INSECT PESTS OF CITRUS AND THEIR CONTROL

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Like all other crop plants, citrus trees also suffer from the damages caused by a great variety of animal pests all over the world. They include mammals e.g., Fruit Tree Rat, birds e. g., the Hooded Crow and the Starling (*Sturnus vulgaris*), voles e. g. Levante vole, nematodes e. g. *Tylenchus semipenetrans*, snails e. g., *Helise pisana*, mites and insects. Out of all these the last group, namely that of insects is the biggest. Though insignificant in size, they more than make up due to their large numbers. Multiplying in geometrical progression they run into millions in no time. Among the insect enemies of citrus plants are : scale insects and mealy-bugs, white flies, fruit sucking moths, fruit flies, butterflies, leaf-miners, bark, twig and stem borers, and termites, etc.

In our country citrus fruits suffer from the attack of a large variety of insect pests. Both seedlings and grown up plants are attacked. Stem, shoots, leaves, flowers and fruits are all damaged in large numbers. The losses suffered by our citrus industry are colossal. On a conservative estimate, not infrequently, no less than 30 per cent of the fruits are lost due to their depredation. It is, therefore, intended to give in this article a brief account of some of the important insect pests of citrus trees in our country and the methods of their control so that losses caused by them may be reduced to the lowest minimum.

1. WHITE FLIES :

The white flies are a serious problem in almost all the old citrus plantations. There are a large number of species of white flies (Homoptera : Aleurodidae) that attack citrus plants. Thirteen species belonging to six different genera have been recorded to infest citrus plants in India, but fortunately only *Aleurocanthus spiniferus* (Q), *A. woglumi* (Ashby) and *Dialeurodes citri* (R. & M.) are found as serious pests.

The adult flies are very minute winged insects. They are not necessarily white in colour. The adult flies lay minute eggs on the tender foliage.

The newly hatched nymphs are quite active. They move about and select a suitable site and fix themselves by inserting their needle-like proboscis into the plant tissue. At the first moult they lose their legs and antennae and become immotile. The nymphs go on sucking the plant juices throughout their life period.

All wild and cultivated citrus trees are attacked by these insects but the attack is usually more serious on sweet limes and oranges. A large number of non-citrus plants like guavas, banana, mango, pomegranate, mulberry, etc. are also attacked by these insects. The injury caused by these insects is two-fold : (i) direct, and (ii) indirect. Direct injury is due to the sap sucking activity. The damage due to sap suction is at times very high and the plants become debilitated. The leaves turn pale or brown and bearing is considerably reduced. The indirect injury caused through the development of rust fungus, *Meliola camelliae* on the fruits and leaves following an attack of white flies is perhaps more serious. This fungus develops abundantly on the honey-dew secreted by the nymphs of the white flies. As a result of the fungal attack the fruit size and its ripening are retarded. The acid and sugar content and the flavour are also badly affected. As a sum total of the direct and indirect injuries caused by these insects flowering becomes scanty and there is a lot of shedding of flowers and fruits. Whatever fruit is produced is of poor quality as regards shape, size, colour and taste, and fetches low price.

Control measures :

It has been seen that the attack of white flies is more severe in old neglected orchards with poor light and aeration. It is, therefore, advisable to give a proper planting distance of 20 to 25 ft. eachway, while laying out a new orchard. Proper sanitary conditions through timely pruning and cultivation are necessary to keep down the population of these insects. Citrus hedges serve as breeding places of these insects and should, hence, be discouraged in citrus growing areas. In case of very young nursery plants, if few in number, the infested leaves may be removed and destroyed.

In case of grown up plants the use of 0.15 per cent BHC or DDT spray gives complete control of the pest. This strength may be prepared by dissolving one ounce of 50 per cent Wettable Powder in two gallons of water. The powder should be first made into a thin paste and then thoroughly mixed with water before spraying. Spraying the plants with any of the following also usually proves quite effective:-

(*a*) *Tobacco decoction* : It may be prepared by boiling one pound of tobacco waste in one gallon of water for half an hour or so until it attains the colour of strong tea. The decoction should be then strained and 4 oz. of soap added to it. It should be diluted 5 to 6 times before use.

