

RICE

Non-chemical Pest Control

K. Vijayalakshmi
Subhashini Sridhar
and
E. Damodharan

Centre for Indian Knowledge Systems, Chennai
Council for Advancement of People's Action and
Rural Technology, New Delhi

August 1998

Non-Chemical Methods of Pest Control and Crop Protection

SOUTHERN REGIONAL WORKSHOP

1st - 3rd July 1998

Rice Pests, Predators and Biocontrol Techniques

Centre for Indian Knowledge Systems, Chennai

Sponsored by

Council for Advancement of People's Action and Rural Technology, New Delhi

Tamil Nadu State Council for Science and Technology, Chennai

<i>Title</i>	Rice Non-chemical Pest Control
<i>Date of Publication</i>	August 1998
<i>Price</i>	Rs.35/=
<i>Copies can be had from</i>	Centre for Indian Knowledge Systems, No.2, 25th East Street Thiruvanmiyur Chennai - 600 041.

© Centre for Indian Knowledge Systems

Cover Design & Illustrations
Saraswathi, V.

Typesetting
S. Ramesh

Printed at
Multi Craft
94, Veeraperumal Koil Street,
Mylapore,
Chennai - 600 004.

Centre for Indian Knowledge Systems : A Brief Profile

Objectives

The major objective of the Centre is to explore the current relevance and applications of Traditional Indian Knowledge Systems. The two areas of focus are - Traditional Agriculture and Traditional Health Care Systems. The Centre is involved in Research, Training programmes and the Production of educational material in the form of publications and audio visuals.

Activities

The following are the major activities :

- a Action research and training programmes on the use of natural products for pest control and crop protection.
- a Setting up of rural Gene Banks for the conservation of traditional seed varieties.
- a Development of the use of Biological control agents for the control of pests in the paddy eco-system and domestic pests.
- a Research on the applications of Vrksayurveda (Traditional Indian Plant Science)
- a Training programmes on the use of traditional medicine for various groups.
- a Preparation of audio visuals on various aspects of traditional health care systems.
- a Publication of Newsletters, Manuals, Monographs on traditional health care and traditional agriculture.

Preface

Rice has been cultivated for countless ages. In the past, rice farmers grew traditional rice cultivars which were highly pest resistant. If at all there was pest occurrence they relied on cultural, mechanical and physical methods of pest control. They also used different plant extracts for controlling these pests. However, the situation has changed in the last three decades. The widespread introduction of high yielding rice cultivars and also the associated changes in production practices have led to the resurgence of several insect pests and diseases. This has led to increased pesticide application which has brought about decrease in the population of beneficial organisms, increase in pesticide resistance and has also led to environmental contamination.

To combat these problems we need to once again look for non-chemical pest control techniques. This publication provides practical information about the non-chemical pest control in the rice crop. It also provides details for identification of pests and predators and briefly describes some of the important diseases of the rice crop and their management. Most of the pest control practices have been tried out by farmers across the country. We hope that in future editions we will be able to add more experiences.

Our sincere thanks are due to the participants of the Trainer's Training Programme on Non-Chemical Methods of Pest Control and Crop Protection who have contributed towards refining the draft of this book which was produced for the training programme. We are thankful to the Council for Advancement of People's Action and Rural Technology (CAPART) for supporting the training programme as well as this publication. We hope that this publication will encourage several farmers to shift to non-chemical alternatives.

Chennai
August 1998

Dr. K. Vijayalakshmi
Editor.

Front Page

RICE

Non-chemical Pest Control

Back Page

Ever since rice was cultivated pest epidemics have also been recorded. Pests such as the brown plant hopper, green leaf hopper and ear head bug have challenged our rice farmers to a great extent. The widespread introduction of high yielding cultivars and associated changes in production practices have led to the resurgence of several insect pests and diseases. Increased pesticide application has brought about a decrease in the population of beneficial organisms, increase in pesticide resistance and has also led to environmental contamination. To combat these problems we need to once again look for non-chemical pest control. This publication provides practical information about the non-chemical pest control in the rice crop. It also provides details for identification of pests and predators and briefly describes some of the important diseases of the rice crop and their management. Most of the pest control practices have been tried out by farmers across the country.

Centre for Indian Knowledge Systems
Chennai

Council for Advancement of People's Action
and Rural Technology,
New Delhi

CONTENTS

1.	Pests of the Rice Crop	1
2.	Diseases of the Rice Crop	28
3.	Beneficial Organisms of the Rice Crop	32
4.	Preparation of Extracts	48
	References	51
	Scientific and Common Names of Pests and Plants	52

Legends

1. Yellow stem borer

Eggmass seen on the leaf surface

Larva inside the stem

Adult moth

Actual size

2. Leaf folder

Larva inside the leaf fold

Adult moth

3. Case worm

Cases attached to the leaf

Caterpillar inside the case

Adult moth

4. Gall midge

Adult fly

5. Green Horned Caterpillar

Caterpillar feeding on the leaf

Adult moth

6. Yellow Hairy Caterpillar

Affected leaf

Caterpillar

7. Army worm

Affected leaf larva

Adult moth pupa

Caterpillar

8. Grass hopper

Adult

Nibbling symptom

9. Black bugs

Adult

10. Rice hispa

Affected leaf

Adult

11. Mealy bug

Affected leaf

Adult

12. Green leaf hopper

Hopper on the leaf surface

13. White backed plant hopper

14. Brown plant hopper

Adult

Nymphs and adults at the base of the stem

15. Ear head bug

Adult

White chaffy ears

16. *Micraspis crocea*

17. *Harmonia octomaculata*

18. *Menochilus sexmaculatus*

19. Ground beetle

20. Crickets

21. Damsel flies

22. Earwig

23. Ants

24. Wasp

25. Long horned grass hopper

26. Small ripple bug

27. Water strider

28. Water treader

29. Mirid bug

30. Orb spider

31. Long jawed spider

32. Wolf spider

33. Lynx spider

34. Jumping spider

35. Dwarf spider

36. Assassin bug

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Actual size

Legends

<i>Name</i>	<i>Page No.</i>
Larva in the stem	2
Egg mass	2
Adult moth	2
Green leaf hopper	5
Brown plant hopper	7
Ear head bug	11
Affected ear head	11
Leaf folder	13
Case worm	14
Horned caterpillar	15
Yellow hairy caterpillar	16
Army worm	17
Rice grass hoppers	19
White backed plant hopper	20
Gall midge	21
Black bug	22
Micraspis crocea	27
Harmonia octomaculata	27

Synharmonia octomaculata	28
Ground beetle	28
Crickets	29
Damsel flies	30
Earwig	31
Ants	32
Wasps	32
Grass hopper	33
Small ripple bug	34
Water strider	34
Water treader	35
Mirid bug	36
Orb spider	37
Long jawed spider	37
Wolf spider	38
Lynx spider	39
Jumping spider	40
Dwarf spider	41

Rice

Chapter - 1

PESTS OF THE RICE CROP

Introduction

Ever since rice was cultivated by man, pest epidemics have also been recorded. Pests such as the Brown plant hopper, Green leaf hopper and Ear head bug have historically challenged rice farmers. Our farmers have responded to these challenges with very innovative pest control measures such as draining the water from stagnated fields, and the practice of "Neekal Podum Murai" (Ref . Pg. 23) for the control of BPH and spreading of Calatropis leaves over the bunds for the control of grass hoppers. This section deals with identification of important pests and symptoms of their attack. Information is also provided on the non-chemical pest control. Pests have been grouped according to the growth stages of rice.

