Practical Manual of ENTOMOLOGY

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(Insect and Non-insect Pests)

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PREFACE

The term 'Pest' in English, derived from the Latin word 'Pestis' means 'causing destruction'. As the name indicates, pests cause extensive damage to cultivated crops and other vegetations, besides destroying household articles and other possessions and attacking livestock and even humans. Some pests are responsible for causing or spreading a few serious diseases in man and livestock. Pests include insects and several other non-insects belonging to invertebrates and vertebrates. Pests are responsible for causing enormous economic losses. According to a survey conducted in India in 1976, it has been established that a total loss upto 18 per cent is caused as a result of pest attack every year. Of this about 33 percent loss is due to weeds, 26 percent due to diseases, 20 percent due to insect and non-insect pests, 6 per cent due to rats and 7 per cent in warehouses. The monetary loss had been estimated to exceed Rupees 5,000 crores at that time. Among the pests, insect pests are more destructive and are responsible for causing huge losses.

Insects constitute slightly over 50 per cent of all living organisms viz, other Arthropods, plants and animals put together. They are ubiquitous and are found in every place on this world where life can be sustained. There are about 1.0 million species of insects, of which comparatively a small percentage of about 1,000 species are pests in the true sense, while the others are wild and harmless. Many species are beneficial because of their role in our ecosystem. Some are a part of the food chains of wild creatures, while some others are either predators or parasites. A vast majority of insect pests are predominently polyphagous. Many of them feed on the foliage or other plant parts. Some of them bore into plant parts, such as stems, branches, roots, flowers, fruits or grains and feed on the inner contents. Some pierce the plant parts and suck and feed on the plant sap, while some others are vectors of virus and mycoplasma diseases. In nature there is hardly any plant species, which is free from attack by insect pests of one type or other. Even plants, which possess insecticidal properties, such as *Azadirachta indica, Calotropis procera, Allium sativum* etc. are also subjected to attack by some pests.

It is an established fact that insects came into this world more than 250 million years ago, while man came into existence only about 1.0 million years ago. Over the several million years, insects have survived because of their innate adaptations to live under any adverse environmental conditions. Actually it is man who has intruded into the domain of the insects. In order to meet his requirements of food, clothing and shelter man started cultivating crops and in doing so, the natural habitats of the insects were destroyed. The insects on the other hand have gradually changed their food habits and have started attacking the crops raised by man to meet their own requirements of food and shelter. Thus many insects have attained the status of crop pests leading to large scale destruction of crops. From the time man stepped in, a stifle has started between the insects and man and the struggle to gain supremacy has begun. Man considers insects as his enemies and to safeguard his interests tries to destroy them by various means. However, inspite of his vast potential, supremacy, intelligence and ingenuity, it has not been possible for man to eliminate these much inferior creatures completely and the struggle is going on as a never ending ordeal.

Unlike plant pathogenic microorganisms, such as fungi, bacteria, viruses, mycoplasma etc., which cannot be seen with naked eye, almost all the pests can be seen with naked eye or with the aid of a simple lens and the damages caused by them are also quite clearly visible and so appropriate control measures can be taken up at the proper time to control them. Knowledge about the nature of damage caused, life cycle and dispersal of pests goes a long way in adopting suitable control measures at the proper time. In this context this book, which has been compiled as per the syllabus of B.Sc.(Ag.) Degree course of the Agricultural Universities will be of great help and guidance to the students of Agriculture. It consists of three chapters. The first chapter deals with 'Pests of field crops'. The second chapter deals with 'Pests of horticultural crops' and the third chapter deals with 'Pests of household and livestock pests'. Detailed account of each of the major pests and possible measures to control them have been given. Besides the major pests, list of minor pests which may assume serious proportions when environmental conditions become favorable for them has also been furnished. The book, I hope will also be of immense help to the officials working in the Department of Agriculture, people interested in Scientific farming as well as the General Public.

Numerous illustrations have been given to amplify the nature of damage and the life cycle of the pests so that the reader can understand and follow the text easily.

In the recent past, there is a tendency to revert back to the old system of natural farming or organic farming so as to safeguard the quality of the soil and to protect the atmosphere from pollution, which is a welcome proposition. But we have upset the natural ecosystem to such an extent that it may not be possible to revert to the old system of organic farming in the near future by avoiding the

use of pesticides and inorganic fertilizers altogether for crop production. However, it is necessary to take utmost care in the judicial use of such chemicals. Only when absolutely necessary pesticides should be used and when using such chemicals care should be taken to select appropriate chemicals. They should be used at the correct and recommended dosage, and at the proper time when the pests are in the most vulnerable stage to ensure maximum control of the pests.

