Chapter 2

Tea Insect Pests and Diseases

2.1. Introduction

Tea is one of the major crops of India and the demand of tea is gradually increasing. But the land under cultivation is not increasing significantly to keep peace with the raising demand of productivity. For India, to retain its major share in the world market as well as to meet up its domestic demand, efforts are to be made to find out the productivity barriers. Undoubtedly, insect pests and diseases are identified as two prime productivity barriers which demand a continuous attention throughout the year.

As a long-lived woody perennial and monoculture, tea provides a stable microclimate and continuous supply of food for rapid build up of phytophagous species that include mites, insects and eelworms. This accumulation takes place rather rapidly, enabling the phytophages to reach an asymptote level within a perceptibly shorter time [1]. There is also simultaneous presence of different species of mites and insects, each with their characteristic mode of feeding, diverse habitat and seasonal cycles. Information on tea pest biology in North-East India can be obtained from Das [2] and Banerjee [3] and that of South India by Muraleedharan [4, 5] and Cranham [6].

The tea plant like any other living plant is susceptible to attacks by diseases as it has been forced to grow under varying climatic and soil conditions remote from its natural environment. As tea is a perennial crop of pure stand extending over a period of about 40 to 100 years and over a vast area, it affords a happy hunting ground for diseases of different types. Vegetable organisms responsible for the disease of higher plants are (i) fungi (ii) algae and (iii) bacteria. Of these, the first two are known to cause diseases on tea while the third (bacteria) is so far unknown to do so. All the recognised tea diseases are caused by fungi except *Red Rust* of which the cause agent is an alga.

To reduce the crop loss by the insect pests and diseases, application of some chemicals (pesticide and fungicide) plays a vital role. Pesticides and fungicides are xenobiotic substances which are used in crop for the control of insect pests and diseases. The application of pesticides and fungicides to field crop like tea implies emission to the environmental components to air and soil. However, there are immense differences in the degree to which chemicals are mobile and biologically active in the environment. In the recent years, there has been a greater dependence on the use of chemicals with little importance laid on the hazards of chemicals. The application of

chemicals also invariably leaves toxic residues in made tea. Indiscriminate use of chemicals may lead to high deposition of toxic residues beyond the permissible Maximum Residual Limits (MRL) fixed by various international agencies like EPA, EEC, WHO etc. So use of approved pesticides and fungicides are very essential. Under Pesticide Act of Govt. of India, the Tea Research Association of India has approved some chemicals to be used in tea as pesticides and fungicides.

It is evident that to control the diseases of tea, not only the chemical measures but some cultural practices have positive contributions. A suitable blending of chemical fungicides and adequate cultural practices is more effective. Cultural practices subsequently reduces chemical hazards in an indirect way.

In the next section, the major insect pests of tea, their classification, morphology and characteristics of damages have been discussed. Section 2.3 contains the major diseases of tea and their damage symptoms. In section 2.4, an account of damage caused by insect pests and diseases of some tea gardens in India are presented. In the next section, we present the chemicals approved and recommended by Tea Research Association for tea, their technical names, types, toxicity, persistence and the MRL values fixed by various agencies. At last in section 2.6, some cultural practices in tea have been discussed.

2.2. Major insect pests of tea

The phytophagous species that cause damage to tea include insects, mites and eelworms. These phytophagous species are quite numerous, more than 300 species of insects, mites and eelworms are active in tea areas, though not all at the same time [3]. Some of them are region specific. The species who make a considerable damage above the economic threshold level have been considered in our work and classified under five groups (i) mites (ii) sap sucking insects (iii) leaf eaters (iv) stem insects and (v) other pests. The classification is shown in fig. 2.1.

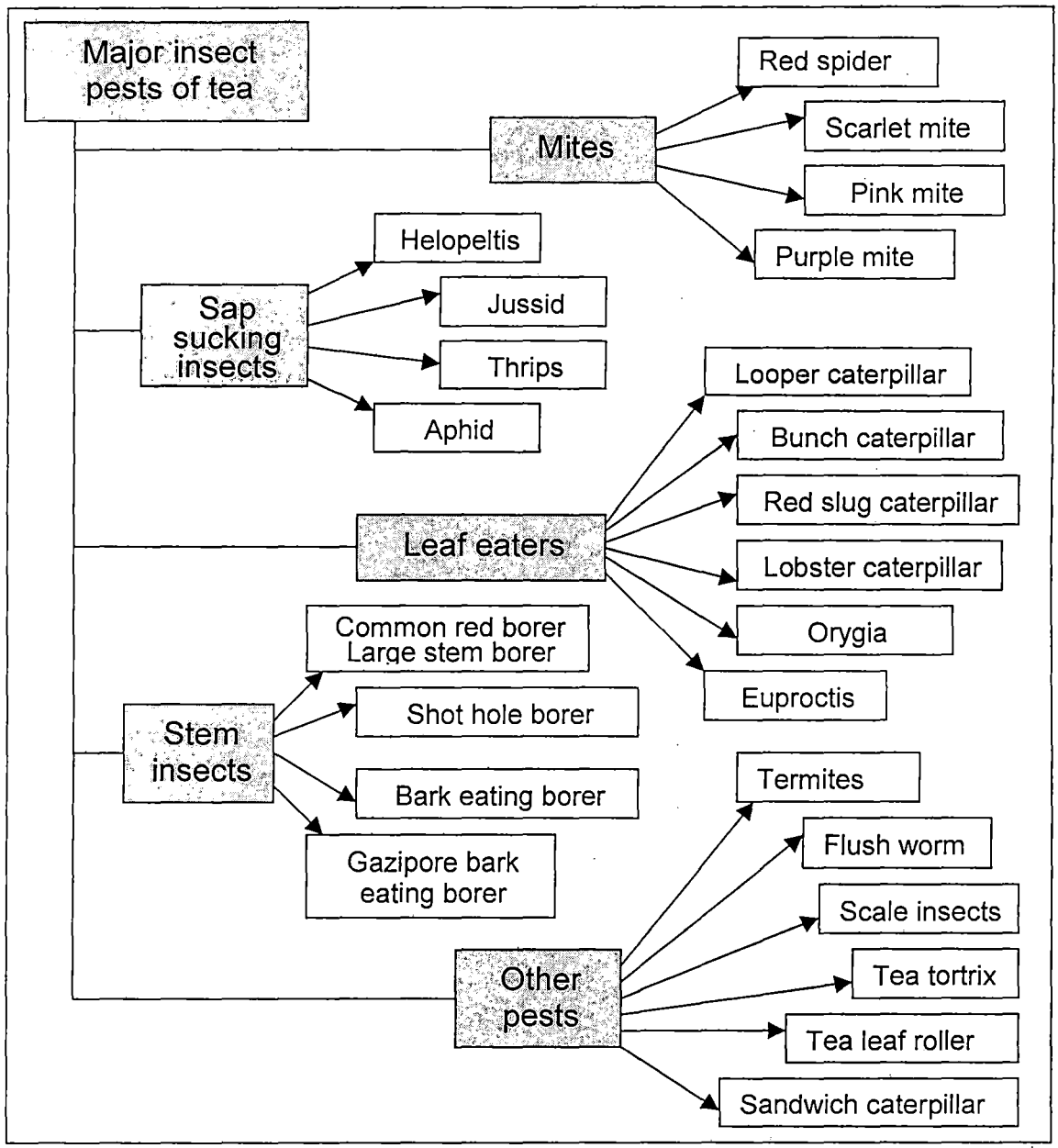

Fig. 2.1. Classification of major tea insect pests.

2.2.1. Mites

Out of 12 species recorded [7], 4 species (red spider, scarlet mite, pink mite and purple mite) are very common and present on tea at varying density almost throughout the year. They start increasing in numbers from March and their population peaks between April and July. A second but small peak may develop during October-November. Each species produces their own characteristic symptoms of damage without overlaps.

2.2.1.1. **Red spider** (*Oligonychus coffeae* (Nietner))

Amongst the major pests of tea in North-East India, the red spider is the most widely distributed and responsible for a considerable loss of crop. Even in the earliest days of cultivation, it was regarded as one of the major pests.

Immediately after hatching, the six legged larva is almost round yellowish orange but the colour subsequently turns to pale orange. After the first mould the larva becomes a protonymph which has four pairs of legs as in the deutonymph and the adult. The body is somewhat oval, the anterior part being pale crimson and the abdomen deep reddish brown. The adult female is elliptical, the posterior end of the abdomen being broadly rounded and dark purplish brown in colour. The male is smaller and has a slimmer body, the abdomen being much narrower almost tapering to a point.