PESTS OF THE VEGETATIVE STAGE

- 1. Rice stem borer or Yellow stem borer**
Scirpophaga incertulas

Symptoms

- i. In the early stage of the crop, growth as well as tillering cannot be seen.
- ii. Eggs covered with yellow hairs are visible on the leaf surface.
- iii. In the under surface of the stem, a hole can be seen made by the larva.

- iv. White chaffy ears can be seen at irregular intervals all over the field.
- v. Only one larvae can be seen inside the stem.

Damage Pattern

Stem borer infestation is severe when rice is grown repeatedly without any crop rotation and when transplanting is delayed. Damage is caused by caterpillars which bore into the leaf sheath and destroy the growing tip by feeding the internal contents. This in turn disrupts the flow of water and nourishment to the plant thereby causing drying of central shoot. This is referred as 'dead heart'. When infestation occurs at the flowering stage, the earheads become chaffy which are referred as 'white ears'.

Conducive Atmosphere

High humidity and low temperature favours the multiplication of the insects. In medium and long duration varieties pest attack occurs in the nursery itself. The incidence is low during June - September, but later on increases from October and becomes maximum during January - February.

Life Cycle

The adult female moth has a bright yellow forewing with a black spot and an anal tuft of yellowish hairs. It lays about 200 eggs on leaves or sheaths and covers them with buff coloured hairs and scales derived from its anal tuft. After 10 days, tiny caterpillars hatch out from these eggs which are the causal agents for damage. They are pale white in colour with dark brown heads. Later they become yellowish in colour. They bore into the stem near the node. After 35 days, they turn into pupae inside the stem. After 10 days of pupation, adult moths come out.

Economic Threshold Level (ETL)

Economic threshold level for every pest is determined by the agricultural scientists. It is the density at which control measures should be applied to prevent an increasing pest population from reaching the economic injury level. Above the ETL level economic injury occurs while below it no control is necessary. 2 egg masses / m² or 10% dead heart or 2% white ears are the ETL level prescribed for stem borer.

Natural Enemies

Some natural enemies do exist in the field itself which feed upon stem borer larvae, eggs and adults. They are described in a latter section. Besides parasites can be used as a part of biological control. The commercially available parasites are *Trichogramma japonicum*, *Trichogramma braziliensis*, *Telenomus beneficiens*, *Tetrahymena sp.*, *Bracon chinensis* etc. They parasitize the egg stage of the pest.

Management

- i. Egg masses should be collected and destroyed.
- ii. Land should be ploughed immediately after harvest to destroy eggs and pupae.
- iii. Light traps can be used to monitor and trap the adults thereby reducing the population. Some common light traps that could be used are bonfire, hurricane lamp, trap with electrical bulb etc. The adult moths have an inherent capacity to get attracted to the light. It should be set up in the field after 5.30 p.m.
- iv. Proper spacing should be given while planting. For short duration varieties a spacing of 10 cm between plants and 15 cm between rows should be provided. For medium duration varieties 20

cm. between plants and 10 cm between rows should be provided and for long duration varieties, 20 cm between plants and 15 cm between rows should be provided.

- v. 5 - 10 kg of husk can be mixed with 3 - 5 litres of kerosene and applied over the plants early morning. This is recommended for an acre. This repels the insects effectively. Even wood ash (8 kg / acre) can be used as an alternative.
- vi. 3% neem oil emulsion can be used. Even 5% neem cake extract can be used as a control. This is sprayed on the crop thrice during growth stages.
- vii. *Vitex* has repellent properties against the stem borer. Extracts of leaves and stem of *Vitex* can be sprayed over plants. It repels the insect for about 2 weeks.
- viii. Flowers of pongam are added while burning the fields. This is practiced in the Konkan region of Maharashtra. It is believed that because of this the stem becomes sturdy enough to check the stem borer's attack.
- ix. While the seed bed is prepared, rice husk powder can be added to check stem borer attack.

2. Leaf folder

Cnaphalocrocis medinalis

Symptoms

- i. The larva rolls the leaf blade by fastening its edges and sometimes even the leaf tip to the basal part of the leaf blade.

- ii. Eggs and the larva can be seen inside the folded leaf blades.
- iii. In a severely infested field, the whole crop gives a sickly appearance with white patches.

Damage Pattern

Larva feeds on the leaf surface and causes longitudinal white streaks on the leaf blade. Heavily damaged leaves become brown in colour. When infestation is high, each plant may contain many folded leaves and yield loss is high.

Life Cycle

The adult moth is small brownish orange in colour with dark wavy lines on fore and hind wings. A dark brown band is seen on their outer margins. The female moth lays eggs in groups on the under or upper surface of the leaf blade. After 7 days, pale yellow green larvae emerge out. They start feeding on the leaves and inner contents. They then pupate inside the leaf roll itself. From pupae, adults emerge in 6 - 8 days.

Management

- i. The field and bunds should be kept free of weeds which serves as a breeding place for the pest.

- ii. Light traps can be used to attract and kill the adult insects thereby reducing its population.
- iii. 3% neem oil emulsion with 5 litres of kerosene can be sprayed which control the pests efficiently.
- iv. 2 - 4% neem oil emulsion can be sprayed over 30 days crop as a prophylactic measure.
- v. Persian Lilac seeds can be used as a control measure. 3% seed extract can be used. This when sprayed controls the pest effectively.

3. Case worm

Nymphula depunctalis

Symptoms

- i. Stunted plants in patches are found around the field.
- ii. Appearance of whitish patches on the tip of the leaves is a visible symptom.
- iii. Tubular cases can be seen hanging on the leaf edges. They are made of cut leaf bits.

Damage Pattern

The caterpillar cuts pieces of leaves and rolls it longitudinally into a box like structure. It remains inside the case itself. Hence this is referred as a “case worm”. It feeds on the chlorophyll by scraping. Since the leaf is damaged, plant growth gets arrested.

Life Cycle

The adult is a small delicate moth with white wings and brown wavy markings on it. The female moth lays eggs on the tender leaves. After 7 days, green caterpillars with orange head emerge out. They scrape the green matter and damage the leaf surface. They are semi aquatic. Hence they can live even when dropped in water. They live in the case itself and pupates inside. The pupae are brown in colour. From the pupae, adult moths emerge.