In the compilation of this book, I have gathered informations from several books, journals and other media and I am very much indebted to the authors concerned. Ackowledgements are due to collegues who have supplied me with informations and also to friends and well wishers who have inspired, helped and encouraged me in my endeavor to complete the book. I wish to place on record my sincere thanks and appreciation to M/S. New India Publishing Agency, 101, Vikas Surya Plaza, Pitam Pura, New Delhi - 110 088 for the excellent manner in which the book has been brought out.

H.Lewin Devasahayam

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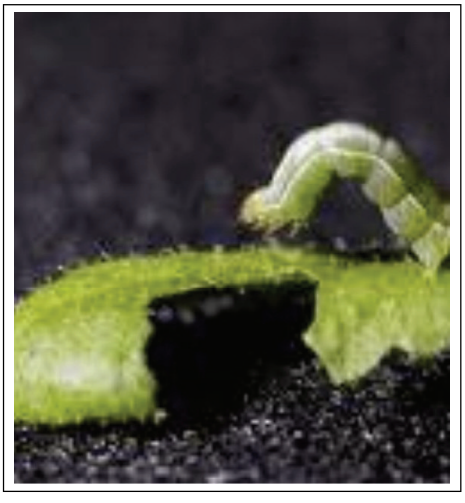

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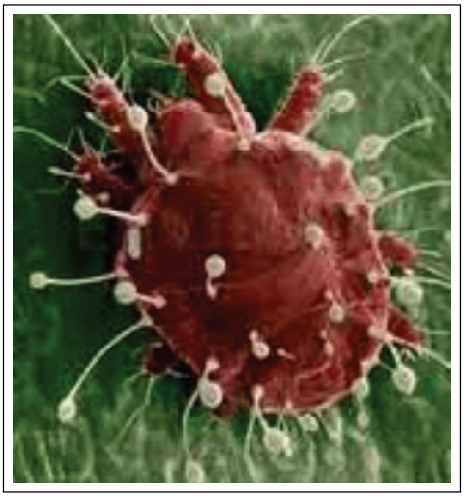

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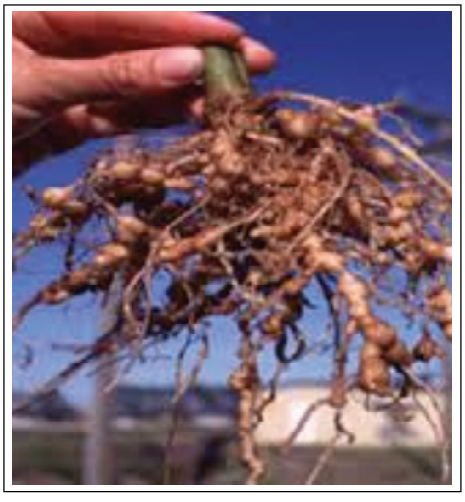

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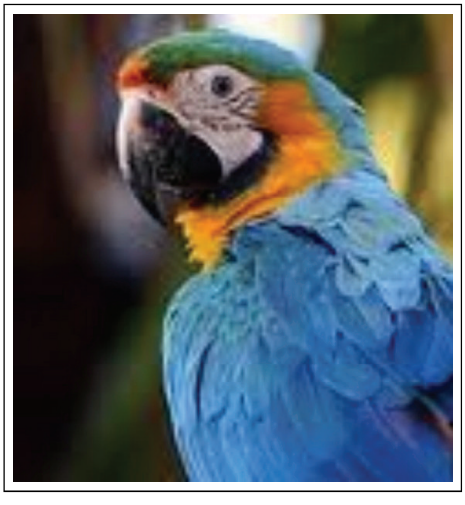

Parrot damaging fruit

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Chapter-1

Pests of Field Crops

PESTS OF CEREALS

Rice (*Oryza sativa*)

Rice is the staple food of a vast majority of people throughout the world, especially in India. Rice crop is grown in about 75 million acres, which is about one-third of the total world area under rice. The warm and humid environment for the rice crop is best suited for invasion by several insect pests and as many as 85 species of insects are known to infest this crop. The damages caused by different pests extend from the seedling to harvest stages of the crop. Some of these pests are widely distributed and cause extensive damage. The more important pests are described below:

1. Rice stem borer or Rice yellow stem borer

Scirpophaga (Tryporyza) incertulas

Order - Lepidoptera

Family - Pyraustidae

Among the pests, which ravage rice crop, 'rice stem borer' is a major one and infests rice crop at all growth stages, from seedling to flowering. It is a specific pest of rice alone and is more serious during the months of October-January. The pest has a wide distribution in all Asian countries. The damages

caused by this pest ranges from 5-20 per cent. Generally, late varieties of rice are more severely infested than the early maturing varieties, because of the possibility of the pest multiplying in larger numbers by the time the late varieties come to maturity. Cold weather with high humidity and low temperature prevalent during October-December is found to be conducive for the multiplication of the insect.