The red spider normally attacks the upper surface of mature leaves but in severe attack, young leaves are also attacked and the mites then spread to undersurface. The damage is characterised by reddish brown spots but as a result of repeated sucking, brown patches are formed and ultimately the whole upper surface turns brown and bronze. The badly damaged leaves may dry up and fall off. The growth of the affected bushes is retarded. In case of severe infestation, the bushes may be completely defoliated leading to a considerable loss of crops.

The development rate and normal biological performance of red spider depends on various climatic conditions like temperature, humidity, light intensity, NPK status of soil etc. Microclimatic conditions, particularly light perforation within tea shade canopy regulates the distribution of red spider mite. The growth and development cycle of the mite also changes with cultivation characteristics which include the morphological and biochemical attributes of Assam and China varieties of tea. The mite shows a marked preference for erect leaves in China varieties of tea [8].

2.2.1.2. **Scarlet mite** *(Brevipalpus phoenicis* (Geijskes))

Though the scarlet mite was initially found in Dooars and Darjeeling but now it has been spread to all over India and demands a considerable attention. The freshly hatched larva is dull red and has three pairs of legs. After a few hours of feeding, black markings appear on the dorsal surface of body. After the first mould it becomes a protonymph which has four pairs of legs as in deutonumphs and adults. The adult male is flat, somewhat elongated oval, scarlet in colour, with black markings on the dorsal aspect. The males are scarlet.

It inhabits the undersurfaces of the leaves and sucks leaf sap and ultimately prevents the flow of nutrients into the leaf lamina. This mite causes a chronic and insidious

damage characterized by a general yellowing of the leaves and brownish discoloration of the mid-rib along the under surface. Occasionally in case of severe infestation, the underside of the affected petiole splits and dries up causing premature leaf fall and the bushes might be completely defoliated. Although differing in taxonomic details, similarities exist in the biology and behavior of three species of scarlet mites [9].

2.2.1.3. **Pink mite** (*Acaphylla theae* (Watt) Keifer)

The pink mite is one of the vital members of the mite family. It is widely distributed in all tea cultivation and is responsible for heavier crop losses [10]. The nymph is elliptical in shape, white at first, gradually becoming orange. It has two pairs of legs directed forwards. The adult female is carrot shaped and orange in colour.

It prefers both surfaces of the leaves but is usually more numerous on the undersurface. Affected leaves turn pale yellowish, assume a dry and leathery texture and ultimately become crinkled. The mite could become a serious problem on young tea during cold weather. The bushes present a sickly appearance with stunted growth.

2.2.1.4. **Purple mite** (*Calacarus carinatus* (Green))

The purple mite is the serious pest both in South and North-East India [11]. The young nymph is pear shaped tapering posteriorly and is cream coloured gradually turning purple. It has two pairs of legs placed anteriorly. The adult is deep purple, spindle shaped with five prominent white waxy ridges on the dorsal aspect of the abdomen. It has two pairs of legs.

The mites prefer the upper surface of the leaves. Older leaves are preferred but in heavy attacks young leaves are also equally infested. The characteristic damage symptom of purple mite is copperish bronze discolouration on leaf surface which is more marked at the margins, particularly on the upper surface. The affected leaves eventually dry up and fall off. The badly infested leaves, when examined with a hand lens, are found to be dusted with white particles.

The distribution and abundance of the mites have been related to climatic factors like ambient temperature, rainfall, shade and cultural practices. Though it is not clear which one is most important, indeed the relative contribution of each of these factors in regulating the peaks and troughs in mite population is not known.

2.2.2. Sap sucking insects

Some hemipterous insects continuously suck the leaf sap making the young shoots completely unproductive. The major sucking insects which demand continuous attention are Helopeltis, Jussid, Thrips and Aphid.

2.2.2.1. **Helopeltis** (*Helopeltis theivora* Waterh.)

Helopeltis is a serious pest throughout India. It is popularly known as "Tea Mosquito". This was a destructive pest of tea even in 1865 in Cachar and a company lost about 22,727 Kg of crop for which a Commission was appointed by the Govt. in 1885 and 1887 to look into the problem [12]. Watt and Mann [13] mentioned that the bug was recorded in the South and North Bank of the Brahmaputra, Cachar, Terai, Dooars and Darjeeling to cause damage to tea.

A severe outbreak of the pest occurred in the Dooars, partially in the Nagrakata Sub-District in 1958. The loss incurred by eleven gardens in the Nagrakata Sub-District was estimated to be about 7,50,000 Kg of made tea [12]. From early eighties, built-up of Helopeltis was recorded again in the Eastern, Central as well as Western Dooars, Terai and Darjeeling and considerable damage to crop was reported. Many gardens list about 40-45 thousand Kgs of made tea in the Dooars.

The freshly hatched nymph is dirty yellow with bright pink antennae and eyes. The nymph undergoes four moults before becoming an adult. The general colour of the first and second instar nymphs is greenish yellow, but it becomes green in the late instars. The adult is a tiny insect with head black or olive green, thorax pale yellow and black and the abdomen yellowish and greenish black. The antennae are long and the horn is strongly recurved to the rear and terminated by a large knob.

The nymphs and adults of Helopeltis suck the sap of the young leaves, bud and tender stems and inject toxic saliva which causes the breakdown of tissues surrounding the puncture. Within 2-3 hours of sucking a circular spot is formed around the sucking point and in 24 hours the inside portion of the ring becomes translucent, light brownish and within a few days the spots appear as dark brown sunken spots which subsequently dry up. The badly affected leaves become deformed and even curl up. Near the apex, the tissues of the tender stems turn dark brown and the shoot die back. In a severe attack, bushes virtually cease to form shoots and affected area may not flush for weeks together.

2.2.2.2. **Jussid** (*Amrasca (Empoasca) flavescens* Fab.)

Jussid is one of the major sap feeder for several cultivated crops and also for tea [14]. It is commonly known as the 'Green Fly' and widely distributed in all the tea growing districts of North-East India and Darjeeling. The newly hatched nymph is a colourless small insect with pink eyes but soon after feeding it becomes slightly yellowish green in colour. The adult is a small yellowish green insect, the forewing being pale yellow.

The insects suck the sap of young leaves and growing shoots of tea and makes a considerable damage. The damage is caused by both adults and nymphs which suck the sap of young leaves and occasionally tender stems but the nymphs are responsible for greater damage than the adults. The affected leaves become uneven and the leaves usually curl downwards, the margins become re-curved and subsequently turn brown and dry up. This particular characteristic symptom is known as the 'rim blight'. Normally the attack is confined to the undersurface of young leaves. The mid-rib and veins of the affected leaves may also show somewhat brownish discolouration. There is hardly any sign of puncture marks but occasionally faint brownish speakes can be seen later at the site of feeding when examined under a microscope. Pruned tea is prone to Jussids, particularly during drought. Damage during this period prevents shoot growth causing the leaves to remain shunted and eventually these leaves dry up and fall off.

2.2.2.3. **Thrips** (*Taeniothrips setiventris* Bagnall.)

This insect is a major problem in Darjeeling when new shoots start coming up after the cold weather and causes a considerable damage. Several species of thrips infest tea recovering from pruning and older tea under plucking [3]. The nymphs are pale yellow. The adult female is a minute yellowish brown insect with a dark brown abdomen and two pairs of brownish wings fringed on both margins with long hairs. The male is slightly smaller than the female and is golden yellow except for the hind end of the abdomen which is brown.

Damage is caused by adults and nymphs mostly to the buds and young leaves, though occasionally petioles are also affected. The adults and nymphs live inside unopened buds and partially opened buds and on young leaves. The initial symptom of attack is light brownish discolouration of tip and basal part of leaf. The badly affected leaf presents a roughened appearance and becomes deformed and may curl up. While feeding, they make small spots on the leaf surface in scattered patches or in continuous lines. This typical symptom of continuous lines on the under surface of the leaves are called "sand papery" lines.

2.2.2.4. **Aphid** (*Toxoptera aurantii* Boyr de Fons.)

The tea aphid is one of the most common pests in India. It was first observed in 1873 on tea in Jorhat then in Kumaon in 1885 and shortly afterwards in Darjeeling [12]. Pruned sections suffer more from worst attack of aphids because during that period migration of winged aphid starts and they settle on almost all the new growths of buds and shoots. It is a small insect with greenish colour. The adults and nymphs of aphids are found on tender stems, buds, petioles and lower surface of tender leaves along the mid-rib. They suck the plant sap and as a result leaves crinkle and curl inwards.

2.2.3. Leaf eaters

The caterpillars are the major leaf eaters and are the most destructive pests in tea. In both young and late instars, caterpillars completely eat both old and young foliage leaving out only the skeleton. In severe attacks, the bushes are often completely stripped of their leaves. There are various types of caterpillars active in tea.