Management

The field should be filled with water upto 6 cm. To this, 1 litre of kerosene should be added and mixed properly. A string should be dragged over the surface of leaves vigorously so that cases fall in the water. Likewise, it is repeated twice and the water is drained from the field.

4. Gall Midge *Orseolia oryzae*

Symptoms

Tubular gall formed in the leafy part of the plant resembles an onion leaf referred as onion leaf gall or silver shoot.

Life Cycle

The adult fly is yellowish brown in colour. It is of the size of a mosquito. The female fly lays 100 - 200 elongated, red colour eggs on the surface of the leaf blades. After 4 days, maggots hatch out of the eggs. They feed at the growing point of the leaf causing gall formation on the leaves. After 20 days, pupa is formed inside the gall itself. In 8 days, adult flies emerge out.

Damage Pattern

Maggot feeds on the leaf sheath and converts it into purple or pale green cylindrical tube which is referred as gall. Tillers with galls do not produce panicles.

5. Green horned caterpillar *Melanitis leda ismene*

Damage Pattern

Caterpillars feed on the leaves which leads to defoliation.

Life Cycle

The adult is a butterfly which is dark brown with a few black and yellow eye markings which is a characteristic feature. It lays white round eggs on the leaves. After incubation, green caterpillars with two red processes in the head emerge out. These larvae feed on the leaves. Pupation occurs on the leaf itself. From the pupae adults emerge.

6. Yellow hairy caterpillar

Psalis pennatula

Damage Pattern

The caterpillars feed on the leaves which lead to defoliation.

Life Cycle

The adult moth is stout with straw coloured forewings. It lays eggs on the surface of the leaf. After incubation, yellowish brown caterpillars emerge out. They have red stripes and tufts of hairs all over the body. After feeding on the leaves, they undergo pupation in a white cocoon of silky nature. From the pupae adults emerge.

7. Army worm or Swarming caterpillar

Spodoptera litura

Symptoms

- i. Larvae feed on seedlings in the nursery presenting the appearance of a field grazed by cattle.
- ii. In the transplanted crop, the leaves are completely eaten away leaving behind the midribs of leaves.

Life Cycle

The adult moth is dark brown with a conspicuous black spot on the forewing. It lays 200 - 300 spherical eggs on the underside of leaves and covers them with greyish hairs. Larvae are stout, smooth and 4-5 cm in length. They are dark green or dull grey in colour with yellow back and side stripes. After 20 days, they enter pupation stage in an earthen cocoon. Pupation occurs in the soil only. After 7 days, adult moths emerge out. Life cycle varies from 30 - 40 days.

Damage pattern

Young caterpillars march in large numbers from field to field and hence they are named as “Army worms”. If the infestation occurs in the later stages of the crop, panicles are cut at the base resulting in heavy loss.

Management of leaf eating pests

- i. After 30 days of transplantation, neem cake or pongamia cake should be powdered and dusted over the field. For an acre, 10 kg powder is needed. This prevents the attack of caterpillars.
- ii. A simple measure to keep the caterpillars away is to keep neem leaves in bunches at different places of the field. These can be placed at 10 places in an acre.
- iii. Wood ash at the rate of 10 - 12 kg for an acre can be dusted. This is a low cost technology which can be followed even by a small farmer.
- iv. Take 5 kg of castor seeds, fry it in a pan and pound it into powder. Then add water to it and make it as a paste. Take this paste in a mud pot and keep it in 5 to 6 places in an acre. Once in 10 days, change the paste. This acts as a trap for the adult insects.
- v. Flooding of nursery exposes the hiding larvae in the soil. These would be picked up by the birds.
- vi. Take 1/2 kg garlic, 1/4 kg chilli and 1/4 kg ginger. Soak the garlic in 100 ml kerosene over night. Next day prepare the paste with considerable amount of water. Likewise make paste of chilli and ginger with water alone. Mix the above ingredients with 60 litres of water and spray over the crops.

8. Rice grass hoppers

Hieroglyphus banian

Symptoms

Cut leaves are seen which are leaves nibbled by the nymphs and adults. Earheads in the early stages, are also damaged.

Damage Pattern

Both the nymphs and adults feed on the leaves and in severe cases, the entire leaf may be eaten away. In the earhead stage, the adults nibble the tender florets or grains resulting in white ear heads.

Life Cycle

The adult grasshoppers are green in colour. Sometimes brown grasshoppers are also seen in the field. The adults mate and lay eggs in the soil during October - November preferably on the sides of the bunds. After 7 months, nymphs emerge out on the onset of monsoon rains. After 80 days, they become adults.

Management

- i. Spreading of calotropis leaves on the bunds of the field prevents the entry of grasshoppers.

- ii. To manage grasshoppers a solution of cow dung or goat dung could be used. 30 - 50 kg of the dung should be taken and filled in a gunny bag. The gunny bag is balanced on a pole. Below the gunny bag a drum filled with 100 - 200 litres of water is kept. The tip of the gunny bag should be kept in such a way that it touches the surface of the water. The gunny bag is shaken twice a day for 15 days. After 15 days the water in the drum will be brown and smell like Ammonia. This should be diluted with twice the amount of water and sprayed. This acts as a repellent for grasshoppers.

9. Black bugs

Scotinophara spp.

Symptom

Blast lesion occurs on the leaf and leaf sheath. Central portion of the leaves roll longitudinally and the entire plant dries up.

Life Cycle

Adult bug is black in colour. It lays eggs on the surface of the leaves in 2 - 4 rows. After a few days, nymphs emerge and move towards the plant base to feed on the leaf sheath and leaves. After moulting, they become adults.

10. Rice Hispa

Dicladispa armigera

Symptoms

White streaks are seen on the leaf veins. The affected leaves become brown in colour. Severe infestation causes burnt appearance of the field.

Damage Pattern

Both the adults and larvae feed on rice leaves. They scrape the leaf surface and leave white streaks between the leaf veins. The larval mines are irregular and semi-transparent in nature.

Life Cycle

Adult is blue black in colour. Each female lays about 50 eggs near the tips of the young leaves. Eggs are oval shaped and white in colour. From the eggs, yellowish grubs emerge out. After feeding, they pupate in the leaf mines itself. After 5 days of pupation, adults emerge out.

Conducive Atmosphere

It is more abundant in the rainy season. Mostly it is prevalent in the irrigated areas where rice grows throughout the year.

Management of black bugs and Hispa

1. Spread calotropis leaves in lumps in different parts of the field. This acts as a repellent and prevents the entry of pests.
2. Fumigation can be done with mahua cake or neem cake at fortnightly intervals. For an acre, 10 - 15 kg cake is required.
3. Mix 5 litres of kerosene with 30 litres of water and spray it in the evening. Kerosene acts as a repellent and prevents the damage.

