow and the plant wilts but usually the disease manifests itself as the crumbling over of the plant at the collar region.

Control

Cutting should be soaked in water containing fungicide e.g. Ridomil at a concentration of 2g per litre. If the disease is noted after planting the cuttings, young plants can be sprayed thoroughly with fungicide at the same concentration.

Chapter

4

METHODS OF PEST CONTROL

PEST CONTROL

Changes in agronomic practices have greatly contributed to increase in tea productivity, but intensive agriculture tends to increase the threat from pests and diseases. The objective of pest control is to reduce the population of the pest or to prevent it reaching such levels that may cause losses in yield or reduce the quality of made tea. It is not necessary to aim always for elimination. A pest control method will be considered successful if it can maintain the pest population well below any damaging level or a level below the cost of controlling it. It is important to note that any pest control method is not to be seen in isolation, but a combination of different control strategies may be used to solve a specific pest problem.

Pest control methods can be divided broadly into the following types:

- Physical control
- Legislative control
- Biological control
- Cultural control
- Chemical control
- Integrated pest management.

Physical control

Include the use of various barriers to prevent pests from physical contact with the crop and mechanical removal or destruction of the pest. Barriers may be mechanical, chemical or behavioral.

Mechanical barriers include hand picking of large insects as well as the use of sticky bands and traps. For example, young cocoa pods are protected from attack by the coca pod borer moth by enclosing the pods in small paper or plastic bags. The attractiveness of modern traps has been greatly improved by physical and/chemical agents.

Behavioral barriers-exploit the fact that the pests locate their hosts by responding to external stimuli such ULV as sight and odours. They include light traps with ultraviolet radiation to attract pests such as moths and reduce their population, as well as attractants which emit particular odours to which the pests respond positively.

Behavioral barriers are more often used for monitoring than control. Repellents act by making the host unacceptable to the pest.

Legislative control

This is the use of laws and regulations to prevent the importation of pest organisms into a country and to restrict the spread of pests in areas where they are already established. Legislative control involves quarantine, eradication regulations and certification.

Quarantine: Quarantine laws stipulate that imported products must be thoroughly inspected in the country of origin and certified free of pest organisms. A phytosanitary certificate by the appropriate authority must be enclosed with the product exported. The importation of some plant materials may be totally prohibited by a country.

Eradication**:** Particularly serious pests are sometimes subject to a notification order which stipulates that their presence must be reported immediately to the appropriate authorities including the police. Warehouses at seaports and ships are regularly inspected and fumigated to eliminate the pests and thereby prevent their spread.

Certification**:** Plants, seeds and other susceptible materials must not be sold unless they have been rigorously inspected and certified free of pests.

Biological control

Biological control means the deliberate use of natural enemies of pests such as parasites, predators and pathogens in order to reduce population of pests. Such natural enemies may be insects and mites, bacteria, protozoans, fungi, viruses, nematodes or even vertebrates such as birds and toads. Successful biological control requires that the pest population is reduced to levels well below the economic threshold but is maintained sufficiently high to allow the survival of the biological control agent. The Darjeeling Tea Research Development Centre, in India has identified a considerable number of natural enemies of pests of tea and some have been proven capable under ideal conditions of keeping the pest population below economic threshold levels. For example mantis, wasp and several types of flies and spiders; a spider can kill five hoppers a day. However, biological methods of control are not available at present for all pests affecting tea.

Cultural control

This is probably the most economical and widely applicable method of pest control. In tea, routine cultural operations such as mulching, plucking, pruning, manuring, regulation of shade and drainage which increase the vigour of the bush plays a predominant role in suppression of pests. The basic principle of cultural control is the disruption of the development and life cycle of pests either by denying them their food or exposing stages in their life cycle to adverse conditions so that they are killed. Also

use of cover crops or live mulches can provide habitat for natural enemies of insects, mites and nematodes.

***Plucking*:** Pests feeding on the flush, e.g. yellow mites, can be manually controlled by removing the infested shoots during plucking.

Pruning and the developmental stage of the bush in the pruning cycle affect the distribution of pest species and the intensity of their attack. Early pruning of tea so that it has fully recovered before the thrips season may reduce thrips infestation significantly.

***Regulation of shade*:** Unshaded tea fields harbour larger numbers of mites and thrips, whereas mosquito bug damage is observed more in moist shaded areas.