2.2.3.1. **Looper caterpillar** (*Buzura* (Biston) *suppressaria Guen.*)

The looper caterpillar is a destructive pest which demands constant attention. In recent years it's activities have greatly increased and has become endemic to many gardens where it was unknown in the past. Though it was first reported in 1890 but around 1900 it caused considerable damage to tea in Dooars and Cachar [15] and since then it has occurred from time to time and has been responsible for considerable losses in tea in Upper Assam, North Bank and Dooars.

The young caterpillar is dark brown with greenish white lines along the back side and has a brownish head. The body colour soon turns to light green and with edge, it acquires a brownish tinge and ultimately attains brownish grey colour. The caterpillar has in addition to three pairs of thoracic legs, a pair of prolegs on the sixth abdominal segment and a pair of claspers at the hind end of the body.

The young caterpillars at first eat out very small holes along the margins of young leaves and then bite of small pieces at the margins. As they grow in size the leaves are more or less completely eaten away. The bushes are often completely stripped of their leaves.

2.2.3.2. **Bunch caterpillar** (*Andraca bipunctata* Wlk.)

The bunch caterpillar was reported as a very widely distributed pest occurring over almost all the districts in North-East India [13]. They defoliates the bushes virtually within hours. The freshly hatched caterpillar is light yellow with the head and first

thoracic segment blackish brown. The body is covered with long, stiff, white hairs. The full grown caterpillar is about 65 mm long. Head and thoracic segments are brownish black and the body is covered with fine hairs. It is tawny yellow with a reddish tinge and broad blackish brown transverse bands running on each body segment crossed by a number of yellowish longitudinal lines. In addition to three thoracic pairs of legs, there are four pairs of prolegs and a pair of claspers at hind end of the body.

From the third instar, the caterpillars stay in close physical aggregation and form typical clusters on the branches during the day, but at night these aggregations break up and they start feeding voraciously. The branches on which they form clusters are completely stripped of their leaves. The caterpillars become full-grown after ravaging a few more bushes.

2.2.3.3. **Red slug caterpillar** (*Eterusia magnifica* Butl.)

The red slug caterpillar is one of the major pests of tea in North_East India. During nineteen fifties and sixties, they appeared and disappeared suddenly after causing severe damage within a short period but now they occur almost regularly every year beginning from early part of the season [12].

The freshly hatched caterpillar has a dirty white colour with two sub-dorsal strips running almost parallel from the third thoracic to the eighth abdominal segment. There are three rows of small round hair-bearing tubercles on each side of the body. The full grown larva is slug like, about 25 mm long, brownish red to brick red with a brown head. In addition to three pairs of thoracic legs, it has five pairs of prolegs, the anal pair being the largest.

The caterpillars at first eat out holes and bites off edges and when they grow in size the whole of the leaf is damaged. The caterpillar prefers mature leaves but if matured leaves are not sufficiently available like in pruned tea, they might attack the bark of one or two year old stems. In severe infestation, the bushes may be completely stripped of their leaves and even the bark of older stems are not spared.

2.2.3.4. **Lobster caterpillar** (*Stauropus alternus* Wlk.)

Being localised and confined to a few scattered bushes the lobster caterpillars are not causing serious damage to tea over a wide area. The full grown caterpillar is 40 to 50 mm long and has large brown head. The body colour is variable, brownish tinged with green or grayish black with black patches or mottled light and dark brown, speckled finely with white dots. The last three abdominal segments are dilated at the sides into a flange. In general appearance the larva resembles a dry crumpled leaf.

The attacked bushes may be completely stripped of leaves within few days. It eats away all the leaves of the branch on which it is present and then moves to another branch. Their migration from one bush to another is very limited and occurs only when the bush on which they are active has been completely defoliated.

2.2.3.5. Orygia (*Orygia* sp.)

This caterpillar was recorded by Das and Roy in 1982 [12] to be occurring in a number of tea bushes of Central and Western Dooars and Darjeeling. The full grown caterpillar measures about 30 mm in length. The general body colour is blackish. The head is reddish. On the dorsal surface of the last abdominal segment, there is a thick bunch of brownish hairs directed posteriorly.

In first instar they feed on the epidermal tissue of the lower surface of matured leaves. As a result of damage small holes are formed on the leaf surface. Caterpillars on the other instars feeding from the margin of the tea leaf and in bad infestations the bushes may be severally defoliated.

2.2.3.6. Euproctis (*Euproctis subnotata* Wlk.)

This caterpillar was first recorded by Das and Goswami [16] in Upper Assam to cause serious damage to mature teas. The caterpillar appears in March-April and June-July and then the population gradually declines. The full grown caterpillar is about 20 mm in length. The body is pale yellow with greenish tinge and head pale brown. Black spots are present on the upper surface of abdominal segments.

The early instar caterpillars feed on the epidermal tissue and skeletonise the leaves but the grown up caterpillars feed from the margin of the leaves and in severe infestation the mature bushes are badly defoliated, even the tender shoots are not spared.

2.2.4. Stem insects

2.2.4.1. Common red borer and Large stem borer (*Zeuzera coffeae* Nietner. & *Casmara patrona* Meyr.)

The common red borer is widely distributed as a pest of tea and has been reported to cause severe damage to nursery plants. The full grown larva is pinkish to purplish brown in colour with a brown head. The ninth and tenth abdominal segments are reddish brown.

The larva bores into the tea stem and as a result the leaves of the branches eventually die. Thick branches may not die back immediately but they remain unproductive and

liable to break off easily. The attack can be very serious in case of nursery seedlings and young plants since the main stem is affected.

The mode of attack and nature of damage of large stem borer are similar to that of the common red borer but the tunneling is more extensive and the thicker stems are also affected.

2.2.4.2. Shot hole borer (*Xyleborous fornicatus* Eichh.)

Das in 1965 [17] recorded the attack of the shot hole borer on healthy young tea over an area of 1.5 hectares in an estate near Jorhat, Assam. The damage symptoms are die-back of the shoots, yellowing of the leaves and subsequent defoliation. The affected branches break off at the slightest disturbance. The adults construct irregular galleries in the stems and pin head like holes are formed on the surface of the stems and collar region which are the exit holes of the adults. The borers show preference for the nodes and much of the die back is caused due to damage after pruning.

2.2.4.3. Bark eating borer (*Inderbela theivora* Hamps and *Inderbela quadrinotata* Wlk.)

The bark eating borer is usually found on scattered bushes in almost all gardens in the plains but in unhealthy tea, it often occurs in a severe form and may cause considerable damage to bushes. The full grown larva is about 25 mm long with a dark brown head and dark patches on the body segments. The prolegs are present on 3rd to 6th abdominal segments and claspers on the anal segment.

The larva bores a small hole in the stem, specially in pruning cuts, snag or knot for retreat. It spins a spiral run round the stem which is composed of fragments of bark and excreta bound together with silk. In addition to damage caused to the bushes, the hole in which the larva takes shelter provides a suitable place for the entry of fungal parasites such as *Poria* sp.

2.2.4.4. Gazipore bark eating caterpillar (*Ptochoryctis simolenta* Meyr.)

The full grown caterpillar is about 13 mm long, dark red brown with a black head. This bark eating caterpillar does not bore into the wood but builds a raised thin case at some convenient places on the bush and feeds on the bark under this case. Another similar bark eating caterpillar is the yellow bark eating caterpillar (*Comocritis pieria Meyr*) which is very common in all tea estates and often occurs in a serious proportion, particularly in the Dooars and Darjeeling.

2.2.5. Other pests

Other than the above specified groups, there are various pests active in tea which requires some attention.

2.2.5.1. Termites (*Microtermes* sp., *Microcerotermes* spp., etc.)

There ten different species of termites both live wood eating, scavenging and mound builder were recorded from tea in North-East India and both are responsible for considerable damage to young and mature teas. At least 15 per cent of total crop is annually lost due to the attack of termites [18]. Termites are highly organised social insects living in colonies and this social organisation is said to prolong the period of immaturity and increases their destructive potentialities.

Termites first attack the dead wood resulting from borer or fungal attacks, branch canker, pruning cuts etc. Fine channels are then excavated along the heart of the wood and these are progressively enlarged and eventually the stems are hollowed out leaving a thin layer of wood and the bark. The attack gradually spreads to other branches causing destruction of the frame and main stem and ultimately resulting in death of bush.

2.2.5.2. Flush worm (*Laspeyresia Leucostoma* Mayer.)

It is the larva of a moth which attacks a few top leaves tying them together. The first severe outbreak of this pest was occurred in Cachar and Darjeeling in 1956 and subsequently spread to other districts causing considerable damage to tea for two to three years. The full-grown larva is 9 to 10 mm in length and is greenish or brownish. The head is yellowish or brownish. There are four pairs of prolegs and a pair of claspers.