11. Mealy bug

Heterococcus rehi

Symptoms

Oval patches can be seen on the leaves. Affected plants produce distorted panicles with chaffy grains.

Damage Pattern

Nymphs and adults remove the plant sap and affected leaves show oval or round patches on the surface. Leaves gradually becomes yellow in colour. This type of damage is known as "Soorai disease".

Life Cycle

Adult female bug lays 100 to 300 eggs inside the leaf sheath. Eggs are yellow white in colour and are laid in chains on waxy threads. After a day, nymphs emerge. They crawl over the stem and move to other plants. They are pink in colour. After 35 days, nymphs turn into adults.

Conducive Atmosphere

Dry spell and drought favours the increase in population.

Management

Take 5 kg Neem kernel powder in a pouch and immerse it in water overnight. Next day squeeze it to get the extract. Filter the extract and dilute it with 50 - 60 litres of water and spray it over the crop. This is recommended for an acre.

PESTS OF THE REPRODUCTIVE STAGE

1. Green leaf hopper (GLH)

Nephotettix virescens

Symptoms

- i. Leaf tips become yellow while the other portions remain green in colour.
- ii. Stunted plants are visible at irregular intervals all over the field.
- iii. If the plants are tapped, nymphs and adults can be seen jumping from the plants.

Damage Pattern

Nymphs and adults suck the plant sap from the leaves which results in distorted growth. The plants lose vitality, form yellow tips and ultimately the entire plants dry up. Green leaf hoppers are vectors of several viruses. Through the sap, these hoppers transmit viruses such as Transitory yellowing virus, Tungro virus and Yellow dwarf virus.

Conducive Atmosphere

A hot weather immediately after a shower encourages the multiplication of the pest.

Life Cycle

The adult fly is green in colour with black stripes on the tip of the wings. It is a very small insect about 3 to 5 mm in size. It lays eggs under the epidermis of the leaf sheath. After 6 days, nymphs emerge and pass over 5 nymphal instars and become adults in 18 days. Nymphs generally remain in the upper part of the plant. Adults are capable of flying over the fields.

Economic Threshold Level

Sweep net method is used to calculate the economic threshold of all sucking pests such as green leaf hopper, white backed plant hopper etc. In this method, the sweepnet is swept over the plant surface and number of insects obtained per sweep is calculated. In 25 sweeps if 60 GLH are obtained it is assumed that the pest has reached the ETL. In growth stages if 5 insects are seen in one hill ETL has reached whereas in the flowering stages 10 insects per hill is the ETL.

Natural Enemies

There are several enemies which occur in the field and exhibit a natural control. Predators like wasps, lady bird beetles are commercially available. Parasites such as *Trichogramma* are also available commercially.

Management

- i. Wild grasses and weeds should be removed from the field bund and field since these are the favourite egg laying spots of the pests.

- ii. Neem oil and Pongam oil should be mixed in the ratio of 1:4 and sprayed on the field. This controls the pest effectively.
- iii. After 5% neem kernel spray, neem cake can be applied as a top dressing @ 50 - 60 kg/acre. This increases resistance to pest.
- iv. Before transplantation the seedlings should be dipped in neem kernel extract for 24 hours. This increases resistance to pests.
- v. For the control of GLH, neem seed extract can be mixed with cow's urine and sprayed over the crop. For an acre, we need 3 - 8 kgs of neem seed powder and 5 - 10 litres cow's urine. This should be diluted with 50 - 60 litres of water and sprayed.

2. White backed plant hopper

Sogatella furcifera

Adults are white in colour and 5 mm in length. They have stripes at the back. Nymphs are white to dark grey in colour. Very often the nymphs and the adults can be seen on the upper canopy of the plants. It rarely causes hopper burn symptoms. The management techniques are similar to that of the green leaf hopper.

3. Brown plant hopper (BPH)

Nilaparvata lugens

Symptoms

- i. Semicircular hopper burn symptom appears in patches in the field.
- ii. In case of severe infestation, blackish appearance of the plants at irregular intervals can be seen.
- iii. When the affected plants are removed, nymphs and the adults sticking to the under surface of the stem can be seen.

Damage Pattern

Adults and nymphs suck the plant sap from the basal part of the tillers resulting in the mechanical stoppage of the nutrients. Infested plants first turn yellow and later starts drying up causing browning of the leaves referred to as hopper burn. They remove more plant sap than they can digest. The excess plant sap which is high in sugar content is expelled from the body as honey dew.

This falls on the base of the plant and turns black from infection by sooty mould fungus. These fungi spread over the plants as a thick growth and reduce photosynthesis and respiration. BPH also transmit viruses such as Grassy stunt virus and Ragged stunt virus.

Conducive Atmosphere

Cloudy weather, closer spacing and heavy application of nitrogenous fertilizers are favourable for the rapid multiplication and outbreak of BPH.

Life Cycle

The adults are brown in colour. They are about 3 mm in length. Female lays 200 white small eggs in two rows on either side of the midrib of the leaf sheath. After 5 days, nymphs hatch out. They are wingless and wings develop later. After passing through 5 nymphal stages, they become adults in 15 days. The total life cycle takes about 25 days.

Economic Threshold Level

ETL for this pest is 1-2 insects per tiller.

Natural Enemies

Besides a number of natural enemies operating in the field wasps, lady bird beetles and ground beetles which are commercially available could be used. *Trichogramma* egg parasites are also available.

Management

- i. Use of high level of nitrogenous fertilizers favours the increase of BPH population. Hence it should be used judiciously.
- ii. Water from the stagnated field should be drained immediately for 3 - 4 days. Otherwise, it forms the breeding place for BPH.

- iii. Field and bunds should be cleaned thoroughly without weeds which forms the alternate host for pests.
- iv. 15kg of rice husk should be mixed with 3 litres of kerosene. Here the husk serves as a carrier. The kerosene has repellent properties. It is better to apply this mixture early morning on the under surface of the plants.
- v. Seed treatment with 2% neem oil emulsion can be done before sowing so that resistance develops from seedling stage itself. Dipping of seedlings in the neem kernel extract can also be practised.
- vi. 3% neem oil emulsion should be sprayed on transplanted plants within 10 days. This can be done on the 40th and 60th day after transplantation.
- vii. In planting the seedlings, 1 feet gap should be given after every 8 feet which enables sunshine to reach the under parts of the plants thereby reducing pest incidence. Bed system of planting should be followed. The land should be ploughed and puddled well. Then it is divided into beds. This space between the beds ensures gap in between the field which allows sunshine to reach the under parts of the plants thereby destroying the pests.
- viii. A practice traditionally known as “**Neekal Podum Murai**” has been followed in the Chengalpet district for a number of years. In this practice, women stand in a line in between the plants. They walk from one end to the other end by pressing the under parts of the plant. This enables sunlight to reach the underside of the plant and thus reduces pest incidence.
- ix. Light traps can be used to monitor and attract adults. The trapped insects can be killed.