(*b*) *Nicotine sulphate* : It is also a tobacco preparation and should be diluted in water at the rate of 1 oz. to 4 glns. of water before spraying.

(*c*) *Fish-oil Rosin Soap* : It is a ready-made insecticide and should be diluted with water at the rate of 1 oz. per gallon of water.

(*d*) *Fish-oil Rosin Soap and Nicotine Sulphate* : This combination may be prepared by first dissolving fish-oil rosin soap in water and then mixing nicotine sulphate in it in the proportions given below :—

Fish-oil Rosin Soap	4 oz.
Nicotine sulphate	1 oz.
Water	8 glns.

The best time for carrying out spraying operations against white flies is when new foliage appear and adult flies are seen clustering on the foliage in large numbers because the adults are highly susceptible to insecticides whereas the nymphs are rather resistant. Wherever white flies are a serious problem a second operation is necessary. Spraying should be carried out either before flowering or after fruit setting so that honey-bees and other pollinators visiting the flowers are not killed.

2. CITRUS PSYLLA :

Diaphorina citri Kuw., commonly known as citrus psylla is a small brownish insect. It has apically banded wings and is usually found on the under-side of leaves and terminal branches. It jumps on the slightest disturbance. It is the most harmful pest of almost all the citrus fruit trees in the Punjab and Delhi. In addition to citrus it attacks several other plants of the citrus family—*Rutaceae*.

This insect breeds all the year round. Nymphs are more destructive than the adults. They crowd together on the tender parts and suck sap from the buds, tender leaves and shoots. A dewy secretion coming out of their anal end often covers the plants, which take a white appearance. Sooty mould grows on this secretion and checks photosynthesis. The leaves of the

attacked plants curl badly and fall off prematurely. The tree may be completely defoliated. In addition, these insects inject some poison into the plants and as a result of this the fruits remain under sized and are poor in juice and insipid in taste. In case of very severe infestation the trees completely dry up.

Control measures :

Spraying the plants with 0.15 per cent DDT proves quite effective in its control. Sprays of tobacco decoction, nicotine sulphate, fish-oil rosin soap, and a mixture of nicotine sulphate and fish-oil rosin soap (details given under control measures for white flies) also give good control of this insect. Special attention should be paid to the lower side of fresh shoots at the time of spraying as they harbour large numbers of the pest.

3. Fruit Sucking Moths :

Fruit sucking moths are a serious trouble in many parts of the country. Twenty-five species of moths belonging to seven different genera have been recorded in India, to suck juice from the fruits of citrus plants. Out of all these, *Ophideres* (*Otheris*) species, particularly *O. materna* Linn., *O. fullonica* Linn. and *O. ancilla* Cram. are the most serious enemies of the citrus fruit growers.

Fruit sucking moths are different from other Lepidopterous pests in that these species are not destructive to citrus in their larvel stages but attack citrus plants only after they have become adults. The larvae of most *Ophideres* (*Otheris*) species breed on different species of the Natural Order Menispermaceae e. g. *Tinospora cordifolia* and *Cocculus hirsutus*, etc. They are large sized, stout bodied moths with grey, brown or dark green fore-wings and orange or yellow spotted hind-wings. These moths have a proboscis which is used to puncture fruits and to suck their juices. Beside citrus fruits, they attack mango, grapes, pomegranate, apple, pear, peach, plum and other sweet and juicy fruits. At times the number of punctures on a fruit is large due to dozens of moths feeding on it. Such a fruit collapses and drops immediately. Sometimes the attacked fruit does not fall immediately but the punctures serve as points of entry for other insects, fungi and bacteria. The fruits rot in a day or two and fall to the ground. Fruits damaged by the fruit sucking moths are very characteristic and, if pressed in the hand, give out jets of juice through the holes pierced by the moths.