Nature of damage. The external symptom of this pest attack is the gradual fading and ultimate death of the central shoot. The larvae bore into the stem, about 1.0-3.0 cm. above the water level and eat the inner tissues, leading to wilting and eventual death of the central shoot. This is referred to as **'dead heart'**. When the larvae attack seedlings, dead hearts appear invariably, which come off easily when pulled. When the plants are attacked at flowering stage, the inner tissues of the stem are eaten away and the earheads dry up without producing grains, as a result, white-colored, chaffy earheads appear, which are called **'white ears'**. The white ears are clearly visible in the infested fields and they also come off easily when pulled. In the basal portion of the infested stem, near the nodes, minute holes made by the larvae are visible on close examination (Fig.1).

Life cycle of the pest. The adult moths rest during the daytime under the shades of plants and become active after dusk. They fly about and mate after dusk. The female moth lays 200-300 eggs in 2 or 3 compact masses on tender paddy leaves and covers the egg masses with buff-colored anal hairs. Freshly laid eggs are oval, flattened and dirty white in color. Before hatching, the eggs turn brown in color. They hatch in 6-8 days. The young larvae after emerging from the eggs spin fine, silken threads from their saliva and hang loosely from the leaves. In the blowing wind, the larvae swing and reach nearby plants within a radius of 10-20 cm. Afterwards, they crawl towards the base of the plants. Some larvae after hatching just crawl along the leaves towards the base of the plants, while some others fall directly into the water and swim freely, because of the presence of a thin air layer next to the body surface. The larvae worm their way along the leaf sheath, enter the leaf sheath and after feeding for 2-3 days, bore into the stem near the nodal region, 1.0-3.0 cm. above the water level. The newly hatched larvae are pale white, with dark brown head and a prothoracic shield. They cut and eat away the tender inner tissues, causing dead hearts. Similarly before flowering, the larvae bore into the peduncle directly, cut and destroy the inner tissues resulting in white ears. Generally only one larva is found in a stem, but occasionally 2-4 larvae may be found. Sometimes after destroying one plant, the larva migrates to the adjoining plant. In such instances, the larva after coming out of the stem, drifts on water by enclosing itself in a case made of leaf bits till it reaches

another plant and attacks it. The larval period extends from 33-41 days. A full-grown larva measures about 2.5 cm. in length, pale yellowish-white in color and smooth, with a well-developed prothoracic shield. Before pupation, the larva covers the exit hole with a web of fine silken thread and pupates within a white, silken cocoon. The pupa is dark brown in color and about 1.2 cm. long. The pupal period lasts for 9-12 days. The adult moth emerging from the pupa comes out through the exit hole already made by the larva before pupation. The female moth has bright, yellowish-brown forewings with a minute, distinct, black spot on each and an anal tuft of buff-colored or yellowish hairs. It is about 1.5 cm. in size across the wings and slightly bigger than the male moth. The male moth has pale yellow forewings and without the black spots. The moths are positive phototrophic in nature and their flight range is about 8.0 km. The moths live for 3-5 days. There may be 3-5 overlapping generations in a season. The entire life cycle is completed in 50-70 days. The larvae are reported to undergo hibernation from November-January in the stubble, 2.0-4.0 cm. below the soil level (Fig.1).

Control Measures

Physical and cultural methods (i) The egg masses on the leaf surface are clearly visible and these can be collected and destroyed (ii) Before planting, leaf tips of seedlings are clipped, thereby the egg masses on the leaf tips can be destroyed (iii) 'Dead hearts' can be removed and destroyed (iv) Light traps can be set up in the fields to attract and destroy the moths (v) After harvest, the fields are ploughed to destroy the larvae and pupae present in the stubble.

Chemical control (i) Chemical control measures should be taken up when the pest level reaches the economic threshold level. Spray application of phosphamidon-110 ml. or fenitrothion-400 ml. or fenthion-200 ml. or endosulfan-400 ml. or monocrotophos-200 ml. or decamethrin-100 ml. mixed in 200 litres of water per acre, using a high volume sprayer affords effective control of the pest. The spray should be directed towards the base of the plants to give a thorough covering of the stem region (ii) Application of granular insecticides such as carbofuran 3G-13 kg. or lindane 10G-5.0 kg. or quinalphos 5G-10 kg., mixed with 10 kg. of sand and spread uniformly on the field after impounding a thin film of water to a height of about 2.5 cm. is also effective in controlling the pest. But the cost of treatment with granular formulations in the main field is comparatively very high.