PESTS OF THE RIPENING STAGE

1. Rice ear head bug

Leptocorisa acuta

Symptoms

- i. It mainly appears before the flowering stage and continues upto the milky stage.
- ii. A characteristic bad odour present in the field is an indication of the presence of the ear head bug.
- iii. White chaffy ears with irregular intervals are seen all over the field.
- iv. A hole can be seen in the affected ears covered with soil. This hole is made by the earhead bug while feeding on the internal contents of the grains.

Damage Pattern

Both nymphs and adults feed on the sap of the peduncle, tender stem and milky grains making them turn chaffy. They

prefer rice at the milky stage but will also feed on soft and hard dough rice grains. Growing nymphs are more active feeders than adults but adults cause more damage because they feed for a longer period. Removal of liquid milky white endosperm results in smaller grains.

Life Cycle

The female lays 250 - 300 eggs on the leaf blade in long rows of 25 eggs. After a week of incubation, slender greenish nymphs emerge. There are 5 nymphal instars and nymphal development is completed in 15 days. Adults are brown, long and slender with long legs and antennae and possess bad odour. The longevity of the adults is 3 to 4 months.

Conducive Atmosphere

If there are woodlands and extensive areas with weeds near rice field an increase in rice bug population is noticed. Staggered rice planting also promotes this pest.

Economic Threshold level

5 bugs / 100 ears at the flowering stage

16 bugs / 100 ears from the milky stage to grain maturity

Management

- i. A cycus flower (*Cycus cercinalis*) by name "Sannampu" which is found particularly in Tirunelveli can be used as a control measure. This flower has to be cut into 5 - 10 pieces and tied to wooden sticks. This has to be kept in fields at different places, say about 15 to 20 places. The fragrance of the flower repels the adult bugs and nymphs.
- ii. At the time of earhead formation, 3% neem oil emulsion or 5% neem seed extract can be sprayed to get rid of the pest.

- iii. Another control measure is the use of tobacco leaf extract. 3 - 5 kg of tobacco leaves should be soaked in the water and boiled for 45 minutes. It is then filtered using a white cloth. It should be mixed with 60 litres of water and the required emulsifier and sprayed over the crop. This is recommended for an acre. After filtration the remaining leaves can be sun dried and powdered. This powder can be used for another 2 sprays.
- iv. 5 kg of tobacco leaf powder should be mixed with 1 kg of chilli powder. To this add 5 - 10 kg of sand. The sand acts as a carrier. This powder has to be applied by dusting over the rice plants.
- v. 1 kg of *Acacia arabica* tree's bark and 1 kg of powdered prickly chaff's root are taken. They are mixed well and dusted on the plants. This is the quantity for application in one acre. This repels the earhead bug effectively.

2. Rats

Rattus rattus

They cause great damage during panicle initiation. They completely cut the stem at the basal part and feed on the inner grains. Plants do not recover from the damage if it occurs in the growing season.

Management of Rats

- i. Take unripe papaya fruits and cut it into small pieces. Spread these pieces over the bunds. A chemical substance present in the raw papaya causes tissue damage in the rats mouth. For 1 acre, 4 to 5 fruits are required. Ripe fruits should not be used.
- 2. Take 2 - 3 kg of *Ipomoea fistulosa* and add 3 litres of water. Boil for half an hour and filter the extract.

Take 2 - 3 kg of sorghum seeds and add it to the above extract. Boil it again for half an hour. Spread these seeds in the rat burrows. Rats feed on these and die.

- 3. Grow turmeric, calotropis or castor on the bunds which reduces the rat damage due to repellent effect of the above plants.
- 4. Spread screw pine tree's bark and leaves over the bunds of the field. When rats try to cross the bunds, thorns seen on the margin of the leaves scratches the lower belly of the rats. This prevents the entry of rats into the field.
- 5. Take a mud pot and fill it with straw. Sprinkle water over the straw. Make a hole at the bottom of the pot. Invert it over the rat hole near the bunds. Light the straw and cover the hole with mud paste before the smoke escapes. This smoke will suffocate the rats due to which they die.

Chapter - 2

DISEASES OF THE RICE CROP

Introduction

Diseases such as blast, brown leaf spot and tungro virus have from time to time caused great damage. Brown spot disease was held to have been the major factor contributing to the Bengal Famine in 1942. The loss of rice yield in India in the year 1961 due to the blast disease alone was 2,65,000 tones or 0.8% of total rice production. Hence knowledge of the disease and early diagnosis will help to prevent the losses considerably. This section deals with important diseases of rice and their control.

1. Rice blast

Causal Organism - *Pyricularia oryzae*

Symptoms

The aerial parts of the plants particularly the leaves, nodes and neck of the panicles are affected. Small specks on the leaves enlarge into spindle shaped spots of varying lengths with a whitish grey centre and brown margin. Nodes and neck of the panicle blacken leading to breaking (neck blast) at the point of infection. The affected panicle breaks due to the weight of the grains. These symptoms occur from the seedling stage upto the third week of harvest. The above symptoms can be seen in the stem also. A black shaded region is seen above and below the node. Heavy doses of urea - predisposes the paddy crop and favours the occurrence of this disease. Continuous rainfall, intermittent cloudy weather and relative humidity greater than 92.7% also favours the occurrence of disease.

2. Rice brown leaf spot

Causal Organism - *Helminthosporium oryzae*

Symptoms

The leaves show round to oval or irregular brown spots which may coalesce to cause withering of tissues. A velvety growth may be seen on the glumes. Sometimes browning or greyish browning may be seen at the neck region. The grains show reddish brown discolouration. These spots are like sesamum seeds. Hence this is also called as sesamum leaf spot.

3. Sheath blight

Causal Organism - *Rhizoctonia solani*

Symptoms

The first symptom seen on the leaf sheath is the appearance of greenish grey lesions. Later, lesions turn to straw colour and increase in size which girdles the stem. The leaf blade of affected sheath dries up from the tip downwards. The grains are shrivelled and poorly filled.

4. Bacterial leaf blight

Causal Organism - *Xanthomonas campestris*
p.v. *oryzae*

Symptoms

It is characterized by the appearance of yellow colour water soaked lesions on both the edges of the leaves. Later they coalesce and the entire surface turns into straw colour. The affected leaves roll completely, droop and ultimately the tillers wither away. These symptoms usually appear 4 to 6 weeks after transplanting. Affected plants produce chaffy grains. High nitrogenous fertilizer rates favour blight epidemics especially where susceptible cultivars are grown.