The moths are nocturnal in habit. During the day time they hide in

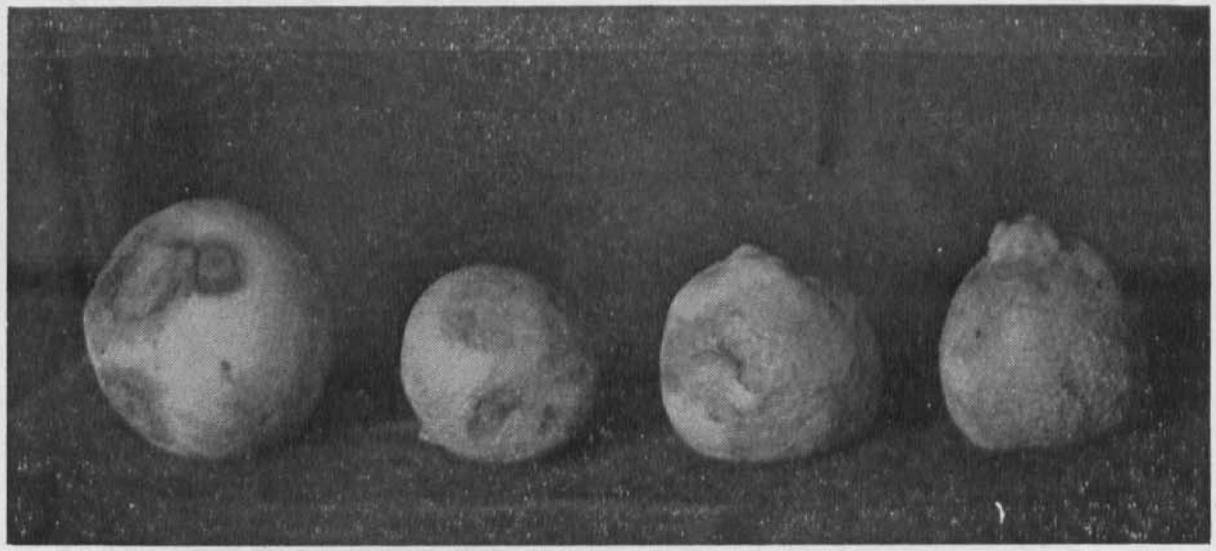

Fig. 1. Orange and *mosambi* fruits showing different stages of damage caused by fruit sucking moths.