The larva normally attacks the young shoots. The young larva feeds by scraping off the tissues of the epical portion of the bud. The leaf becomes rough, thick and brittle in texture with brownish discolouration of damaged surface. The quality of tea is also being hampered by the flush worm attack and the infusion prepared from damaged shoots is so 'flat' that it is virtually undrinkable.

2.2.5.3. Scale insects (*Eriochiton theae* (Green), *Pinnaspis theae* (Maskell) etc.)

Scale insects are one of the important pests which attack the foliage and stems of tea. So far 44 species of scale insects have been recorded from tea in North-East India. They basically suck the sap from leaves and stems. Badly damaged leaves turn yellow and fall off. In some cases the damaged parts of the leaves show brownish

discolouration, leaves crinkle and curl inwards and leaf surface presents a rough and wavy appearance. Badly infested shoots show symptoms of die-back and become unproductive, occasionally swelling at the site of infestation, die-back of main stem of young plants are also observed and defoliation also takes place. Young colonel plants and seedlings are occasionally in poor growth.

2.2.5.4. Tea tortrix (*Homona coffearia* Nietner.)

It was first recorded by Watt & Mann [13] but was not considered to be a serious pest. Although it was not considered as a major pest, it had on occasions been found to cause considerable damage to tea seedlings in nurseries. The larva is about 23 mm long. The body is green, the head and the pro-thoracic plate are shiny black. There are four pairs of prolegs on the 3rd to 6th abdominal segments and a pair of claspers on the last segment.

The larva ties up margins of a young leaf usually the first leaf, often enclosing the bud and feeds at the margins. It also often fastens two leaves one above the other and being stationed inside feeds upon the edges and epical portions.

2.2.5.6. Tea leaf roller (*Gracilaria theivora* Walsm.)

The tea leaf roller is known from the early days of tea. Watt & Mann [13] considered it as a serious pest. However during 1988 the intensity of attack of this insect was quite high in Jorhat circle where 40 to 60 % of the shoots and matured tea were badly affected [12]. The larva is about 8 to 10 mm in length. The head is black and the body is pale yellow in colour. The larva in the first instar is a leaf roller but subsequently it rolls up the leaf from the apex downwards and feeds inside. As feeding proceeds, the leaf is further rolled up until about a half of it is eaten away and then it migrates to another leaf. It usually attacks the second and fourth leaves and if an outbreak occurs, the damage thus caused may be serious.

2.2.5.7. Sandwich caterpillar (*Agriophora rhombata* Mayer.)

Occasionally it appears in a severe form and causes considerable damage to matured leaves of pruned tea during the winter. There are reports of outbreaks of this pest in a few gardens of Jorhat circle in recent times. The body colour of the larva is dirty brown with a pale yellow band running along the mid-dorsal line, the underside being orange. The head and the last abdominal segment are dark brown. There are four pairs of prolegs and the claspers on the last segment.

The larva draws a few mature leaves and places them one above another and feeds there. The excreta and unconsumed pieces of leaf tend to decompose the damaged

leaves. In an epidemic outbreak after pruning and during the early part of the flushing season can greatly affect the production and growth of shoots with the consequent loss of crop. The larvae after damaging the few old leaves left on the bushes, attack the bark causing die-back of young stems.

2.3. Diseases of tea

Fungal diseases of tea plants have been reported from the very beginning of planting for over 150 years [19]. The diseases of tea are rather numerous and they specialise on attacking different parts of the plants, such as leaves, stems and roots. It is fairly known today that about 385 species of fungi occur on tea world over, of which just about half occur on tea in north-east India [20]. The nursery plants are not being spared. Collar rot and Dumping off diseases cause death to the young vegitatively propagated tea plants in nurseries. A detailed study of tea diseases can be found in [21].

This section describes the characteristics of some diseases which cause considerable damage to the nursery as well as productive tea plants. Depending upon the site on attack, the diseases of tea are classified in four groups: (i) nursery diseases (ii) root diseases (iii) stem diseases and (iv) leaf diseases are presented in fig. 2.2.

2.3.1. Nursery diseases

There are two diseases which are responsible to cause severe damage to the nursery plants, collar rot and dumping off.

2.3.1.1. Collar rot (*Phomopsis* sp.)

This fungus is common in tea nurseries throughout the tea growing region of North-East India and is known to occur in tea nurseries where the soil is sticky, tending to form a crust on the surface after heavy rains or where the soil remains unduly wet for long periods. The fungus attacks young seedlings at their collar region, encircling the main stem in a ring and extending over a region of 1 to 2 inches above and about 0.5 inch below the soil level. The affected portion of the stem is usually smaller in girth than the adjoining unaffected portions on either sides. The upper edge of the diseased area is marked by a ring of callus growth which pushes the bark up. Affected seedlings suddenly wilt and die when a hot sunny period prevails towards the end of the rainy season. Deaths occur either in groups or in a scattered manner.

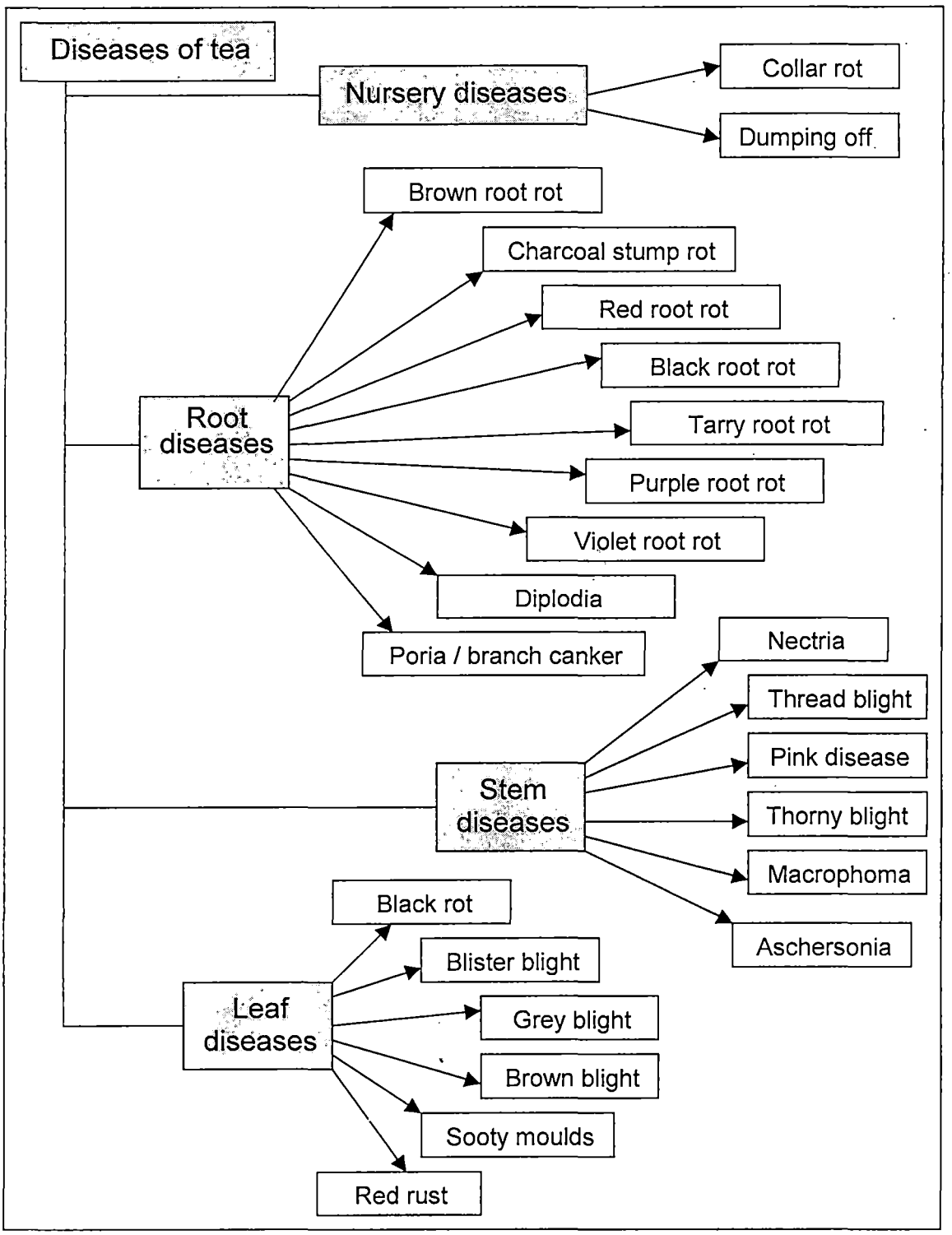

Fig. 2.2. Classification of tea diseases.

2.3.1.2. **Dumping off** (*Pythium* sp.)