***Application of fertilizer*:** Fertilizer may have either a stimulating or depressing effect. High levels of nitrogen in a fertilizer generally have a stimulating effect on the pest, and may increase their severity.

***Resistant varieties*:** Resistant crop plants have been developed by plant breeders which show levels of tolerance or resistance characteristics to particular pest. This will provide inexpensive, environmental sound and highly effective way to avoid pest problems; as even low levels of resistant are important since the need for other control methods can be reduced.

Chemical control

The tea crop in East Africa is free from serious pests and diseases which require routine application of chemicals. Whenever possible, cultural practices are modified to reduce the use of chemicals. However, sometimes chemical control is necessary to curb localized outbreaks of pests and diseases. The success of chemical control relies on the proper identification of the pest, right choice of chemical, dosage and time of application, and its use in suitable mixture.

Integrated pest management (IPM**)**

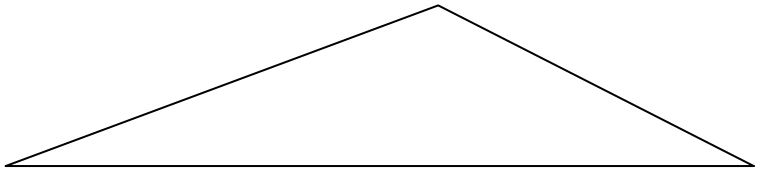
The terms pest management and integrated pest control are not synonymous. Pest management is a general term which applies to any form of pest population manipulation used by man. It includes all approaches ranging from a single method such as the repetitive application of a broad spectrum insecticide schedule without regard to population densities, to the most sophisticated integrated control system. IPM, by definition of UN-FAO, is a pest management system that , in the context of the associated environment and the population dynamics of pest species, utilizes all suitable techniques and methods in as compatible manner as possible and maintains the pest population at levels below those causing economic loss. It could be also described as a system approach to reduce pest damage to tolerable levels through a variety of techniques, including natural predators and parasite, genetically resistant

hosts, environmental modification and, when necessary and appropriate, chemical pesticides.

The effect of disruption of the equilibrium level on pest populations

Although the inherent tendency of pest population is to increase in numbers, the carrying capacity of the environment invariably imposes restriction on this. Populations grow when the birth rate exceeds mortality and they decline when mortality surpasses birth rate. The population dynamics of a pest species depend on the following:

Environmental factors
(Temperature, humidity, rain, wind and photoperiod)



Management or Cultural practices (Shade management, plucking pruning etc)

Biological factors (Parasites, predators and pathogens)

In nature, insect numbers tend to fluctuate up and down and, in the absence of the influence of some external factors, their numbers move around an equilibrium position. Damage-causing agents are often well balanced with their natural enemies. If the equilibrium level is disturbed, such as by the use of highly susceptible varieties, or the repeated use of insecticide, then populations may reach damaging levels more frequently. The application of chemicals to control insects and mites frequently, therefore, have deleterious effects on the natural enemies such as beneficial predators, parasites, or disease-causing organisms that regulate the ‘’target’’ pests. The resulting effects are referred to as **‘’target pest resurgence’’ and ‘’induced secondary pest outbreak’’.**

Target pest resurgence is the rapid increase of the target pest population following application of an insecticide, often to the level higher than existed prior to the control measure. The insecticide may destroy a high percentage of the target population, but it rarely eliminates all members and frequently destroys a large portion of the target pest’s natural enemies as well. Also the insecticide may disrupt food chain important to the target’s natural enemies, thus causing the enemies to starve, migrate, or cease to reproduce. Because the natural enemies usually recover considerably more slowly from pesticide treatment than do the pests, the pests population may reach a much higher level than before the treatment.

Chapter

5

PESTICIDES

Classification of pesticides

The term pesticide is used to designate all forms of toxic chemicals used to control pest organisms. Specific names are given to chemicals which are developed for specific pest groups as follows:

- Insecticide for insects pests
- Fungicide for fungi
- Nematicides for nematodes
- Herbicides for weeds.

Pesticides can be classified according to:

- the mode of entry into the pest,;
- the specific way in which the pesticide behave within the body of the pest organism; and
- the chemistry of the compounds from which they are derived.

Mode of entry

Contact poisons are applied to the infected organism. The pesticide is absorbed through the body surface when the pest makes physical contact with the poison or treated surface.