Biological control (i) Eggs of the pest are parasitized and destroyed by the egg parasites-*Trichogramma australicum, Tetrastichus schoenobii, Telenomus manolus* etc. (ii) The larval parasite-*Isotima javensis* is found to parasitize the larvae (iii) The fungal parasite-*Beauveria bassiana* affects the larvae.

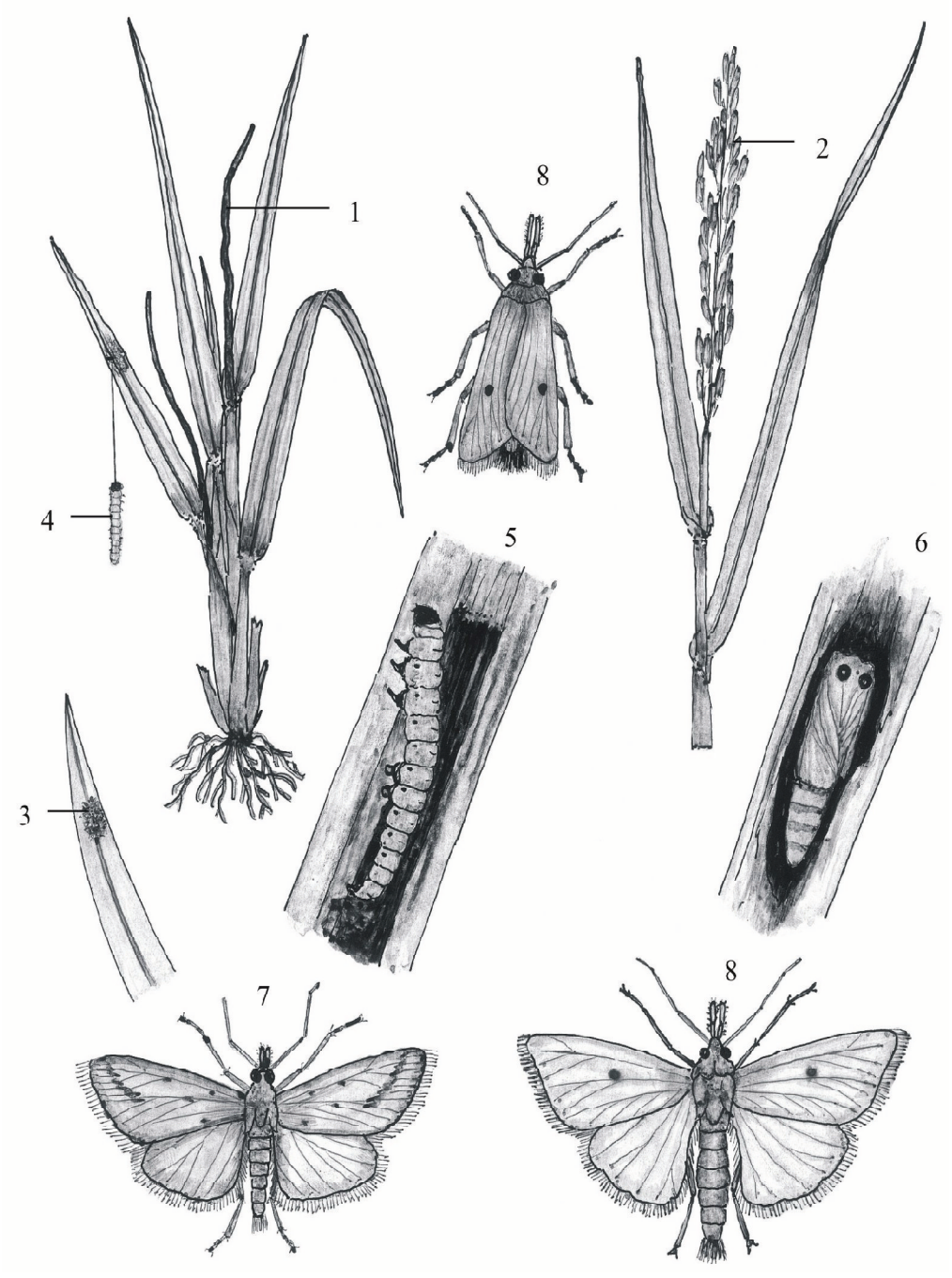

Fig. 1 : Rice Yellow stem borer- *Tryporyza incertulas*

1. Dead heart 2. White ear 3. Egg mass 4. Young caterpillar 5. Larva inside the stem 6. Pupa inside the stem 7. Male moth 8. Female moth