This soil fungus occurs in tea nurseries in the plains of North-East India under the similar soil condition for which the collar rot appears. The fungus attacks the main stem of young seedlings near the soil surface. The stem is affected all round to about an inch above and the root to about 2 inch or more below the soil level. The bark of the affected region becomes very soft so that it crumbles away when rubbed with the fingers. Diseased seedlings look yellowish and unhealthy during the rainy period and suddenly wilt and die when a period of hot, dry weather prevails towards the end of it. The disease does not produce any other external symptoms.

2.3.2. Root diseases

There are various soil-borne fungal pathogens causing root diseases to the tea plants. Some of them which make considerable damage to the tea plants are discussed below.

2.3.2.1. **Brown root rot** (*Fomes lamaoensis* (Murr.) Sacc. and Trott.)

This disease is more common on sandy soils and usually occurs on tea plants from about 3 years upwards but younger plants may easily be attacked and killed in a few months if their roots happen to come in direct contact with diseased material in the soil. Diseased plants die suddenly and their leaves remain attached for sometime. Roots of affected bushes are encrusted with soil, sand and stone particles firmly by a brown mycelium, which sometimes forms sheets with a blackish surface on the main stem, often as a felt, extending to a few inches above the soil surface. In an advanced stage of infection, brownish mycelia are found beneath the bark of the affected wood and the soft wood inside these rings decays giving a honey comb structure.

2.3.2.2. **Charcoal stump rot** (*Ustulina zonata* (Lev.) Sacc.)

Charcoal stump rot is probably the commonest of all the root diseases of tea in North-East India and generally attacks tea from about 3 years upwards. Infected young bushes die rather suddenly but their withered leaves remain attached to the main plant. Sometimes only a part of a mature bush dies while the other remains absolutely functional [22], often creating an impression that all is well with the plant. The fungus develops a characteristic fructification at first white changing to charcoal-like black, brittle encrustation which is wavy on the surface. It appears on the bark and exposed wood at the collar region or on exposed roots. The infected roots usually show small, black or white cushion-like growth, fan shaped and dull white silky mycelia growth on diseased wood underneath the bark. Colour of the wood is dull white, almost normal with black bands or lines.

2.3.2.3. Red root rot (*Poria hypolateritia* (Berk.) Coock.)

It attacks all tea from about 3 years upward. Diseased plants die suddenly and their withered leaves remain attached for sometimes. In the early stages of attack, the roots bear white threads or cords of mycelium on the surface. At a later stage of growth, the mycelial cords fuse with one another to form a chocolate red to black sheet. The infected roots encrusted with soil particles, often present a mottled appearance which may be red or black. A thin film of white mycelium may develop on the surface of diseased wood underneath the bark. Colour of the wood is normal except in very advanced cases when it becomes soft and soden.

2.3.2.4. Black root rot (*Rosellinia arcuata* (Petch.))

This disease is found in all tea districts but it is more common in the hills than in the plains. Diseased bushes die suddenly and the withered leaves remain attached for sometimes. It produces a characteristic black, irregular, almost cob-webby mycelial growth on root surface, accompanied by stellate markings with numerous black dots and dashes on wood surface underneath the bark. Sometime, the stem consists of black, spherical bodies which look like grains of shot, growing side by side to form a crust.

2.3.2.5. Tarry root rot (*Hypoxylon asarcodes* (Theiss.) Mill.)

In all instances the disease has been found to occur on mature tea bushes only. Affected bushes die suddenly and the withered leaves remain attached for sometimes. The fungus does not produce any external symptom on the affected roots. Instead, a smooth black encrustation which is smooth, hard, effused and adherent like dried wound paint, develops on the stem a few centimeter above the ground. In advanced stage, the infection produces dark black lines, closely similar to those produced by charcoal stump root on root surface.

2.3.2.6. Purple root rot (*Helicobasidium compactum* Boedijn.)

Purple root rot is not very common but is pathogenic enough even to kill old matured bushes. This disease is found on all soils. Affected roots produce numerous round purplish mycelial cords which extend right up to the collar region. A thick and velvety and purplish mycelium pad often develops around the collar. Colour of the affected wood is pinkish. Affected plants die suddenly and their withered leaves remain attached for sometimes.

2.3.2.7. **Violet root rot** (*Sphaerostilbe repens* B. & Br.)

It is more common on stiff, clayey ones and attacks all tea from about 1 year upwards but the characteristic symptoms are produced on plants of about 2 years and above. Diseased plants die gradually, leaves turn yellowish, drop and become flaccid and often drop off while still green. Roots with enlarged lenticels are the main target of infection. The affected roots turn light violet colour and when the surface is peeled off, thick violet irregular purplish strands of mycelial growth becomes visible.

2.3.2.8. **Diplodia** (*Botryodiplodia theobromae* Pat.)

It is probably the commonest of all the fungi recorded on tea in North-East India. It can attack any part of the tea plant, young or old, only when the plant is debilitated by other causes. It does not produce any external symptoms by which it can be easily recognised. Affected roots usually look normal except in very advanced stage where the surface is covered with small, isolated or groups of grayish-black to coal-black, hairy cushions giving a sooty appearance. These are sometimes produced also at the collar region. The wood when sliced often shows an even bluish-black discolouration.

2.3.2.9. **Poria / Branch canker** (*Poria hypobrunnea* Petch.)

It is a stem-cum-root disease of tea and is extremely common on matured tea throughout the whole of North-East India. The affected bushed die gradually. Thin films and small cushions of yellowish-brown mycelium are produced on the root surface as well as on the wood, beneath the bark. Wood is yellowish, soft and decayed, marked with thin, irregular, light-brown lines and permeated with thin sheets of yellowish-brown mycelium. This is also the most widely prevalent stem disease of tea and affects nearly 70% of existing tea bushes in one way or other [23]. This disease debilitates and kills the bushes extremely slowly taking nearly 10 to 15 years for mature bushes and two to three years for young plants. It causes the affected wood to turn yellowish, soft and gray. Thin, irregular, brown lines are formed in the wood. It produces a yellowish to fawn coloured, later dull gray, corky encrustation on the underside of big branches at their base or at the collar region.

2.3.3. **Stem diseases**

Some diseases which cause damage to the stem of the tea plants can be assigned in this group. Some of them draw a considerable attention to be controlled to minimise the crop loss.

2.3.3.1. Nectria (*N. cinnebarina* (Tode ex Fr.) Fr. And *Nectria* sp.)

Nectrias are wound parasites. They usually attack mature tea. Young tea below 5 years is very rarely affected. Nectria affected branches die back from the seat of infection but it is only the weak, unhealthy tea which suffers the most [21]. Small pinkish, soft pinhead-like cushions are found on the affected stem.

2.3.3.2. Thread blight (*Marasmius pulcher* (B. & Br.) Petch.)

The disease is prevalent throughout the whole of North-East India [24]. It attacks all teas, from about 3 years upwards, growing in heavily shaded, damp, cool places. It occurs year after year on the same bushes if not controlled. The fungus produces chalky-white, branching threads or strands on the stems. These threads grow upwards along the stem to the undersurface of the green leaves where they spread out fan-wise. The dead leaves remain hanging on the stems being held by the white threads.

2.3.3.3. Pink disease (*Pellicularia salmonicolor* B. & Br. Rogers and *Corticium salmonicolor* B. & Br.)

This fungus is closely allied to the Black rot fungi of tea. It produces a thin film of silky-white mycelium on the stem which penetrates into live tissues [22]. The affected plant wilts and dies. It is very uncommon on tea elsewhere in North-East India.

2.3.3.4. Thorny blight (*Aglaospora* sp.)

This disease is very common in Darjeeling and the effect is more pronounced. It is a disease of week bushes. It goes downwards slowly, killing the branches one by one until it reaches the collar and finally the roots when the bush is completely killed. The fungus does not produce any external mycelium. Fructifications appear on the bark as small swelling with a black, pointed, thorn-like projection. Wood of the stem is marked with blackish patches and black lines. Small dull white strands are sometimes seen on the wood surface when the bark is peeled off.

2.3.3.5. Macrophoma (*Physalospora neglecta* Petch.)

This disease is prevalent mostly on tea in drought susceptible areas in the plains where the soil is light or stony. Diseased patches on the branches appear as slightly sunken lesions surrounded by a ring of callus growth. Sometimes the callus ring is killed by the fungus. Affected bushes are killed slowly at first branch by branch until the disease reaches the collar when the whole of the upper portion dies.

2.3.3.6. **Aschersonia** (*Aschersonia* Sp.)

It is common on all teas throughout the whole of North-East India. It produces red isolated, yellowish-red, orange-red or pinkish-red lumps on green or old living stems and occasionally on the undersurface of green leaves. These lumps are sometimes confused with the fructifications of *Nectris*.

2.3.4. Leaf diseases

Diseases under this group affect the leaves of the tea plant and make a considerable loss in the industry. Since green leaves are the only raw material of the industry, so the leaf diseases are one of the major constraints of the productivity.