Stomach poisons enter the pest through the mouth with the food. These chemicals kill by action on, or absorption by, the digestive system.

Systemic poisons are applied to the soil or infested plant and are absorbed into the tissues of the plant thus rendering the plant poisonous to the pest.

Fumigants are in vapour form and can be absorbed through the respiratory system of the pest..
Many pesticides have more than one mode of entry into pests and therefore these classes are not rigid.

Mode of action

- *Respiratory poisons* interfere with the mechanism of respiration of the pest and this leads to rapid death of the pest.
- *Neurotoxic* agents act as nerve poisons affecting the balance and nervous coordination of the pest.
- *Protoplastic* poisons cause disintegration of tissues.
- *Anti-coagulants* act on the blood of the pest.

Chemical grouping

Organochloride are chlorinated hydrocarbons that have a broad spectrum and are persistent in soil and water. Examples- Aldrin, Dicofol, Endosulfan, Heptachlor.

Organophosphates are pesticides in which the phosphorus is chemically bound to the carbon atoms of organic radicals. Examples: Fenitrothion, Diazinon, Malathion.

Synthetic pyrethroids are compounds with an activity similar to that of natural pyrethrins e.g. Cypermethrin, Deltamethrin.

Other chemical groupings are: *Botanicals* (Nicotine, Neem seed oil, Tagetes etc.)
Inorganic salts are aluminum phosphide, copper sulphate, mercuric chloride.

Formulation of pesticides

Because pesticides are, in general, used in very small dosages, the active ingredient(s) of a pesticide must be distributed over as wide an area and as evenly as possible, so they must be properly formulated.
The formulated material consists of the actual chemical compound known as the active ingredient (a.i), and the carrier, i.e. the medium in which the active ingredient is contained. In addition to the carrier, the formulation contains supplementary materials such as stabilizers, dispersing agents and emulsifiers.

The types of pesticide formulation are:

Wettable powders (WP) have the appearance of dusts but are meant to be suspended in water and used as sprays.

Emulsifiable concentrates (EC) consist of active ingredient of pesticide, solvent and an emulsifying agent. When added to water the concentrate disperses as fine droplets to form a milky emulsion.

Dusts (D) contain 0.05-10% of pure insecticide such as talcum powder, dolomite or clay. The mixture must flow easily without forming lumps and carrier must be compatible with the pesticide. They must not be mixed with water.

Granules (G or GR) are formulation whereby the pesticide is incorporated in small kaolin granules. The size of granules varies from 0.01-3 mm in diameter. The granule size affects placement, distribution and release rate of the insecticide. Granules are highly suitable against soil-inhabiting pests and for the distribution of systemic chemicals which translocated through the roots.

Baits (B) are made by mixing pesticide with attractive food material which is offered to the pest in locality frequented by it. Baits are used for snails, rats and termites.

Fumigants are liquids with comparatively high vapour pressure and may either be used in soils or enclosed spaces. The active ingredient is formulated to act in the gaseous state. Fumigants are often the only effective means of controlling pests of stored products.

Micro-encapsulations are very small, non-volatile gelatine capsules enclosing the pesticide, appearing as milky or cream-like liquid. The capsules are non-toxic by contact but when the capsule is ingested, the active ingredient is released and becomes toxic to the pest.
A seed dressing is a coating, either dry or wet, of protectant pesticide applied to seeds before planting. Dry seed dressing are often physically stuck to the coat of seed by a sticker such as methyl cellulose.

Ultra-low volume (ULV): ULV formulations are usually solutions of pesticide in an involatile (non-evaporation) oil. They do not mix with water and should be applied undiluted. **They must be put on special spray machines/pumps which produce a mist of small drops.** If applied with ordinary pumps they will harm the plant.

Pesticide Toxicity

All pesticides are poisonous chemicals. The relative toxicity varies considerably and so does their toxicity to mammals, fish, birds and pests. The hazard of a treatment depends on the concentration of the pesticide as well as on its formulation. The higher the concentration of active ingredient, the more the hazardous it becomes.