2. Rice leaf folder

Gnaphalocrocis medinalis

Order - Lepidoptera

Family - Pyraustidae

'Rice leaf folder' or 'Rice leaf roller', which was considered as a minor pest has assumed serious proportions and causes severe losses to rice during some seasons. In Tamil Nadu, it is an endemic pest and appears in all the seasons and all cultivated varieties of rice have been found to be susceptible. The infestation is more in fields, which receive excess amount of nitrogenous fertilizer and in shaded places. The pest infestation is more severe during the months October-January. Besides rice, it attacks several graminaceous weeds.

Nature of damage. The newly hatched larva produces fine, silken threads from secretion of its salivary glands and folds or rolls the leaves and webs them. The larva stays inside the folds of the leaves securely, scrapes and feeds on the green portion of the leaves, as a result the scrapped portions become white and papery in patches. Severely affected leaves have many such patches, sometimes extending to the entire length of the leaves. Growth of such infested plant is retarded and grain formation is adversely affected. The pest infests the crop at all growth stages. If the infestation occurs at the flowering stage and if the boot leaf is affected, the yield is reduced to a considerable extent (Fig. 2).

Life cycle of the pest. The female moth lays eggs singly, mostly in lines of 10-15 on the under surface of tender leaves. The eggs are spherical, white in color and smooth. They hatch in 6-7 days. The young caterpillar emerging from the egg starts feeding by scraping the chlorophyll portion of the leaves. Simultaneously the larva rolls the leaf blade and fastens the edges with silky thread. Sometimes the leaf tip is folded and fastened to the basal part of the leaf blade. The larva remains securely inside the leaf roll or fold, scrapes, feeds on the green portion of the leaf blade and grows. The larva is pale yellowish-green in color and smooth. It becomes full-grown in 25-30 days. The grown-up larva pupates inside the leaf roll or inside the leaf fold and in 6-8 days, the adult moth emerges from the pupa. The entire life cycle is completed in 30-42 days. The moths are small in size and brownish-orange in color. The forewings are light brown in color, with two, distinct, dark, wavy lines on each wing. The hindwings are also light brown in color with one dark, wavy line and a dark brown band along the outer margin of each of the wings. There are 3-5 overlapping generations in each season (Fig. 2).