2.3.4.1. **Black rot** (*Corticium invisum* Petch. and *C. theae* Bernard.)

Black rot disease is caused by the two fungi noted above. The disease is very common in the plains and it is rare in the hills. The disease persists in the same areas for years, if not controlled, causing gradual deterioration in the health of the tea bushes and loss in crop. It produces irregular patches with a slightly raised wavy margin on the leaves. These patches are often accompanied by many small, grayish-white, more or less circular spots. Colour of the large patches is a mixture of brown, yellowish to chocolate brown and gray on the upper surface, the undersurface is evenly brown or gray. Diseased parches and young affected leaves look black and slimy when wet. Diseased leaves often remain attached to other leaves and stems, held together by small cushions or films of pinkish-white or cream coloured mycelium.

2.3.4.2. **Blister blight** (*Exobasidium vexans* Massee.)

This disease is prevalent throughout the whole of North-east India and severe outbreaks may, however, take place when favoured by climatic conditions [25]. The disease attacks young succulent growth on all teas including young seedlings especially under heavy shade and in areas where the air is moist and cool. The fungus produces on the first three leaves pale yellowish, circular spots which are glistering and concave on the upper surface and white or pink, powdery and convex on the underside. On the succulent stem, the diseased patches are white and powdery. The fungus thrives on wild tea in the Himalayan foot hills and outbreaks occurring from such sources are usually of an epidemic nature, so it is evidently not possible to avoid Blister blight epidemics.

2.3.4.3. Grey blight (*Pestalozzia theae* Sawada.)

It is the commonest of all leaf blights of tea. The diseased patches on the leaves turn light to dark brown, with a grayish centre on the upper surface, circular or oval in outline, characterised by concentric zonations from the centre to the edge. Black pustules somewhat bigger than those of Brown blight are produced in concentric lines on the upper surface. The diseased patches may occur at the margin or in the middle of the leaf.

2.3.4.4. Brown blight (*Collectotrichum camelliae* Mass.)

This disease is extremely common and prevalent throughout the whole of North-east India. The diseased patches usually start at the margin of the leaves and spread inwards. When two or more patches occur side by side the whole leaf may be affected. The colour of the upper surface is yellowish to chocolate brown at first, gradually changing to gray from centre outwards. Minute black, scattered dots appear on both sides of the diseased patch.

2.3.4.5. Sooty moulds (*Limacinula theae* Syd. & Bult., *Capnodium* sp., *Meliola* sp., etc.)

It is found everywhere in North-East India. The fungus produces an entirely superficial coating on the upper surface of the tea leaves which is either a thin film or a wooly powdery growth, soot-like appearance. The film peels off in flakes when dry. They interfere the normal functions of the tea leaves by obstructing the light with their compact, black covering.

2.3.4.6. Red rust (*Cephaleuros parasiticus* Karst)

This disease is caused by an alga. Red rust causes severe damage especially to young tea by attacking and killing stem in patches. Its wide spread occurrence symptoms of infection and economic significance were reported by Watt [26]. This disease is common everywhere in the plains and it attacks all kinds of tea both young and old when vitality is impaired by adverse conditions like odd soil, climate etc. Red rust lesions on the stem can be recognised by their circular to oval shape, purplish-black colour and longitudinal cracks on the surface. The leaves produced above the affected region become variegated with yellow patches. As a result severely affected stems on weak bushes die back.

This disease is fairly common on the older tea leaves. Affected spots are more or less circular, with a slightly swollen appearance on the upper surface, the margin is purplish in colour. Sometimes a watery green ring of tissues surrounds the diseased spots.

2.4. Damage accounts due to insect pests and diseases

In this section we present our study on the damages due to insect pests and diseases of different tea gardens in Dooars region of West Bengal, India. As illustrative cases, we present here the accounts of five tea estates namely, Radharani T.E., Mechpara T.E., Madhu T.E., Kalchini T.E. and Majherdabri T.E.

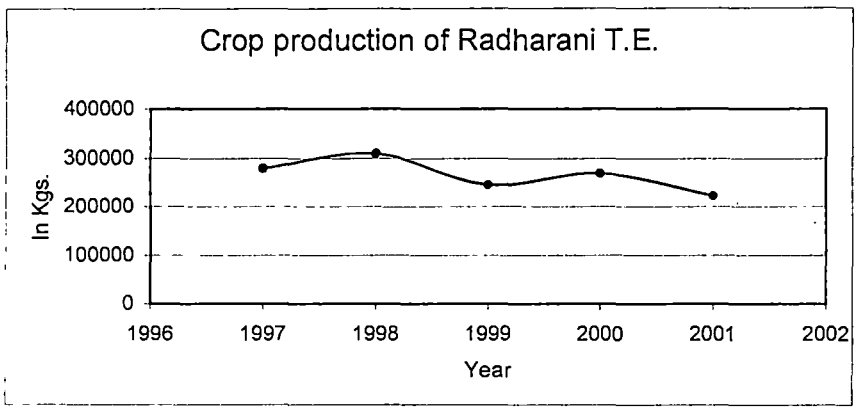

Fig. 2.3. Crop production of Radharani T.E [27].

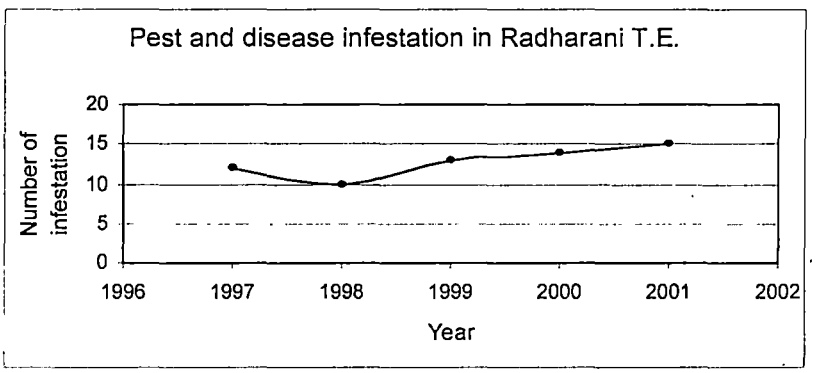

Fig. 2.4. Pest and disease infestation in Radharani T.E [28].

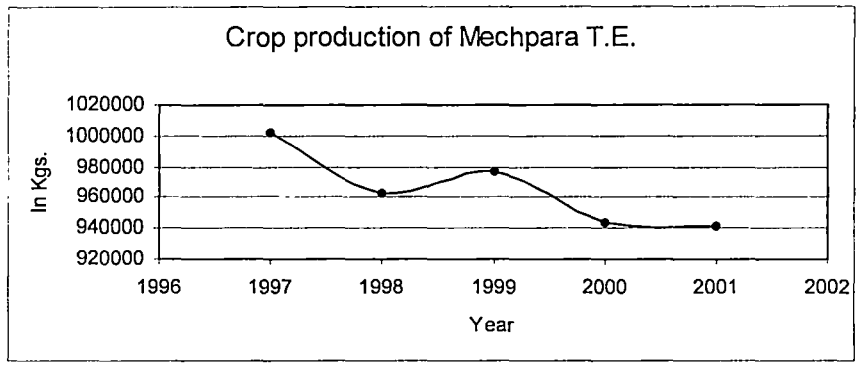

Fig. 2.5. Crop production of Mechpara T.E [27].

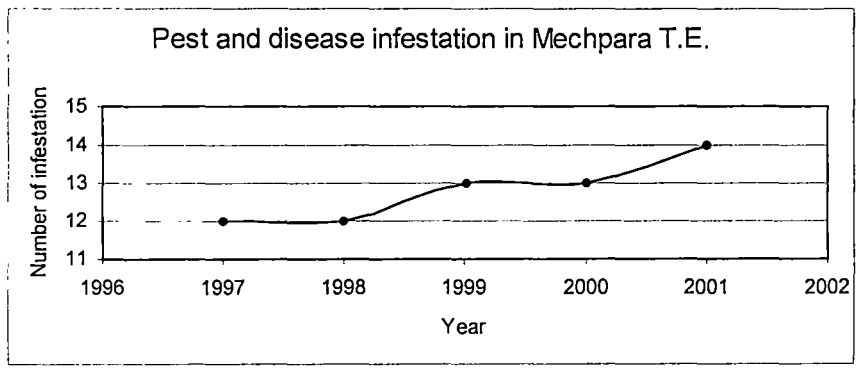

Fig. 2.6. Pest and disease infestation in Mechpara T.E [29].