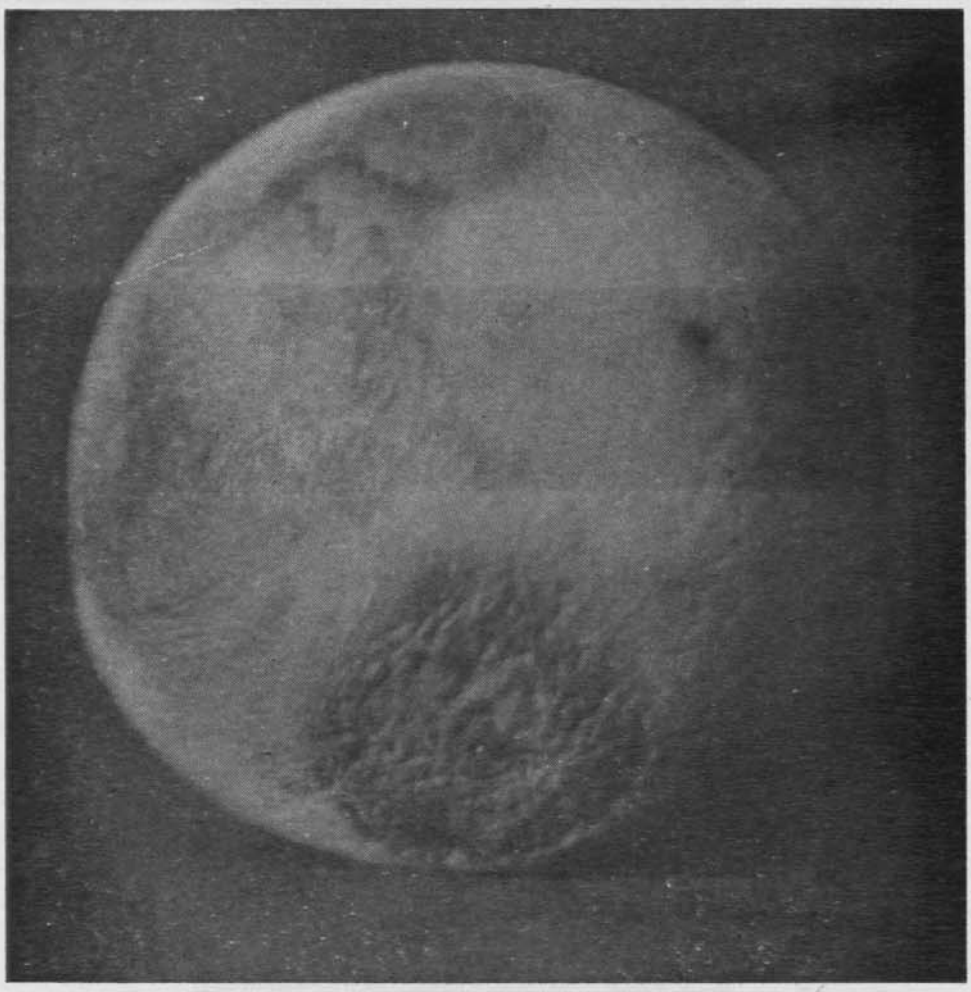

Fig. 2. A *mosambi* fruit badly damaged by fruit sucking moths.

the fallen leaves and in the weeds etc. They are active at dusk and swarm in large numbers when citrus fruits are about to ripen. Some moths remain sucking the fruit for over an hour. The moths continue feeding throughout the night and cause colossal damage.

Control measures :

The control of the fruit moths is a very difficult job as many of the species spend their larval period on numerous wild plants and the adults attack the citrus fruits at night only. Adoption of the following methods has, however, proved quite effective in checking the losses caused by these insects.

(i) Destroy the wild species of *Menispermaceae* on which they breed, from the vicinity of the orchard.

(ii) In small orchards the best way is to protect the fruits by providing mechanical barriers like paper, plastic (alkathine etc.) bags or wicker baskets.

(iii) Use of light traps and deterrents like crude-oil emulsion, fish-oil emulsion, tobacco decoction sprays and "Gammexane Smoke Generators" has not proved effective. On the other hand, some attractant poison baits have proved quite useful. An effective bait may be prepared by mixing ½ oz. of lead arsenate, 1 lb. of molasses and one gallon of water. A little vinegar may be added to it and the bait should be suspended from the trees in shallow wide-mouthed containers.

(iv) Spraying the plants with 0.25 per cent DDT suspension should also reduce the damage due to these insects quite appreciably. These moths have been seen to be attracted to the gum like exudations coming out of the stem and main branches. These places should, therefore, be thoroughly sprayed.

(v) In central India the adult moths appear only in August-October season. The damage from these pests can, therefore, be completely eliminated if the crop ripening during this period is not taken. Instead of this crop, the crop ripening during winter and early spring months should be taken. This can be easily accomplished by watering heavily for checking flowering and/or destroying mechanically, or by hormone treatment the flowers appearing in February-March. A heavy flush of flowers may be obtained in June July by light root-pruning and manuring followed by very light irrigation shortly

before the rainy season. In actual practice it has proved quite successful in Madhya Pradesh where it was tried in the year 1944-45. The yield of fruits of this crop was quite high because there was no damage due to the fruit sucking moths. Moreover, the quality of the fruits of this season is better than the fruits of the rainy season as the latter are not so sweet. It is, therefore, recommended that this method of evading the attack of fruit sucking moths should be adopted wherever practicable keeping in view the climatic conditions and the irrigation facilities available.