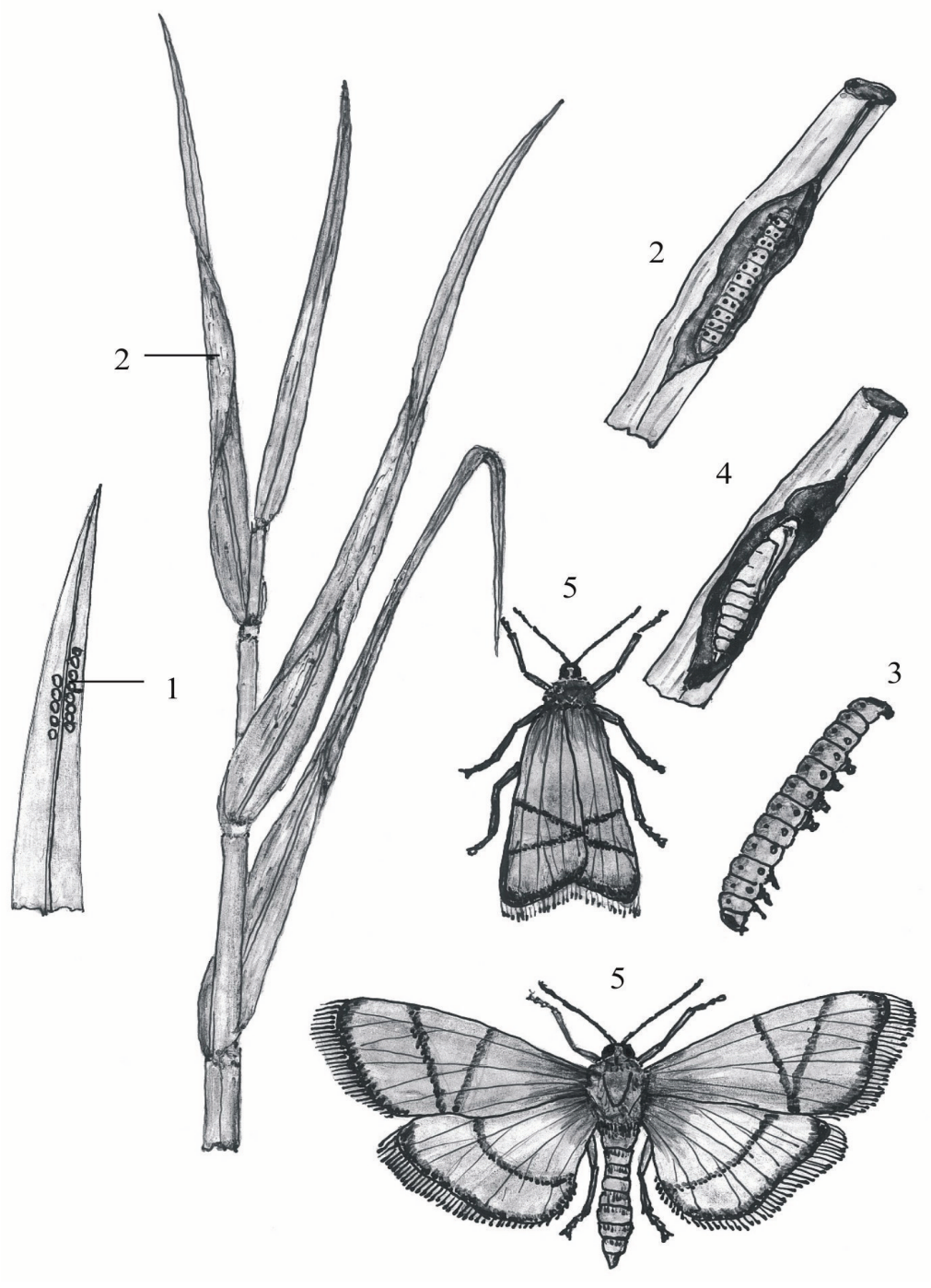

Fig. 2. Rice leaf folder-*Gnaphalocrocis medinalis*

1. Egg mass 2. Larva inside the leaf fold 3. Larva 4. Pupa inside the leaf fold 5. Moth

Control measures

Cultural methods (i) Graminaceous weeds, which serve as collateral hosts of the pest in and around rice fields should be eradicated (ii) More than the required quantity of nitrogenous fertilizer should not be applied. Further, instead of applying nitrogen in a single dose, split application should be followed. Application of large dose of nitrogen at the flowering time should be avoided (iii) By using light traps, the moths can be attracted and destroyed.

Chemical control (i) Foliar spraying with carbaryl WP-1000 gm. or quinalphos-400 ml. or monocrotophos-200 ml. or phosalone-400 ml. or fenitrothion-400 ml. or chlorpyrifos-400 ml. in 200 litres of water per acre, using a high volume sprayer will control the pest effectively (ii) Spraying with neem seed kernel extract-5% also controls the pest effectively.

Biological control. A few egg parasites belonging to *Trichogramma* species parasitize the eggs of the pest. *Elasmus brevicornis* and a few *Bracon* species destroy the larvae. *Tetrastichus israli* parasitizes the pupae.

3. Rice case worm

Nymphula depunctalis

Order - Lepidoptera
Family - Pyraustidae

'*Rice case worm*' is a sporadic pest but may assume very serious proportions in some seasons and during some specific weather conditions, especially when there is continuous water inundation during the young stages of the crop. Besides rice, the pest breeds on a number of grass hosts.

Nature of damage. The pest is more serious in young transplanted crop. The larva cuts the leaf blade into small bits, constructs a tubular case and lives inside the case securely. The case is attached to the stem or leaf at or above the water level or the larva may float on the water along with the case. When about to feed or while swimming, the head and a portion of the body protrudes out of the case. With any slight disturbance, the larva retracts its body and head into the case. The larva feeds by scraping the under surface of the leaf blades, leaving the upper epidermis intact and as a result of such scraping, characteristic whitish, papery patches are seen on the leaf blades. The area near about the cut ends of leaves also appears whitish. Severely infested crop appears as if grazed by cattle. The affected tillers become stunted and lose their vigor and often the plants are killed. Even if the plants are not killed, earhead formation is adversely affected. If the plants are disturbed, the larvae attached to the stem and leaves detach, fall into the water, start swimming and go to some other plant. The larvae are semi-aquatic in nature.

