

# **ZOO506 IMPORTANCE OF INSECTS**

[www.vuways.com](http://www.vuways.com)

<https://web.facebook.com/groups/vuways>

**Regards VUWAYS Team**

**Welcome To All New Members**

## **ZOO506 - Applied Entomology and Pest Management**

### **60-61-62-63-64-ECONOMIC IMPORTANCE OF INSECTS (INSECT DAMAGES)**

#### **Introduction**

- A. Of the many thousands of insect species known to man some affect him and his property only slightly; some are beneficial; others are injurious in various degrees
- B. Only rough estimates can be made of the monetary losses and gains by insect activities and even these are made with difficulty



- C. Although it is the general practice to express losses in terms of dollar valuation
- D. It probably would be safer to give them in bushels, tons, etc., because the relative values of different crops and products change from year to year



- E. No crop of either vegetable or animal origin appears to be entirely free from insect injury
- F. Field, truck and fruit of crops, both growing and in storage, household goods and food products, forests and the wood products derived from them, domestic animals and animal

products, all are more or less liable to insect attack



G. Because there never has been a season free from the ravages of insects which might serve as a standard for comparison, much of this loss is not appreciated

H. If there could once be such a year entirely insect free, the difference would be apparent at once



## INSECT DAMAGES

A. It is the general conclusion that the loss to all sorts of crops by insect damage in an average year is about 10 per cent

B. This estimate covers field crops, forests and forest products, farm wood lots, domestic animals and their products, stored articles, shade trees and ornamental plants, household goods and foods.



C. Generally the injury to fruit and truck crops is believed to be more than one tenth

D. Hyslop estimated in 1938 that the annual loss to agricultural crops by insects, including the costs of control, amounts to somewhat over 1,600 million dollars



E. No estimate of injury to human health is included

F. To value this destruction we have as a criterion only the price for which crops sell



G. If the tenth of all crops destroyed had been saved, the price of the whole might have been no greater than it was for the nine-tenths actually produced

H. The loss by insect injury usually far exceeds the actual quantity consumed.



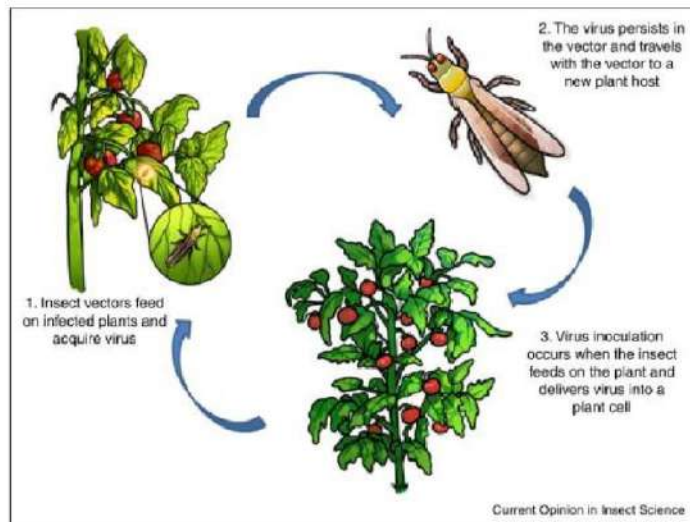
I. Insect-contaminated food products originally intended for human consumption often must be destroyed or used in stock feeds

J. Blemishes in fruit caused by insect bites impair the sale value much more than is accounted for by the actual loss in substance.











## Plant Diseases



- ▶ The most obvious losses are those caused by the feeding of insects
- ▶ But it is now known that some of the most serious plant diseases are carried by them.
- ▶ The organisms that cause these, whether they are
  - ▶ Filterable viruses
  - ▶ Fungi
  - ▶ Bacteria,







































**List of Insect Vector Transmitted Plant Diseases**

Crop	Insect Vector	Technical Name	Insect Photo	Pathogen Transmitted	Disease	Disease Photo
<b>Viral Diseases</b>						
Cotton	Whitefly Homoptera: Aleyrodidae	<i>Bemisia tabaci</i>		Geminivirus Particle	Cotton Leaf Curl Virus	
Papaya	Whitefly Homoptera: Aleyrodidae	<i>Bemisia tabaci</i>		Geminivirus Particle	Papaya Leaf Curl Virus	
Banana	Aphid Homoptera: Aphididae	<i>Pentalonia nigronervosa</i>		SSRNA Particle	Banana bunchy Top Virus	
Potato	Beetle Coleoptera: Coccinellidae	<i>Ephilachna ocellata</i>		Potato Virus X	PVX	

	Aphid Homoptera: Aphididae	<i>Macrosiphum euphorbiae</i>		Potato Virus Y	PVY	
	Aphid Homoptera: Aphididae	<i>Myzus persicae</i>		<a href="#">RNA virus</a>	Potato Leaf Roll Virus	
Tomato	Whitefly Homoptera: Aleyrodidae	<i>Bemisia argentifolii</i>		PLRV	Tomato Leaf Curl Virus	