4. Citrus Leaf-Miner :

Citrus leaf miner (*Phyllocnistis citrella* Staint) is a major pest of citrus trees throughout the country. It has been recorded to mine the leaves of the following citrus and non-citrus trees : oranges, limes, lemons, pomelo, *Aegle marmelos*, willow, *Murraya exotica*, *M. kcenigi*, *Loranthus*, *Jasminum sambac*, *J. cinnamonum*, cinnamon and *Alseodaphne semecarpifolia*.

The adults are minute silvery white moths. The larvae mine into the leaves producing silvery serpentine mines. The injury is caused by the larvae feeding on the cell sap and the solid tissues of the leaves. The larvae also attack the tender branches where also they mine under the epidermis. Both old and young plants are attacked but the damage to the young plants is very serious. These insects are more active at the time of new flush i. e. in spring and in rainy season. Practically every leaf is sometimes mined and the mines are also extensive and involve almost whole of the leaf-blade. As a result of the activity of these insects the leaves turn yellowish, curl up badly and eventually dry up. A severe attack of this type may result in complete loss of the nursery stock. Further, the mined leaves also serve as a focus of infestation by fungi and bacteria which cause serious diseases like citrus canker.

Control measures :

Citrus hedges should be avoided especially near the nursery. When the attack of this pest is not very extensive, mechanical control measures like hand-crushing the larvae in the mines, collecting mined leaves and destroying them, and pruning prove quite useful. The leaf-miners are often attacked by parasites. In the mechanical control, therefore, care should be exercised not to kill the parasites along with the pest. This can be best achieved by gathering mined leaves in a dark box with a small glass

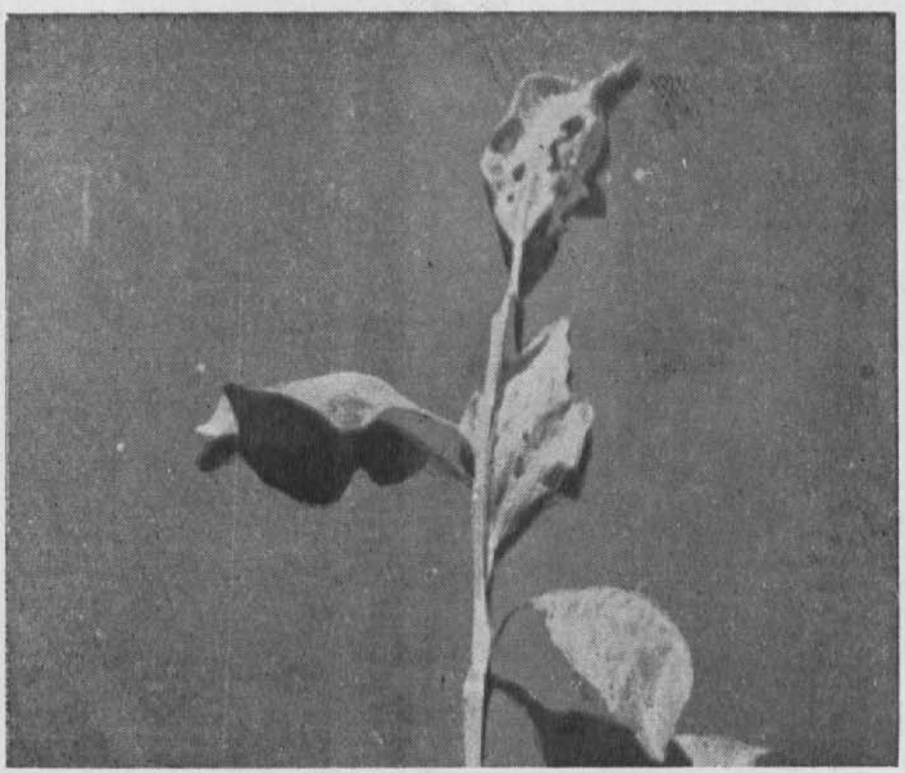

Fig. 3. Leaves and the shoot badly mined by the citrus leaf-miner.