The toxicity of a pesticide is calculated as the **LD_{50}.** This is the **D**ose of the pesticide which is **L**ethal to 50% of the animals, usually rats, in an experimental population to which the dose was administered. The LD_{50} is expressed in milligrams of toxicant per kilogram of body mass of the animal. The pesticide may be administered orally or by skin contact. The LD_{50} will differ in these cases. The higher the figure for LD_{50} the safer the pesticide. The LD_{50} values serve as a useful guide to the safety of various pesticides to humans. Compared with the oral toxicity of commonly known substances, e.g. the oral LD_{50} for table salt is 3320 mg/kg or that of aspirin which is 1,240 mg/kg body mass, helps appreciate these figures for LD_{50}.

The potential hazard of a pesticide should not, however be judged only by its oral toxicity. Many pesticide can be absorbed through the skin, eyes and lungs and are thus dangerous via these routes as well. Chlorinated hydrocarbons can accumulate in the body and reach undesirable levels by repeated exposure to small quantities. Organophosphorus compounds can condition the body, upon repeated contact or intake of small quantities, to increasing sensitivity so that later exposure to further small dose may suddenly cause acute poisoning symptoms or even death. The label of each chemical indicates the potential hazard of that chemical.

Table B: WHO pesticide classification

Hazard level	LD_{50} Acute oral mg/kg		LD_{50} Dermal mg/kg	
	Solids	Liquids	Solids	Liquids
Slightly hazardous	>500	>2000	>1000	>4000
Moderately hazardous	50-500	200-2000	100-1000	400-4000
Highly hazardous	5-50	20-200	10-100	40-400
Extremely hazardous	<5	<20	<10	<40

Pesticide calculations

After choosing the correct pesticide for a specific pest, the correct amount of pesticide needed for a specific area needs to be calculated:

a) Determination of the quantity of a pesticide formulation (A) needed to apply a recommended amount of active ingredient per hectare (B) using a pesticide formulation containing (C) per cent active ingredient:
Solution A = B x 100/C

Example: How much 5% Furadan granules do you need to apply at 0.25 kg per ha?
Solution A = 0.25 x 100/5 kg granules per ha; = 5.0 kg granules per ha.
b) Determination of the quantity of a.i (Y) required to mix with a known quantity of water Q to obtain a given concentration of spray.

Y = % concentration x Q/% concentration a.i.
Example 1: how much 85% wettable powder do you need to mix 100 litres of 0.5% a.i?

The quantity of formulation required = 100 x 0.5/ 85; which is = 0.6 kg wettable powder.

Example 2: What is the quantity of Malathion 25% wettable powder required for preparing 2 litres of spray fluid containing 5% of a.i?

The quantity of formulation required = 2000 x 5/25; which is = 400 g wettable powder.

Application of pesticides

Pesticides are usually applied to growing crops in the form of liquid sprays using a variety of spraying equipment. The kind of equipment selected will depend upon the target pest organism, the nature and size of the pest environment, and on the physical nature of the formulation of the pesticide.

The correct spraying technique

Proper application of pesticide is an art and requires skill. Irrespective of the application method the aim always remains to obtain an even deposit of the spray mixture on all the plant surfaces. The smaller the droplet size the smaller the volume of spraying liquid that is required to obtain this even deposit.

For spraying insecticides, acaricides and fungicide using a manually operated knapsack sprayer, the following should be observed:
In mature tea, it is desirable and economical to spray two rows at a time. In young or low pruned tea, one row should be treated at a time to avoid wastage of chemical.

- Select the right nozzle
- Adjust the pressure to high.
- Adjust the height of the nozzle for the required swathe width using a plumb-line aid.
- Always spray with the wind never against it.
- Follow the contour line when spraying.
- Commence spraying and keep the lance steady.
- Pump constantly to maintain pressure.
- Walk at the same normal and comfortable speed used at the time of calibration.

For spraying herbicides the technique is the same as for spraying insecticides except for the following:

- Adjust the height of the lance above the ground or above the weeds as appropriate.
- Set pressure to low.

Safe Use of Pesticides

All pesticides must be treated with extreme care whether they are known to be poisonous or not. On the label of the chemical, the minimum requirements for safe handling are given. The use of chemicals which taint tea or leave unacceptable residues are restricted.

The following safety precautions should be observed at all times.