They are capable of swimming in water to some extent and can breathe under water with the help of tracheal gills found on the sides of the body. If the water is drained off, the larvae crawl and remain inside the base of the hills (Fig.3)

Life cycle of the pest. The female moth lays about 50 eggs, singly on the under surface of leaves. The eggs hatch in 2-6 days and the young caterpillars emerging out of the eggs start feeding by scraping the chlorophyll portion from the under surface of the leaf blades for a few days. Then they cut the leaf blades into small bits and construct tubular cases, live inside the cases and feed on the under surface of the leaf blades. With every moulting, the case is replenished. The larva is pale green in color, with a light brownish-orange head and thin hairs on the body and measures about 2.5 cm. in length. The larval period extends over 14-20 days. The grown-up larva pupates inside the case, which is attached to the base of a tiller and the adult moth emerges from the pupa after a period of 4-7 days. The entire life cycle is completed in 20-37 days. The moths are small, whitish in color and on the white wings, light brown, wavy markings are seen and they live for about 4 days (Fig. 3).

Control measures

Physical and cultural methods (i) A long rope is held across the field from the two opposite bunds by two persons and the rope is slowly dragged along the top canopy of the crop, so as to disturb the crop. Because of the disturbance, the larvae attached to the leaf and stem portions fall into the water. A small quantity of kerosene oil is poured over the standing water, which spreads to the entire area as a thin film. Under this condition, the larvae falling into the water cannot breathe and so they die of suffocation (ii) Too much of water should not be allowed to stagnate in the fields.

Chemical control (i) Dusting with carbaryl 10 D at 10 kg. per acre may be resorted to in case of mild infestation (ii) Foliar application of monocrotophos-200 ml. or endosulfan-400 ml. or fenitrothion-400 ml. or phosphamidon-110 ml. in 200 litres of water per acre, with a high volume sprayer effectively controls the pest.

4. Rice thrips

Stenchaetothrips biformis

Order - Thysanoptera
Family - Thripidae

'Rice thrips' is a specific pest of rice and has a wide distribution. It was first reported in Tamil Nadu in 1915 and occurs sporadically in different parts

Fig. 3. Rice case worm-*Nymphula depunctalis*

1. Egg 2. Larva inside the case 3. Larva 4. Pupa inside the case 5. Moth

of Tamil Nadu. The pest may assume serious proportion in some seasons and cause extensive damage to the crop and yield loss. It also infests *Echinochloa crusgalli.*

Nature of damage. The pest infests the nursery crop and the young transplanted crop to a large extent. The nymphs and adults have rasping and sucking type of mouthparts and they attack the terminal shoots and tender leaves, lacerate the leaves and suck the sap, as a result the leaf tips become rolled and twisted and eventually the leaf tips dry out. The nymphs and adults are seen in large numbers in the rolled leaf tips. In ill-maintained nurseries and when there is lack of sufficient irrigation in the nurseries and transplanted crops, the infestation is severe and tips of the plants present a burnt appearance. In severe cases, the seedlings may completely dry and may even die. However, after one or two heavy showers, the crop becomes free of the pest.

Life cycle of the pest. The adult female insect inserts the eggs individually into the leaf tissues. The eggs hatch in 3-5 days and the newly hatched young ones are very active. They feed by lacerating the leaves and sucking the sap from young leaves. The nymphal period lasts for 7-14 days, after which they shed their antennae and legs, and attain the pupal stage. After a few days the adult insects emerge from the pupae. The life cycle is completed in 14-20 days. The adults are very minute, dark brown or blackish in color and have fringed wings (Fig. 94).

Control measures

Cultural methods. The nursery and young transplanted crop should be properly irrigated and maintained

Chemical control. (i) For 8 cent nursery area, dusting with carbaryl 10 D at 0.5 kg. gives effective control (ii) Instead of dusting, the nursery can be sprayed with endosulfan-60 ml. in 20 litres of water (iii) In the transplanted crop, foliar spraying of endosulfan-300 ml. or phosalone-400 ml. or phosphamidon-110 ml. or fenitrothion-300 ml. or fenthion-200 ml. in 200 litres of water per acre with a high volume sprayer gives appropriate control.

5. Dark-headed caterpillar

Chilo polychrysa

Order - Lepidoptera

Family - Crambidae

The pest was first noticed in Kerala in 1956 and since then has been reported to occur in Tamil Nadu, Orissa, West Bengal and Assam. In case of

severe infestation, the loss in yield may go up to 60 per cent. In South India, the pest occurs from July-January. It also attacks the weed-*Panicum crusgalli.*

Nature of damage. The larva feeds on the inner tissues of the central shoot by boring into it. As many as 7 larvae may be found in a single shoot. Later on, the adjacent tillers are also damaged by the larvae, which migrate and infest them. The infestation may result in the ultimate death of the plants.