5. Tungro or leaf yellowing

Causal Organism - *Maize chlorotic dwarf virus*

Symptoms

Older leaves turn yellow orange starting from the tip and margin. Young leaves are mottled with pale green to whitish spots. Root development is poor and grains are usually covered with dark brown blotch. Plants become stunted and bear poor panicles with empty glumes. This disease is transmitted by green leaf hopper (*Nephotettix virescens*).

6. Stem rot

Causal Organism - *Leptosphaeria salvinii*

Symptoms

The disease appears after transplanting in the form of small black irregular lesions at the water line on the leaf sheath and stem. Such infected stem rots and falls down. Spikelets appearing in the affected plants remain chaffy. Disease is more severe in the fields, where water remains stagnant and lack proper drainage facility.

Management of above Diseases

- i. After 25 - 30 days of transplanting, drain the water completely. Mix 40 kg of poultry waste and 25 kg of neem cake together and apply as top dressing. After 3 days, allow the water into the field. This controls the above diseases effectively.
- ii. Take 8 kg of neem cake in Gunny bags and tie it well. Dip the gunny bags in the irrigation and leave it there. Once in 25 days, change the neem cake and fill it with new quantity. This ensures building up of resistance inside the plant itself.

- iii. Take 4 kg of chilly powder and mix it with 60 litres of water. Filter the extract and spray after transplanting. The above quantity is recommended for an acre.
- iv. Take 20 kg of cow dung and mix it with 200 litres of water. Filter the extract through a gunny bag. Mix it again with 50 litres of water and spray it immediately over the crop.
- v. Take 1/2 kg garlic, 1/4 kg chilli and 1/4 kg ginger and make it into a paste. Take 500 ml neem oil or neem kernel extract, 500 ml tobacco extract and 100 ml asafoetida extract. Mix all the above extracts with 72 hours old cow's urine (5-6 litres). Dilute it with 60 litres of water. Before spraying, add 4 ml of khadi soap solution per litre as emulsifier. The above quantity is recommended for an acre.

Chapter - 3

BENEFICIAL ORGANISMS OF THE RICE CROP

Introduction

There are rich communities of beneficial insects, spiders and diseases that attack insect pests of rice. Without these beneficial organisms, the insect pests would multiply so quickly that they would completely devastate the rice crop. Before decisions are taken regarding pest control it is necessary to be able to identify which insect species are pests and which are beneficial. This section provides information regarding important beneficial organisms.

1. Lady bird beetles

a. Micraspis crocea

This is a typical coccinellid beetle. The body is oval shaped and brightly coloured in shades of red. Adults are yellow in colour with different spots behind the head. These are active during the day mostly seen on the upper half of the rice canopy in dryland and wetland habitats.

Prey

Small brown plant hopper, small larvae and exposed eggs, aphids, coccids and other soft bodied insects.

b. Harmonia octomaculata

These are black spotted lady bird beetles that catch slow moving prey. A lady bird beetle takes 1 - 2 weeks to develop from egg to adult and produces 150 - 200 offsprings in 6 - 10 weeks. Lady beetle larvae are more voracious than adults and consume 5 - 10 prey/day.

Prey

Brown plant hopper eggs, nymphs and adults.

c. Menochilus sexmaculatus

Adults are round in shape with size ranging from 6 - 7 mm. Each female can lay 45 eggs. Larvae are long and segmented. They are more active and gregarious feeders. They are seen all over the rice plant. Their life span is 150 days.

Prey

Brown plant hopper, green leaf hopper, rice aphids, leaf folder, stem borer.

2. Ground beetle

Ophionea nigrofasciata

Ground beetles are active hard bodied insects. Their body is about 8 mm in length. Each female can lay about 28 - 30 eggs. Larvae are shiny and black in colour. They pupate in the soil of wetland rice or dryland fields. Adults are reddish brown in colour with stripes spread over the body. They are long legged, swift running beetles. They are mainly seen within the folded leaf chambers and lower stems. They are active searchers during daytime. Their life span is 120 days.

Prey

Leaf folder larvae, brown plant hopper, green leaf hopper, white backed plant hopper, hairy caterpillars, green semilooper and stem borer. An adult consumes 3 - 5 larvae per day.

3. Crickets

Metioche vittaticollis

They occur in wetland and dryland paddy fields. Nymphs are pale brown in colour with stripes and adults are black in colour. Adults has sword like ovipositor. It is used to insert eggs into leaf sheaths of rice and grasses. The life cycle from egg to adult lasts for 60 - 80 days. A female produces 40 - 80 young ones.

Prey

Striped and dark headed stem borers, leaf folders, army worms, whorl maggots, nymphs and adults of brown plant hoppers.

4. Damsel flies

Agriocnemis pygmaea

Agriocnemis femina femina

Damsel flies are weak fliers compared to their dragonfly cousins. Their body is slender, mostly red, orange, grey or bluish in colour. Their size ranges upto about 30 mm. Complex network pattern are seen on the wings. Males are more colourful than the females. The tip of the abdomen of **A. pygmaea** males are orange in colour and that of **A.f.femina** are blue green in colour. The characteristic feature of these insects is that they can fly while mating to escape from their enemies. Each female is capable of laying 30 - 50 eggs. Nymphs are aquatic and can climb up the rice stems in search of hopper nymphs. Adults fly below the rice canopy in search of flying insects as well as hoppers on plants. Their life span is about 30 days.

Prey

Brown plant hopper, green leaf hopper, leaf folder, white backed plant hopper.

5. Earwig

Euborellia stali

Earwigs are shiny black in colour with white bands between abdominal segments and a white spot on the tip of each antenna. They are mostly seen in dryland habitats and nest in the soil at the base of the rice hills. Digging the soil is the

best way to identify them. Each female is capable of laying 200 - 350 eggs. Their life cycle lasts for about 3 - 5 months. They are nocturnal insects. Earwigs have a characteristic hind pair of forcep like pincers. It is used as a defence organ. One special feature of earwigs is that are they can enter the stem borer tunnels in search of the larvae.

Prey

Stem borer larvae and leaf folder larvae. Each earwig consumes 20 - 30 prey daily.

6. Ants

Solenopsis geminata

Ants are red or brown in colour. They make nests in the dryland fields as well as in bunds of wetland rice. They are otherwise called fire ants which inflict a painful bite on the feet and legs of any person walking on the bunds.

Fire ants are quick to colonize a newly established field. They make nests for hundreds and even thousands of workers and soldiers.

Prey

Wide variety of insects e.g. adult black bugs and their eggs.

7. Wasps

Wasps belonging to different families are found in the paddy field. Generally, they are small with reduced wing veins. Wasps are of different colours. Their life-cycle consists of 4 different stages namely egg, larva, pupa and adult.

Prey

Stem borer larva, brown plant hopper, green leaf hopper, skipper, green hairy caterpillar.