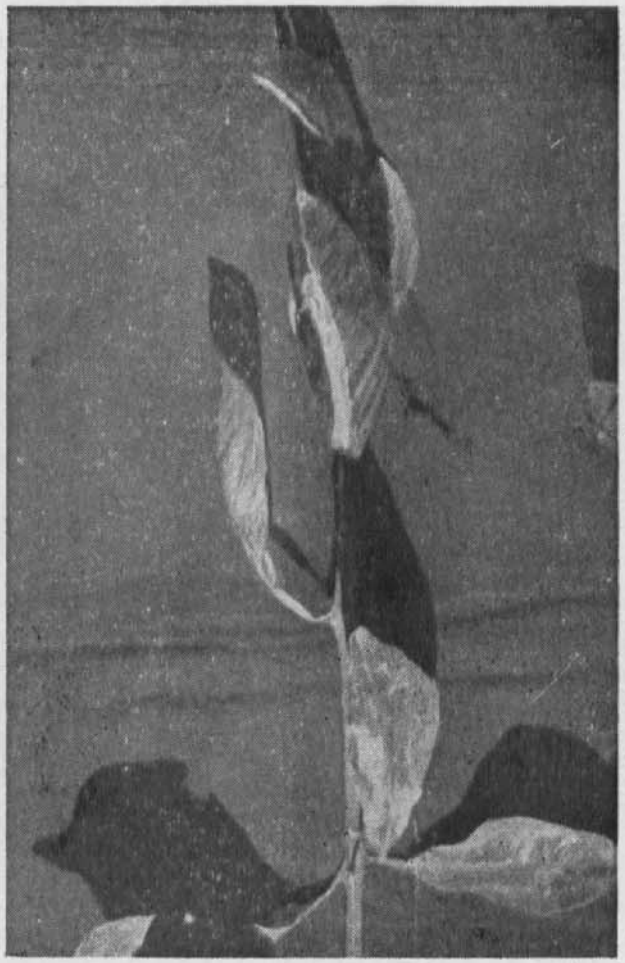

Fig. 4. Leaves badly mined by the citrus leaf-miner.