Life cycle of the pest. The female moth lays 20-150 eggs on the lower or upper surface of the leaf. The eggs are flat, broadly oval and are laid in two or more longitudinal rows, overlapping each other. The egg period lasts for about 6 days. The full-grown larva is characterized by the presence of three dorsal and two lateral, purplish-brown stripes on the body, a brownish-black head and prothoracic shield. It measures about 2.1 cm. in length. The larval period extends from 23-36 days. The full-grown larva pupates in a thin, silken web inside the stem. After a period of about 4 days, the adult moth emerges from the pupa. The moth has brownish forewings, with 6-7 black spots on each of the forewings.

Control measures. The control measures suggested for the control of rice stem borer may be adopted.

6. Rice gall fly or Rice gall midge

Orseolia (Pachydiplosis) oryzae

Order - Diptera

Family - Cecidomyiidae

The pest is found in all rice growing tracts of India, including Tamil Nadu, Kerala, Orissa, Telungu Desam, Madhya Pradesh, and Bihar and in some seasons, when the weather conditions are favorable for the pest, it appears in a serious form. The infestation is commonly referred to as **'silver shoot'** or **'onion shoot'** or **'anaikomban'** in Tamil, because of the formation of hollow, pink, purple, dirty white or pale green, cylindrical, tubular structures bearing at their tips a green, reduced and malformed leaf blade with ligules and auricles. In case of severe infestation, the yield loss may go up to 50 per cent.

The pest also attacks a number of grass hosts such as, *Paspalum scrobiculatum, Paspaladium geminatum, Panicum* sp., *Ischaemum ciliare, Cynodon dactylon* and *Eleusine indica.*

Nature of damage. The pest infests rice crop even in the nursery, but 5-6 weeks old, actively tillering transplanted plants are more vulnerable to attack. The maggot bores into the stem, feeds on the shoot apex and the growth of the apical meristem is suppressed. The first instar larva produces a hormone,

'cecidogen', which causes some type of stimulation in the plants and instead of the normal growth of the shoot, the leaf sheath of the innermost leaf primordium elongates into a long, hollow, tubular structure like a long tusk of an elephant, commonly called as 'silver shoot' or 'onion shoot'. This elongation of the leaf sheath is attributed to cell proliferation caused as the result of the hormone secreted by the larva. The silver shoot is actually the modified leaf sheath and its color resembles the color of the normal leaf sheath of the particular rice variety. The infested plants fail to produce earheads (Fig. 4).

Life cycle of the pest. The female midge lays 100-300 eggs, singly or in batches of 2-6, just below or above the ligules of the leaf blade. Occasionally, the eggs may be deposited on the surface of standing water. The eggs are reddish in color, elongate and tubular, with rounded ends. The eggs hatch in 3-4 days. The young maggot, which emerges out from the egg, crawls along the leaf sheath, reaches the stem region, bores into it and finally reaches the shoot apex in 6-12 hours. Only one larva is present in a shoot apex and after the formation of the gall due to its feeding, remains inside the gall throughout its development. The young grubs are whitish-pink in color, while the grown-up grubs are pink in color. They lack legs. The larval stage lasts for 15-20 days. The full-grown grub pupates inside the gall and after a period of 2-8 days, the fly emerges from the pupa. Before emergence, the pupa wriggles up to the tip of the gall and projects half way up the gall. The pupal case is seen protruding out of the mouth of the exit hole after the emergence of the fly. The entire life cycle is covered in 19-21 days, but during winter it may take 32-39 days. After the exit of the fly, the gall dries up. The development of the pest may be staggered due to larval dormancy and the dormant maggots remaining in the axillary shoot apices help in the carry over of the pest. The adult flies are small, delicate, mosquito-like, with long, thin legs. The females are yellowish-red in color, with swollen abdomen, while the males are thin and dark red in color. The wings are almost transparent. The adults are active during the nighttime (Fig. 4).

Control measures

Cultural methods (i) Infested plants should be removed and destroyed (ii) After the harvest of the crop, the field should be ploughed to destroy the larvae and pupae that may be present in the inactive axillary shoots

Chemical control (i) Spray application with endosulfan-400 ml. or phosalone-400 ml. or phosphamidon-110 ml. in 200 litres of water per acre with a high volume sprayer controls the pest. The spray should be directed towards the basal parts of the plants (ii) Seed treatment with chlorpyrifos-0.2% emulsion for 3 hours or seed mixing with chlorpyrifos