A. Before applying pesticides

1. Know the pest, and how much damage is really being done by it.
2. Seek advice on the proper method of control.
3. Use recommended pesticides and only when really needed. If several pesticides are recommended, choose the least toxic to mammals and if possible the least persistent.
4. Read the Label including the small print.
5. Make sure the appropriate protective clothing is available and is used. An adequate number of long-sleeved overalls, hats, rubber boots, chemical resistant gloves and face masks/respirators must always be provided.
6. Check the application equipment for leaks, calibrate with water and ensure it is in proper working order.
7. Check that plenty of clean water is available with soap and towel and that a change of clean clothing is on hand.
8. Take only sufficient pesticide for the day's application from the store to the site of application. DO NOT transfer pesticides into other containers such as drink bottles.

B. While measuring and mixing pesticides

1. Wear appropriate protective clothing of good condition, and wear it correctly.
2. Never work alone when handling the most toxic pesticides.
3. Never allow children or other unauthorized persons near the mixing.
4. Re-check the instructions on the label and calculate the appropriate amount for the equipment accurately.
5. Use suitable equipment for measuring and mixing.
6. Avoid contamination of skin, especially the eyes and mouth. If contaminated with the concentrate/powder formulations, wash immediately with plenty of clean water and soap.
7. In case of spillage use dry soil, sand or ash to cover the spilt product. Transfer it into a container and bury it away from streams or water supplies.
8. Never eat, drink or smoke when mixing or applying pesticides. To avoid contamination danger, do not carry cigarettes or edibles in your pockets while handling or spraying pesticides.
9. Always have plenty of clean water available for washing
10. Always stand upwind when mixing.
11. Make sure the pesticides are mixed in the correct quantities.
12. Avoid inhalation of chemical, dust or fumes.
13. Start spraying near the downwind edge of the field and proceed upwind so that operators move into unsprayed areas.
14. Spray during cool hours of the day.

15. Avoid spray drift. DO NOT spray if wind conditions cause drift onto waterways, other crops.
16. NEVER leave pesticides unattended in the field. Provide proper supervision to those assisting with pesticide application, and have adequate rest periods.

C. After application of pesticides

1. Return all unused pesticide to the store.
2. Safely dispose of all empty containers.
3. Never leave pesticides in application equipment. Clean equipment and return to store.
4. Remove and clean protective clothing. Never take home contaminated clothing.
5. Wash well with water and soap and put on clean clothing.
6. Keep records of the use of pesticides noting the formulation, concentration etc. of each type of chemical sprayed.
7. Do not allow other persons to enter the treated area for the required period if restrictions apply to the pesticide used.

Extreme caution should be taken when handling pesticides. Never open a container at eye level, especially wettable powders in paper bags. Use proper safety equipment in a well-ventilated area away from children and animals. Keep them clean and use only those tested by the Tanzania Pesticide Research Institute (TPRI). Pesticide wastes are toxic. Always have a special place away from people, water sources and buildings for cleaning spray equipment and rinsing spray tanks. Read the label for disposal instructions.

Pesticide residues in tea

Tea importing counties are concerned about pesticide residues in tea. Recent focus on pesticide residues on processed tea has led issuance of Maximum Residue Limits (MRL) on a group of pesticides by different producing and consuming countries and various International agencies. The MRL is a measure used by regulatory authorities to provide acceptable standards of safety for pesticides. MRLs are expressed in parts per million or milligram per kilogram and primarily used as trading standards for bulked samples. A MRL is based on experiments with laboratory animals and a safety factor to calculate the acceptable daily intake (ADI). An ADI is the amount of chemical which can be consumed every day of an individual's entire lifetime in the practical certainty, on the basis of all known facts, that no harm will result.

In an experiment conducted in Darjeeling, no residue of monocrotophos after 4 hours of its application was detected during dry and wet seasons. The residues of malathion, fenvalerate, dimethoate on 5th day after application in dry season were found below the MRLs established by various organisations and countries. Further, in case of quinalphos it was on 7^{th} day after application. While in case of dicofol the residue on

7th day during wet season was found below MRLs but it was higher in dry season. Researchers have also observed in Darjeeling that the residue of organophosphate and chlorpyriphos in processed tea on 5th day after application at the recommended dose (1:400) are well below the prescribed MRLs. They further observed there is no necessity to discard first plucking when cypermethrin is applied at the recommended dose (1:4000). Loss of pesticide residue also takes place in storing and with the passage of time between processing of tea and use of the same. When tea is infused with boiling water, pesticide residues contained in tea are partly degraded by high temperature and partly by dissolving in the liquor which will be consumed. Generally, only those pesticides with high water solubility may potentially be transferred to the tea cup in significant amounts. In addition to the matter of toxin residues the improper use of some pesticides may result in detectable taint or taste to the tea.