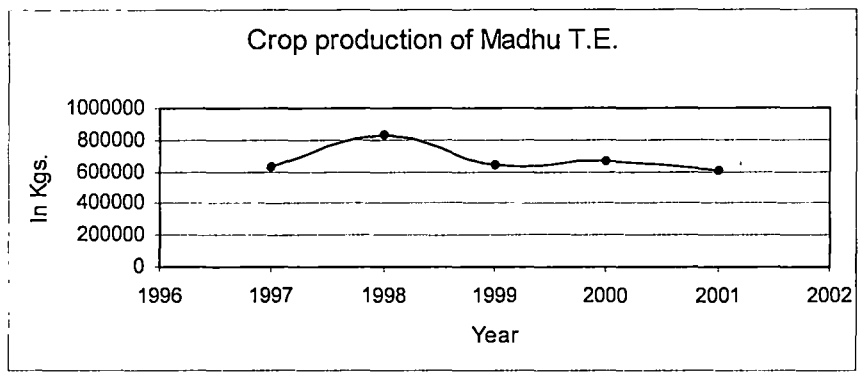

Fig. 2.7. Crop production of Madhu T.E [27].

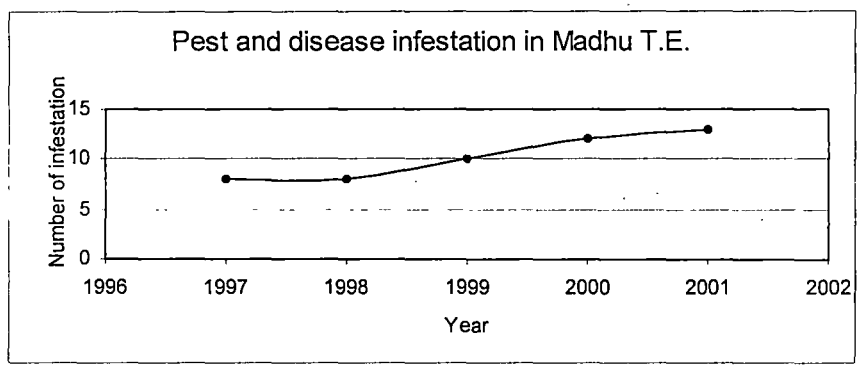

Fig. 2.8. Pest and disease infestation in Madhu T.E [30].

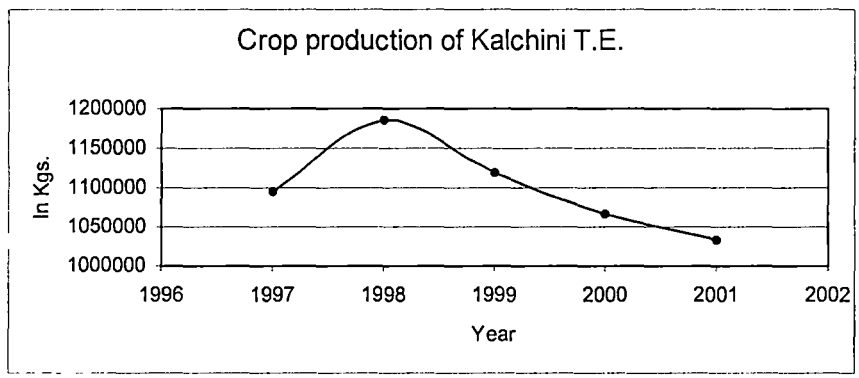

Fig. 2.9. Crop production of Kalchini T.E [27].

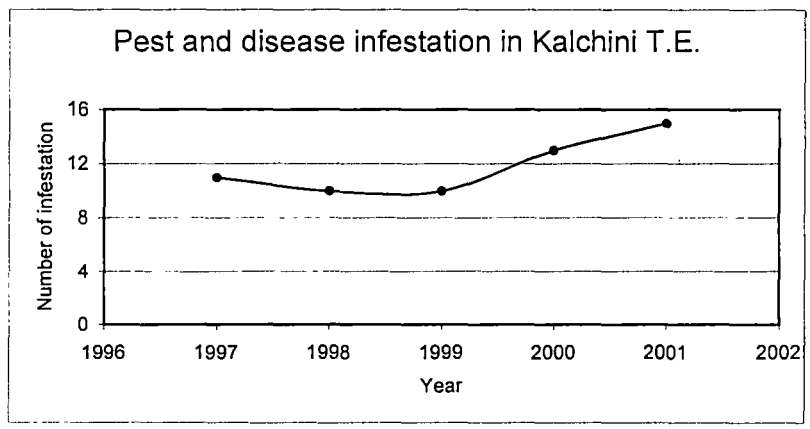

Fig. 2.10. Pest and disease infestation in Kalchini T.E [31].

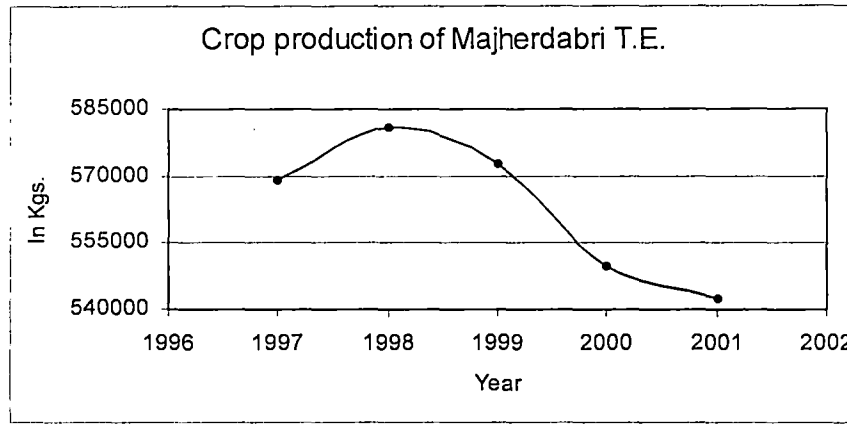

Fig. 2.11. Crop production of Majherdabri T.E [27].

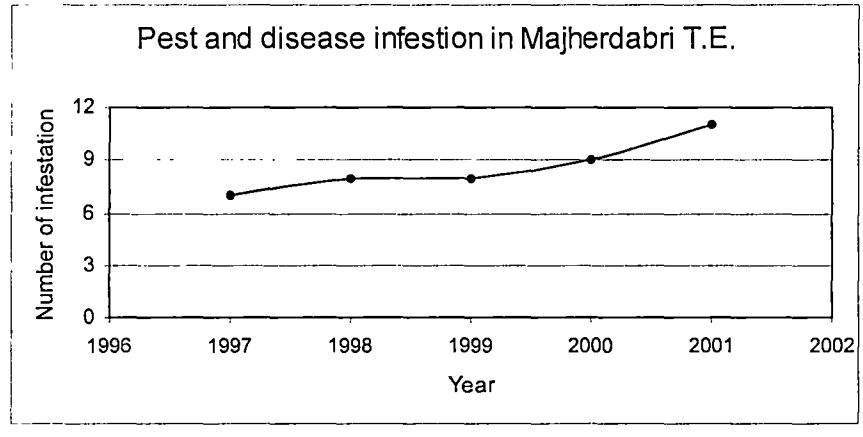

Fig. 2.12. Pest and disease infestation in Majherdabri T.E [32].

From the figs. 2.3 - 2.12, it is observed that the production decreases as the number of insect pest and disease infestation increases. For example,let us consider the figs. 2.3 and 2.4. In the year 1998, the number of infestations was 10 compared to 15 in the year 2001. The production, obviously, was high in the year 1998 compared to the year 2001.

2.5. Approved chemicals in tea

For chemical control of insect pests and diseases, the Tea Research Association of India has approved some chemicals to be used as pesticides or fungicides in tea [33]. Depending upon the target pests and diseases, the recommended chemicals for insect

pest and disease control in tea can be classified as (i) miticides (ii) pesticides and (iii) fungicides. Miticides are those chemicals (a sub-group of pesticides) which show an effective result only against mites. The term 'Pesticide" is used here in conventional sense. Pesticides are used against sap sucking insects, leaf eaters, etc. other than mites. Fungicides include the chemicals effective against fungi and algae, responsible for various diseases. The miticides, pesticides and fungicides, approved and suggested by the Tea Research Association of India, are presented in tables 2.1, 2.2 and 2.3 respectively.

Table 2.1. Approved miticides for tea.

Sl. No.	Common name	Technical name	Type
1.	Neem product	Extract of *Neem* tree	Contact & repellent
2.	Sulphur	---	Contact
3.	Dicofol	4,4 dichloroalpha-trichloromethyl benzhydrol	Contact & ovicidal
4.	Ethion	0,0,0,0-Tetraethyl-S,S,methylenebis (Dithiophosphate)	Contact & ovicidal
5.	Thiometron	0,0-Dimethyl-5-(2-ethyl-mercapto ethyl) dithiophosphate	Systemic
6.	Dimethoate	0,0-dimethyl-S-(Nmethyl Carbamoyl methyl) dithiophosphate	Systemic & contact

Table 2.2. Approved pesticides for tea.