8. Long horned grass hoppers

Conocephalus longipennis

Meadow grasshoppers are large insects with slanted faces. They are green in colour. Their body size ranges from 25 - 32 mm. Antennae are 2 - 3 times longer than the body. Adults lay eggs on the bunds. Each female can lay 15 - 30 eggs. Nymphs emerging are green in colour and can be distinguished from adults by the absence of wings and ovipositors. Life cycle lasts for 3 - 4 months. They are more active at night. They are seen mainly on leaves and panicles.

Prey

Rice bugs, stem borer eggs, brown plant hopper and green leaf hopper, nymphs and adults. Each predator can consume 3 - 4 yellow stem borer egg masses a day.

9. Small ripple bug

Microvelia douglasi atrolineata

They are fast moving small ripple bugs seen mostly in flooded fields. Their body size is about 1.5 mm. Each female lays 20 - 30 eggs in the rice stem above the water line. Their life span is 1 - 2 months. Adults are broad shouldered, black in colour and are seen either with or without wings. They occur mainly on the water surface occasionally on the lower stem. They are fast moving insects attracted towards the light.

Prey

Brown plant hopper, stem borer - 1st instar larva, green leaf hopper and other soft bodied insects.

10. Water strider

Limnogonus spp.

These are large, long legged, fast moving insects. Adults are black in colour with 2 pairs of very long hind legs. Their

body size ranges from 6 - 15.5 mm. Each female can lay 10 -20 eggs in the rice stem above the waterline. They are very fast swimmers and attack the prey very quickly. Their life span is 1 - 1½ months.

Prey

Green leaf hopper, brown plant hopper, rice leaf roller, army worm and cut worms.

11. Water Treader

Mesovelia vittigera

Water treaders are found only in wetland habitats. Adults are pale green in colour with or without wings. Their body size ranges from 3 - 4 mm. Legs are seen with small spines. They mainly occur on the water surface and the basal part of the plant. Each female can lay 28 eggs. They are non gregarious feeders. Their life span is about 45 days.

Prey

Green leaf hopper, brown plant hopper, white backed plant hopper and zigzag leaf hopper.

12. Mirid bug

Cyrtorhinus lividipennis

Adults are green in colour. The head and shoulder region are marked with black colour. Their body size ranges from 2.5 - 3.25 mm. Each female can lay 30 eggs. They are seen in rice plants and weeds. They are attracted towards light at night. They are mobile like hoppers. Their life span is about 30 days.

Prey

Brown plant hopper, green leaf hopper, stem borer, white backed plant hopper. Each adult can consume 7 - 10 eggs or 1 - 5 hoppers a day.

13. Assassin bug

Polytoxus fuscovittatus

They are solitary predators seen in both wetlands and dry lands. Adults are brown in colour with three prominent spines on the back. They have needle like mouth parts which is used to pierce the insect body and inject the toxin.

Prey

Larva of moths and butterflies.

14. Orb spider

Argiope sp.

They are otherwise called as cross spiders. Their body size ranges from 4 - 25 mm. Each female can lay 600 - 800 eggs. The female has yellow and greyish white markings on the abdomen. The male is comparatively smaller than the female and they are reddish brown in colour. Eggs are seen inside a light brown cocoon mostly hanging on the web. Their life span is 2 to 3 months. They are seen mainly on the upper surface of the rice canopy in circular webs. Males do not spin webs but occupy the periphery of the female's web.

Prey

Leaf folders, brown plant hopper, green leaf hopper, white backed plant hopper and stem borers.

15. Long jawed spider

Tetragnatha sp.

The body size of long jawed spider ranges upto 25 mm. They have long legs often extended in one line and are greenish brown in colour. They are commonly seen lying outstretched along the rice plants. Males have enlarged jaws. Each female is capable of laying 120 eggs. Eggs are seen in a cottony mass mostly on the upper half of rice plants. Their life span is about 3 months. Normally, they spin a ring shaped weak web. When prey hit the web, these spiders wrap them quickly.

Prey

Green leaf hopper, white backed plant hopper and brown plant hopper.

16. Wolf spider

Lycosa pseudoannulata

They are highly mobile and readily colonize wetland and dryland rice fields. Their body size ranges upto 18 mm. Each

female lays 200-400 eggs. A special feature of the female spider is that it carries the hatched spiderlings on its back for quite sometime. It carries 60 - 80 spiderlings. Adults have fork shaped markings on the back. Abdomen has white markings over the surface. Their life span is 3 months. They are mostly seen among tillers at the base of the plants. When they are disturbed, they move across the water surface. These spiders do not make webs but attack their prey directly. They are active searchers and hunters.

Prey

Stem borers, brown plant hoppers, green leaf hoppers (both adults and nymphs). An adult consumes 5 - 15 prey day.

17. Lynx spider

Oxyopes sp.

These are called hunting spiders. They do not build webs. Their body size ranges from 7 to 10 mm. Legs have long spines. Females have 2 pairs of white or brown bands on the sides of the abdomen. Each female is capable of laying 350 eggs. Their life span is 3 - 5 months. They are seen within the rice canopy. They normally hide from their prey and attack them preferably from a striking distance.

Prey

Brown plant hopper, case worm, green leaf hopper and white backed plant hopper.

18. Jumping spider

Phidippus sp.

They are hunting spiders. They have brown hairs all over the body. Their body size ranges from 5 - 9 mm. They have

two bulging eyes which is an important feature. Each female is capable of laying 90 eggs and they guard the egg mass till birth. Their life span is about 2 - 4 months. These spiders prefer dryland habitats and always remain within the rice foliage. They hide themselves within the folded leaves and wait for the prey.

Prey

Green leaf hopper, brown plant hopper, white backed plant hopper and stem borer moths. Each spider consumes 2 - 8 prey/day.

19. Dwarf spider

Atypena sp.

They are small in size (1 - 3 mm). Hence spiderlings and adult spiders cannot be differentiated based on size. Adult spiders have 3 pairs of grey markings on the back of the abdomen. Each female lays 80 - 100 eggs. Eggs are covered with a thin layer of silk or dried leaf sheath. Absence of maternal care is a characteristic feature of spiders. They make irregular webs within the base of rice tillers above the water line. They are both hunters and web catchers. Their life span is 1 ½ to 2 months.

Prey

Green leaf hoppers and brown plant hoppers (both adults and nymphs). An adult consumes 4 - 5 prey a day.

Chapter - 4

PREPARATION OF EXTRACTS

In the following section detailed instructions regarding the preparation of various extracts which have been mentioned in the text are given.

Leaf Extract

For preparing the leaf extract, required quantity of leaves should be collected. Leaves should be soaked in water overnight. The next day, the leaves are ground and the extract is filtered. To 1 litre of extract, 1 ml of an emulsifier like khadi soap solution is added. The emulsifier helps the extract to stick well to the leaf surface.

The following quantity of leaves of various plants are required for an acre.