Some of EU limits for pesticide in tea are:

PESTICIDE	**MRL (mg/kg tea)**
Atrazine (Gesaprim)	0.1
Endosulfan (Thiodan)	30
Glyphosate (Roundup/Sting)	0.1
Paraquat (Gramaxone)	0.1
Permethrin (Ambush)	0.1

The UN Food and Agricultural Organization, World Health Organization and the US Environmental Protection Agency have all proposed maximum residue limits for pesticides in tea.

In order to minimize pesticide and potential risks in tea production it is suggested to:

- Follow recommended pruning schedules and other cultural practices.
- Use pesticides when there is no alternative and is economically justified.
- Never used banned or non-approved chemicals.
- Apply chemicals only after plucking and strictly observe the ‘’pre-harvest interval’’ or safety period.
- Remove alternate hosts from the proximity of tea fields.

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Annex 2

PRACTICALS

1. Insect pest identification
2. Identification of symptoms of diseases
3. Pesticide calculations
4. Measuring and mixing pesticides
5. Spraying techniques
6. Safe use of pesticides
7. Cleaning and storage of sprayers.
8. Storage of Pesticides

INSECT PEST AND DISEASE IN TEA

DATE
VENUE
DURATION: 2 DAYS.
COURSE TITLE: Insect Pest and Disease Control in Tea.

COURSE OBJECTIVES
At the end of the session participants will be able to:

- Understand major types of insect pests and diseases found in tea fields
- Identify symptoms of particular insect pests and diseases found in tea fields
- Understand the effect caused by insect pests and diseases in tea production
- Understand the appropriate control measures of insect pests and diseases
- Know different pesticides recommended in tea

TARGET GROUP
Researchers, Estate managers, Extension workers and Farmers.

NUMBER OF PARTICIPANTS
Approximately 24 per each training session.

COURSE DELIVERY
One day will be spend on indoors workshop while another day spend on practical session. The course will emphasize learning through group discussions, identification of insects and symptoms of particular diseases and practical skills in use of pesticides in the field.

COURSE METHODOLOGY
Participatory approach will be used. Trainers will encourage trainees to participate in different ways like plenary sessions, group discussion, etc. and the participants are expected to contribute towards field experiences.

TRAINING MATERIALS

WHO	MATERIALS
For each trainee	Pen, Pencil, Rubber, Ruler, My clear bag, Calculator, Notebook
For trainers	Flipchart (2 rolls), Flipchart stand (1), Marker pens (3 boxes), Masking tapes (3), PowerPoint projector (1), Handouts
For practical	Aprons (12), Tea field (2), Sprayers (2), Rubber gloves (12), Rubber boots (12), Long sleeved overall (12), Measuring container (2), Face shield/Mask (12), Pesticides

TIMETABLE

TIME	DAY 1	DAY 2
8:00-8:30	INTRODUCTION	RECAP
8:30-9:00	PROGRAMME&METHODOLOGY	FIELD WORK
9:00-10:00	EXPECTATION & FEARS	FIELD WORK
10:00-10:30	TEA BREAK	TEA BREAK
10:30-12.00	MAJOR INSECT PESTS OF TEA	FIELD WORK
12.00-1.00	CLASSIFICATION OF PESTS	FIELD WORK
1.00-2.00	LUNCH	LUNCH
2:00-3.00	DISEASES OF TEA PLANT	FIELD WORK
3.00-3.30	METHODS OF PEST CONTROL	EXCERCISE
3:30-4:30	RECOMMENDED PESTICIDES	ACTION PLAN
4:30-5:00		EVALUATION

SESSION PLAN

SESSION 1

WHAT	WHY	HOW
Introduction	To know each other	Pair wise introduction
Course Programme & Methodology	Trainees to understand the course programme and methodology to be used	Plenary
Expectation & Fears	Participants to mention their expectation & fears to guide trainers on topics to be delivered	Flipchart
Major insect pests of tea	To have a common understanding of major insect pests of tea in Tanzania	Plenary, Buzz groups
Classification of pests	Trainees to understand different categories of pests	Plenary, Question& Answers, Group work
Diseases of tea plant	Trainees to know symptoms of tea diseases	Plenary, Question& Answers, Group work
Methods of pest control	Trainees to know different methods of pest control	Plenary, Question& Answers, Group work
Recommended pesticides	Trainees to have a basic knowledge on the use, handling and storage of pesticides	Plenary, Question& Answers, Group work