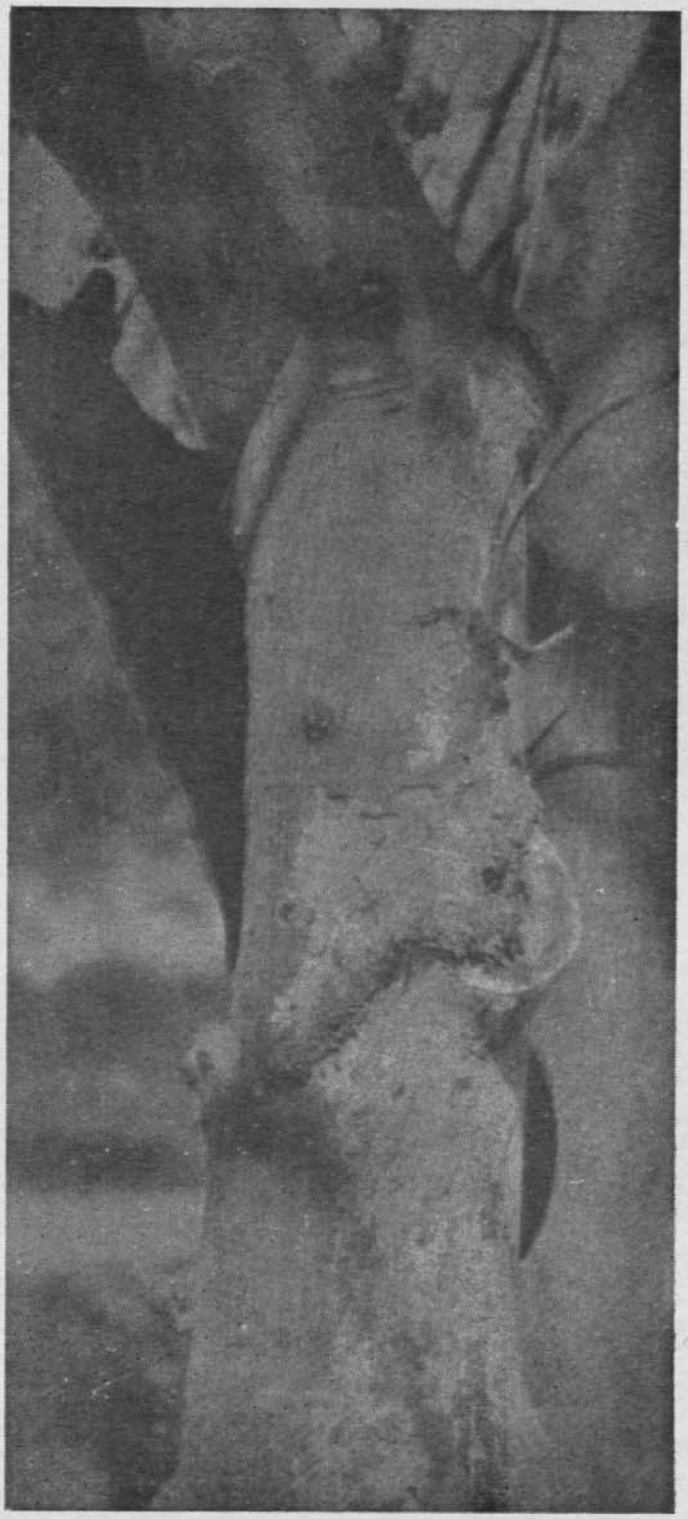

Fig. 5. Citrus stem showing the tunnel of the bark borer and also bark eaten away by it.

tube inserted into a hole at one end. The parasites that emerge from the mines get into the tube in their attempt to fly towards the light while the moths being negatively phototropic remain inside the box. The parasites thus collected should be released in the orchard and the moths killed.

In orchards very badly attacked by this pest spraying with 0.2 per cent suspension of DDT or BHC should be carried out. This may be prepared by dissolving 1 lb. of the 50 per cent wettable powder in 25 gallons of water.

5. LEMON BUTTERFLIES :

Citrus plants are defoliated by caterpillars of many species of the genus *Papilio* (Lapidoptera ; Papilionidae). They are the worst leaf destroying pests of citrus. In India five different species have been recorded out of which one species namely *Papilio demolius* Linn. is very common and at times very abundant especially in nurseries where they completely defoliate the young plants.

The adult butterfly is a beautiful creature. Its wings are black in colour with a number of yellow assorted blotches. This pest breeds throughout the year and larvae can be found any time of the year but the attack is more severe in March-April and August-September when new leaves are produced. Young larvae are brownish black with an irregular broad, white bar across the back, and resemble bird's droppings. Full grown caterpillars are dirty green with slightly brownish flanks. When alarmed they thrust out a forked flesh coloured structure at the back of the head and emit an obnoxious fluid. Being thus protected from their natural enemies they sometimes multiply in large numbers and completely defoliate the young plants.

Control measures :

Hand-picking of eggs and larvae and hand-netting of butterflies and their subsequent destruction by dropping in kerosenised water is ordinarily good enough to keep the pest under check. In case of epidemic, spraying with lead arsenate or dusting with sodium fluosilicate had been used with great success before the advent of synthetic insecticides. In recent years the latter have been used and 5 per cent dusts of DDT and BHC have been employed at many places with extremely satisfactory results.