Sl. No.	Common name	Technical name	Type
1.	Endosulfan	6.7.8.9.1.0,10-hexachloro-1,5,5a,6,9,9a-hexahydro-6,9 methano-2,4,3-benzodi oxathiepin-30 oxide	Contact & stomach
2.	Phosalone	0,0-Dimethyl-S-(6 chloreben-zolinyl-3-methyl) dithiophosphate	Contact
3.	Malathion	0,0-Diethyl-S-1,2-Dicarboethoxy ethyl-dithiophosphate	Contact
4.	Monocrotophos	Dimethyl phosphate of 3 hydroxy-N-methyl-ciscrotonamide	Systemic & contact
5.	Fenitrothion	0,0-dimethyl 0,4 nitrol- 3 methylphenyl thiophosphate	Contact
6.	Chlorpyriphos	0,0-Diethyl-0-3,55,6-trichloropyridyl thiophosphate	Contact
7.	Quinalphos	0,0-Diethyl-0-quinoxalin 2-yl phosphorothioate	Contact
8.	Synthetic pyrithroid	Cypermethrin, Deltamethrin, Fenvelerate, Fluvalinate, Alphamethrin, Fenpropathion	Contact
9.	Phosphamidon	0,0-Diethyl-0 2-chloro-N,N diethyl carbomyl methyl vinyl phodphate	Systemic
10.	Formothion	0,0-Dimethyl-S-(N-methyl-N-formylcarbon methyl) dithiophosphate	Systemic
11.	Acephate	0,S-Dimethyl acetyl-Phosphoramidothioate	Systemic & contact
12.	Thiometron	0,0-Dimethyl-5-(2-ethyl-mercapto ethyl) dithiophosphate	Systemic
13.	Ethofenprox	----------	Contact
14.	Carbofuran	2,3-Dihydro-2,2-dimethyl 7-benzofuranyl methyl carbamate	systemic
15.	Cartap HCL	Cartap hydrocloride	Systemic, stomach

Table 2.3. Approved fungicides for tea.

Sl. No.	Common name	Technical name	Type
1.	Copper fungicide	Copper oxychloride	Contact
2.	Carbendazim	Methyl bezimdazol 2-yalcarbamate	Systemic
3.	Carboxin	2,3-Dihydro-6-mwtazl-5-phenylcarbamozl-1,4-oxatin	Systemic
4.	Tridemorph	2,6-Dimethyl-4-tridecylmorpholine	Systemic

2.5.1. Toxicity of chemicals

Toxicity is one of the vital issues to select the pesticide or fungicides. As per the Pesticide Act of Government of India [33], the chemicals have been put into four categories depending on the toxicity (LD 50 mg/kg of the body weight of test animal (Oral route)), as shown in table 2.4. Higher the value of LD 50 mg/kg, safer the chemicals to be used.

Table 2.4. Toxicity of chemicals.

Toxicity of pesticides	LD 50 mg/kg of the body weight of test animals (Oral route)	LD 50 mg/kg of the body weight of test animals (Dermal route)
Extremely toxic	1 – 50	1 – 200
Highly toxic	51 – 500	201 – 2000
Moderately toxic	5001 – 5000	2001 – 20000
Slightly toxic	More than 5000	More than 20000

On the basis of the above criteria, the toxicity of miticides, pesticides and fungicides used in tea are presented in tables 2.5, 2.6 and 2.7 respectively.

Table 2.5. Toxicity of some miticides for tea.

Sl. No.	Miticides	Toxicity
1.	Neem product	Slightly toxic
2.	Sulphur	Slightly toxic
3.	Dicofol	Moderate toxic
4.	Ethion	Highly toxic
5.	Thiometron	Highly toxic
6.	Dimethoate	Highly toxic

Table 2.6. Toxicity of some pesticides for tea.

Sl. No.	Pesticides	Toxicity
1.	Endosulfan	Highly toxic
2.	Phosalone	Highly toxic
3.	Malathion	Moderately toxic
4.	Monocrotophos	Extremely toxic
5.	Fenitrothion	Highly toxic
6.	Chlorpyriphos	Highly toxic
7.	Quinalphos	Highly toxic
8.	Synthetic pyrithroid	Highly toxic
9.	Phosphamidon	Extremely toxic
10.	Formothion	Highly toxic
11.	Acephate	Moderately toxic
12.	Thiometron	Highly toxic
13.	Ethofenprox	Extremely toxic
14.	Carbofuran	Extremely toxic
15.	Cartap HCL	Highly toxic

Table 2.7. Toxicity of some fungicides for tea.

Sl. No.	Fungicides	Toxicity
1.	Copper fungicide	Moderately toxic
2.	Carbendazim	Slightly toxic
3.	Carboxin	Moderately toxic
4.	Tridemorph	Moderately toxic

2.5.2. Decomposition of chemicals after application on foliage

Chemicals applied on tea are degraded and further diluted by rain and dew, evaporation, photolysis through sunlight and bio-degradation. Synthetic pyrethroids and organochlorines are lipophilic and they get bound to cuticle. Some of the organophosphatic compounds penetrate the leaf and this depends on the type of polar solvents that are used in the formulation. The available average half-life of the chemicals are presented in table 2.8.

Table 2.8. Half-life of some chemicals used in tea.

Sl. No.	Chemicals	Half-life (days)
1.	Neem product	--
2.	Sulphur	--
3.	Dicofol	3.9
4.	Ethion	3.4
5.	Thiometron	---
6.	Endosulfan	3.2
7.	Phosalone	---
8.	Malathion	0.50
9.	Monocrotophos	2.1
10.	Fenitrothion	1.3
11.	Chlorpyriphos	1.4
12.	Quinalphos	1.2
13.	Synthetic pyrithroid	2.5
14.	Phosphamidon	2.0
15.	Formothion	---
16.	Acephate	---
17.	Thiometron	0.9
18.	Ethofenprox	1.5
19.	Carbofuran	3.1
20.	Cartap HCL	---
6.	Dimethoate	0.96

2.5.3. Maximum Residue Limits (MRL) of some chemicals

The problem of pesticide residues in made tea has become a cause of serious concern for all of us. In view of enormity of chemical residue problem in made tea, various international agencies have fixed the Maximum Residue Limits (MRL) [33] of some chemicals are presented in table 2.9.

Table 2.9. MRL values of some chemicals used in tea.

Sl. No.	Chemicals	Maximum Residual Limits (in ppm)			
		EPA (USA)	CPDEX (UK)	EEC (German)	WHO
1.	Dicofol	45.0	8.0	20.0	5.0
2.	Ethion	10.0	5.0	2.0	7.0
3.	Endosulfan	24.0	30.0	30.0	30.0
4.	Phosalone	8.0	---	0.5	--
5.	Deltamethrin	---	10.0	5.0	10.0
6.	Synthetic pyrithroid	---	20.0	0.5	20.0
7.	Chlorpyriphos	---	---	0.1	---
8.	Dimethoate	---	---	0.2	---
9.	Cartap HCL	---	---	20.0	---
10.	Malathion	---	---	0.5	---
11.	Monocrotophos	---	---	0.5	---
12.	Formothion	---	---	---	2.0
13.	Fenitrothion	---	---	---	0.5

2.6. Cultural practices in tea

Other than chemical applications, some cultural practices are very effective particularly to suppress the diseases of tea [22]. The cultural practices adopted in tea are discussed below.

2.6.1. Soil rehabilitation

Improve of soil productivity plays a vital role to resist some diseases. Correction of NPK ratio and pH level is very effective. Efforts must be made to provide balanced nutrition which improves vigour of the plant and help to withstand pest and disease attack. Improvement of soil structure and nutrition by proper rehabilitation is advisable. This helps the bush to improve its natural immunity against various diseases.

2.6.2. Disnagging

Practices like knife cleaning of the diseased and dead branches from the bushes help to resist the spreading of diseases and to eliminate some pests in addition to improving bush hygiene.

2.6.3. Weed control

Weed free cultivation of tea is emphasized strongly because weeds compete for nutrition and soil water. Some weeds smother the plucking surface. They also harbour a number of pests and diseases. All the vacant areas should be consolidated by infilling to obtain full ground cover to shade out the weeds.

2.6.4. Shade management

For tea cultivation shade is an essential criteria. The lack of shade is as bad as over shaded condition. So efforts are to be to maintain a good balance shade canopy. Shade species should be carefully selected as some of the shade trees are as known alternate host of pest and disease.

2.6.5. Other practices

Certain practices like forking of soil around the collar of tea bush, ground leveling, filling up the collar depressions, alkaline wash of bush frames, bitumen paint on cut surfaces have positive contribution towards reduction of diseases.

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