Plant Name	Amount of leaves required 1 acre
Persian lilac	6 kg
Pongam	10 kg
Tobacco	4 kg
Vitex	7 kg
Neem	12 kg

Note : For preparation of tobacco extract and vitex extract, leaves should be soaked in water and boiled for 1 hour. Then the extract is filtered. This is used for preparing 100 litres of extract.

Seed Kernel Extract

For preparing the seed extract, required amount of seed kernel should be taken and pounded gently. It should be pounded in such a way that no oil comes out. The

pounded seed kernel powder is gathered in a muslin pouch and soaked overnight in water. Next day, the pouch is squeezed and the extract is filtered. To the filtrate, an emulsifier like khadi soap solution is added. One ml of emulsifier is added to one litre of water.

The following quantity of seed kernel powder is required for spraying an acre :

Plant Name	Amount required
Pongam	5 kg
Persian lilac	6 kg
Neem	3 kg

Note : This is used for preparing 100 litres of extract.

Cake extract

For preparing the cake extract, required amount of cake powder should be taken. The cake should be powdered well and tied in a muslin pouch and soaked overnight in water. The next day the pouch should be squeezed and the extract is taken out. The extract is then filtered and emulsifier is added at the rate of 1 ml per litre of water. Emulsifier used is khadi soap solution.

The following amount of cake is required for spraying an acre :

Plant Name	Amount required
Pongam	5 kg
Persian lilac	6 kg
Neem	3 kg

Note : This is used for preparing 100 litres of extract.

Oil Emulsion

For preparing this extract, required amount of oil should be taken. First the oil is added to the emulsifier (1 ml/1 litre) and stirred well. It is very essential to add the emulsifier and mix with oil properly. This enables the oil to mix with water well. To this, little amount of water is added and stirred well. This process is repeated till the required quantity of extract is obtained.

The following amount of oil is required for spraying an acre.

Plant Name	Amount required
Pongam	3 litres
Persian lilac	1 ½ litres
Neem	3 litres

REFERENCES

1. Gaby Stoll. 1986. **Natural Crop Protection in the Tropics**. Agrecol, Germany. 188 pp.
2. **Handbook of Agriculture**, 1997. Published by Indian Council of Agricultural Research, New Delhi.
3. **Honey bee**. Quarterly Newsletter Published by Shristi Innovations, Ahmedabad, various issues.
4. International Rice Research Institute, Philippines, **Field Problems of Tropical Rice**. 172 pp.
5. **Nam Vazhi Velanmai** - Bimonthly Newsletter published by Seva, Virattipattu, Madurai, various issues.
6. Other India Press, Mapusa, Goa. **Organic Farming Source Book**, 1996. 336 pp.
7. Reissig, W.H., E.A. Heinrichs, J.A. Litsinger, K. Moody, L. Fiedler, T.W. Mew, and A.T. Barrion. 1986. **Illustrated Guide to Integrated Pest Management in Rice in Tropical Asia**. IRRRI publication, Philippines, 409 pp.
8. Saha, L.R. **Handbook of Plant Protection**. 1992. Kalyani Publishers, 928 pp.
9. Shepard, B.M., A.T. Barrion, and J.A. Litsinger. 1987. **Helpful Insects, Spiders and Pathogens**. IRRRI publication, Philippines, 136 pp.
10. Vasantha raj David, B. and T. Kumaraswami. 1975. **Elements of Economic Entomology**. Popular Book Depot, Chennai, 536 pp.

LIST OF COMMON NAMES AND SCIENTIFIC NAMES

Ant	-	<i>Solenopsis geminata</i>
Army worm	-	<i>Spodoptera litura</i>
Asafoetida	-	<i>Ferula asafoetida</i>
Assasin bug	-	<i>Polytoxus fuscovittatus</i>
Bacterial leaf blight	-	<i>Xanthomonas campestris</i> pv. oryzae
Black bug	-	<i>Scotinophara spp</i>
Brown plant hopper	-	<i>Nilaparvata lugens</i>
Calotropis	-	<i>Calotropis gigantea</i>
Case worm	-	<i>Nymphula depunctalis</i>
Castor	-	<i>Ricinus communis</i>
Chastetree	-	<i>Vitex negundo</i>
Chilli	-	<i>Capsicum annum</i>
Crickets	-	<i>Metioche vittaticollis</i>
Damsel fly	-	<i>Agriocnemis pygmaea</i>
Dark headed stemborer	-	<i>Chilo polychrysus</i>
Dwarf spider	-	<i>Atypena sp.</i>
Earwig	-	<i>Euborellia stali</i>
Gall midge	-	<i>Orseolia oryzae</i>
Garlic	-	<i>Allium sativum</i>
Ginger	-	<i>Zingiber officinalis</i>
Grass hopper	-	<i>Hieroglyphus banian</i>
Green leaf hopper	-	<i>Nephotettix virescens</i>
Green semi lopper	-	<i>Naranga aenescens</i>
Green hairy caterpillar	-	<i>Rivula atimeta</i>
Ground beetle	-	<i>Ophionea nigrofasciata</i>
Gum arabic tree	-	<i>Acacia arabica</i>

Horned caterpillar	-	<i>Melanitis leda ismene</i>
Jumping spider	-	<i>Phidippus sp.</i>
Lady bird beetle	-	<i>Several species</i>
Leaf folder	-	<i>Cnaphalocrocis medinalis</i>
Long horned grasshopper	-	<i>Conocephalus</i> <i>longipennis</i>
Long jawed spider	-	<i>Tetragnatha sp</i>
Lynx spider	-	<i>Oxyopes sp.</i>
Mahua	-	<i>Bassia latifolia</i>
Mealy bug	-	<i>Heterococcus rehi</i>
Mirid bug	-	<i>Cyrtorhinus livoidipennis</i>
Neem	-	<i>Azadirachta indica</i>
Orb spider	-	<i>Argiope sp</i>
Papaya	-	<i>Carica papaya</i>
Persian lilac	-	<i>Melia azederach</i>
Pongam	-	<i>Pongamia pinnata</i>
Rice blast	-	<i>Pyricularia oryzae</i>
Rice brown leaf spot	-	<i>Helminthosporium</i> <i>oryzae</i>
Rice earhead bug	-	<i>Leptocorisa acuta</i>
Rice stem borer	-	<i>Scirpophaga incertulus</i>
Sannampu	-	<i>Cycus cercinalis</i>
Screw pine tree	-	<i>Pandanus</i> <i>odoratissimus</i>
Sheath blight	-	<i>Rhizoctonia solani</i>
Skipper	-	<i>Pelopidas mathias</i>
Small ripplebug	-	<i>Microvelia douglasi</i> <i>atrolineata</i>
Sorghum	-	<i>Sorghum vulgare</i>
Stem rot	-	<i>Leptosphaeria salvinii</i>
Striped stem borer	-	<i>Chilo suppressalis</i>