6. Citrus Bark Borer :

The bark and shoot borers belonging to two species, namely, *Indarbela quadrinotata* W. and *I. tetraonis* (Moore) are quite a serious pests in most orchards. The caterpillars bore a hole into one of the main branches, generally at a joint. During the day they remain hiding in the hole but at night they come out under the cover of a tunnel which they construct out of frass, faecal pellets and silken threads, and feed on the bark. By feeding on the bark and boring into the branches they weaken the tree. Weakened branches at times give way under pressure of strong wind. Young branches if attacked may get killed affecting the yield badly.

Control measures :

This notorious insect is rather easy. to control. Killing the larvae mechanically by thrusting a wire into the holes is practised in many places but is not very effective. The best way to kill these insects is to inject a few drops of ethylene dichloride : carbon tetrachloride : : 3 : 1 mixture (sold in the market as KILLOPTERA), carbon disulphide, petrol or kerosine oil emulsion and then plug the hole with wet clayey earth. They may also be controlled by putting a little 5 per cent BHC dust into the hole or by painting the surroundings of the tunnel with dilute suspension of lead arsenate, Paris green, DDT or BHC.

A single control operation carried out after the rains or in the spring is enough. It is important to look for this pest on trees other than citrus also at the time of carrying out the control operations because it is known to attack a wide variety of trees, e. g. mango, litchi, guava, pomegranate, ber (*Zizyphus jujube*), jaman (*Syzygium cumuinii*) and rose, etc. Bark borers on these plants should also be controlled so that the control operations may be successful.

7. Stem Borer :

Stromatium barbatum (Fabr.), the stem boring beetle is known to occur in most citrus growing regions of India. Besides different varieties of oranges, other plants like mango, pomegranate, *Dalbergia sissoo*, *Acacia arabica*, *A. catechu*, bamboo and teak, etc. are also attacked by the grubs of this beetle in different parts of the country.

Previously it was thought that this is a pest of the dry wood but now there are authentic records of the grubs destroying living trees. The

grubs bore irregular tunnels in dead or living branches of living trees which ultimately dry up. The damage is very serious in the Nagpur area. Trees of the age of twelve years or more are the main victims of this pest. The branches dry up due to the attack of this pest, exhibit small exit holes and if they are split open numerous irregular tunnels full of frass can be seen.

Control measures :

These beetles lay eggs in the cracks and crevices in the bark. Sanitary measures like cutting off all the dry branches, scrapping loose bark from the stem and branches, and removing the dead trees go a long way as preventives. Painting the bark with 1 per cent DDT or BHC suspensions may prove quite useful by killing the larvae hatching out of the eggs.

Once the grubs have entered into the branches or the stem, it is very difficult to detect the place where the grub lies, and the only way to destroy it is to cut down and destroy the branch showing damage. This operation should be carried out by the end of March, that is well before May when the beetles appear. The cut ends should be painted with 1 per cent DDT or BHC and Bordeaux paste to avoid damage by other insects and fungi that attack plants through the wounds.

8. Lime Tree Borer :

Chelidonium cinctum Guer , lime tree borer is a serious pest of lime trees. It attacks other citrus plants also and is a very serious pest in Bangalore and Mysore. The injury to the plants is caused by the grubs of the beetle which tunnel into the wood. The gradual destruction of the sap-wood affects the health and vigour of the plant. When trees are three to four years old, a single grub would suffice to kill them, but when the trees are older it takes several years to destroy the tree. Nevertheless so much of the wood is destroyed that not only the yield but also the quality of the fruit becomes poor.

Control measures :

The only way to deal with the pest effectively is to remove the affected twigs with the aid of a long stick ending in a fork, and destroying them before the adult beetles can emerge. The operation should be carried out in the end of June and end of July in the *maidan* parts of Mysore where beetles emerge in May and June ; and in the end of November and end of January in Coorg

and western Mysore where the drying twigs are not noticed until the middle of October.

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