SESSION 2

WHAT	WHY	HOW
Recap	Revision	Each trainee
Field work	First-hand identification of pests and symptoms of diseases by trainees	Trainers and trainees
Exercise	Trainers examine the understanding of the trainees	Group
Action plan	Trainees to prepare their action plan which will be followed up	Each trainee/Group
Course evaluation	Trainees to evaluate the course for the trainers to improve on their future training	Each trainee/Group

EXERCISE

A. Circle the correct answer

1) The term pest can be defined as
a) Any living organism which causes damage to tea plant
b) A plant or animal which causes damage to tea plant
c) Both a and b are true
d) None of the above

2) The frequency of pest control on tea bushes depends on
a) Weather conditions
b) Soil conditions
c) Age of tea plant
d) Size of pest infestation

B. Write T for True statements and F for False statements

- Insect pests are classified according to the way they feed on tea plant._____
- Mosquito bug belongs to Biting and chewing pests whereas cockchafer bug belongs to termites._____
- Fungi, bacteria, moulds, armillaria are causes of tea plant diseases._____
- Pesticides are usually applied to growing crops in the form of liquid sprays using a variety of spraying equipment._____
- Fumigants are wettable powders with comparatively high vapour pressure and may either be used in soils or enclosed spaces._____
- Ultra low volumes do not mix with water and should be applied undiluted._____
- Physical control include hand picking of large insects as well as the use of sticky bands and traps._____
- Wood rot disease affects roots of older tea._____

C. Fill in the space given

Define
3) Botanical insecticides

……
……

4) Pesticide Toxicity
……
……

5) Baits

……
……

6) Damping off

……
……

7) Pesticides can be classified according to:

……
……
……
……

8) Mention six methods of pest control

l) ……
ii) ……
iii) ……
iv)……
v) ……
vi) ……

D. Answer in a given piece of paper

9) What suggestions will you make to minimize use of pesticide and potential risks in tea production?

10) Calculate the quantity of a pesticide formulation (A) needed to apply at recommended amount of active ingredient per hectare (B) using a pesticide formulation containing (C) per cent active ingredient:

Solution A = B x 100/C

Example: How much 5% Furadan granules do you need to apply at 0.25 kg per ha?

Annex 7

ACTION PLAN

Name:…… Organisation……..……

Title……..

ACTION	EXPECTED RESULTS	COLLABORATORS	BY WHEN

Trainees should fill in 2 copies of their Action plans in groups or individually. One copy will be returned to the trainer while the other will help the trainee in implementation.

COURSE EVALUATION

Your frank assessment is needed in order to improve future training.

Please cirle:
1-Very Good
2-Good
3-Average
4-Bad
5-Very bad

1) Course objectives were:

1. Very relevant
2. Relevant in parts only
3. Not quite sure
4. Not at all relevant

2) Did the training course meet its objectives?

1. Yes
2. Yes in some but not all
3. Not quite sure
4. Not at all

3) Did the trainers meet your expectations?

1. Yes
2. Yes in some but not all
3. Not quite sure
4. Not at all

4) Level of understanding

	Rank				
Major insect pests of tea	1	2	3	4	5
Classification of pests	1	2	3	4	5
Diseases of tea plant	1	2	3	4	5
Methods of pest control	1	2	3	4	5
Pesticides	1	2	3	4	5

5) Aspects of the programme

	Rank				
Plenary	1	2	3	4	5
Buzz groups	1	2	3	4	5
Group Discussions	1	2	3	4	5
Training Aids	1	2	3	4	5
First –Hand identification of pests	1	2	3	4	5
Handout materials	1	2	3	4	5

Please tick:

6) What is your view on the subjects/Topics discussed?

Too advance ☐ ☐ ☐ ☐ ☐ Too elementary

7) What was your feeling about the pace of the course?

Too fast ☐ ☐ ☐ ☐ ☐ Too slow

8) What are your views on the volume of trainers' voice?

Very clear ☐ ☐ ☐ ☐ ☐ Not clear

9) Was there any subject which
You felt it could have been omitted, if so which?

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You felt could have been included

……

10) Do you have any comments/suggestions for future improvements?

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