	Tomato Thrip Thysanoptera: Thripidae	<i>Frankliniella schultzei</i>		TSWV	Tomato Spotted Wilt Virus	
Chilli	Aphid Homoptera: Aphididae	<i>Aphis gossypii</i>		CMV	Chilli Mosaic	
	Whitefly Homoptera: Aleyrodidae	<i>Bemisia tabaci</i>		Geminivirus Particle	Chilli Leaf Curl Virus	

Rice	Rice Leafhopper Hemiptera: Cicadellidae	<i>Nephotettix nigropictus</i>		DSRNA Particle	Rice Dwarf Virus	
Wheat	Planthoppers Delphacidae: Hemipter	<i>Javesella pellucida</i>		SSRNA Particle	Wheat Striate Mosaic Virus	
	Wheat Curl Mite Acari : Eriophytidae	<i>Aceria tulipae</i>		Mite	Wheat Spot Mosaic Virus	
	Wheat aphid	<i>Diuraphis noxia</i> Hemiptera : Aphididae		WYLV	Wheat Yellow Leaf Virus	

Barley	Aphid Hemiptera: Aphididae	<i>Schizaphis graminum</i>		Geminivirus Particle	Barley Yellow Dwarf Viruses	
Fig	<i>Eriophyid Mite</i> Acari : Eriophyidae	<i>Aceria fici</i>		SSRNA Particle	Fig Mosaic Virus	
Peach	Fastidious Bud Mite Acari : Eriophyidae	<i>Eriophyes insidiosus</i>			Peach Mosaic Virus (PMV)	
Maize	Small Brown Planthopper, Delphacidae: Hemipter	<i>Laodelphax striatellus</i>		DSRNA Partical	Maize Rough Dwarf Virus	
	Maize Leafhopper Cicadellidae: Hemipter	<i>Cicadulina Mbila</i>		Geminivirus Partical	Maize Streak Mosaic Virus	
<b>Fungal Diseases</b>						
Mango	Bark Beetle Coleoptera: Curculionidae	<i>Hypocryphalus mangiferae</i>		MSDS	Mango Sudden Death Disease	
	Mango bud (or gall) mite, Acari : Eriophyidae	<i>Aceria mangiferae</i>		fungal	Mango malformation	
Elm	European Elm Bark Beetle Coleoptera: Curculionidae	<i>Opiostoma ulmi</i>		spore	Dutch Elm Disease	
Oak	Sap Beetle Coleoptera: Nitidulidae	<i>Carpophilus lugubris</i>		<i>Ceratocystis fagacearum</i>	Oak Wilt Disease	
<b>Bacterial Diseases</b>						
Citrus	Asian Citrus Psyllid Hemiptera: Psyllidae	<i>Diaphorina Citri</i>		<i>Labri Bacteri</i>	Citrus Greening	
Sesame Indicum	Leaf Hopper Cicadellidae: Hemiptera	<i>Orocious Albicinctus ; O. Orientalis</i>		Phytoplasma	Phyllodi	
Pear	Pear Psylla Hemiptera: Psyllidae	<i>Cacopsylla Pyricola</i>		Phytoplasma	Pear Decline Phytoplasma	
Potato Psllid	Potato Psyllid Triozidae : Hemiptera	<i>Bactericera Cockerelli</i>		Psyllid-Borne Bacterium	Potato Zebra Chip Disease	
<b>Nematodal Diseases</b>						
Milkweed	Milkweed Bug Hemiptera : Lygaeidae	<i>Oncopeltus fasciatus</i>		Nematode	Trypanosomes	

## Terminology

### A. Vector

- An agent that transports a microorganism from one host to another. Insects that transmit plant disease are called vectors.

## B. Disease

- a. Any condition that impairs the normal functioning of an organism or body. Or Disorder of normal functioning of an organism

## C. Epidemiology

- a. The study of disease in populations of an organism.

## 65-66-67-INSECT DAMAGES

### Transmission

1. Transmission is the passing of a pathogen causing communicable disease from an infected host individual or group to a particular individual or group
2. Regardless of whether the other individual was previously infected
3. **Physical Transmission**
4. In case of mechanical transmission the pathogen is simply carried externally or internally by the insect
5. Mostly Caused insects that have biting/chewing mouthparts.



6. **Biological Transmission**
7. Specific insect and the specific viral pathogen have some kind of association or relationship between the two
8. Mostly Caused insects that have sucking mouthparts
9. 1-The pathogens may enter the plant through feeding injuries made by either the chewing or the sucking type of insect
10. 2-Through punctures made for egg laying and by way of the burrows and galleries of insects in wood
11. Particularly in the case of the filterable viruses, those little-known agents causing the so-called mosaics and related plant diseases
12. insects become carriers of the disease from plant to plant.



13. In such cases the insect involved is usually of the piercing-sucking type



14. Often this insect is essential to the overwintering of the disease, sometimes even necessary to carry the disease from one plant to another



15. Insect Vector born Diseases in Human

16. Another field in which insects are highly injurious is that of human and animal health and comfort

17. Some insects, notably mosquitoes and flies, annoy man and other animals by their bites and stings



18. Other insects such as lice have become adapted to more or less continuous life upon animals and cause much discomfort and loss of vitality

19. Not only do insects live externally on animals but also internally in the skin tissues, and in a few cases within the flesh and in the alimentary tract



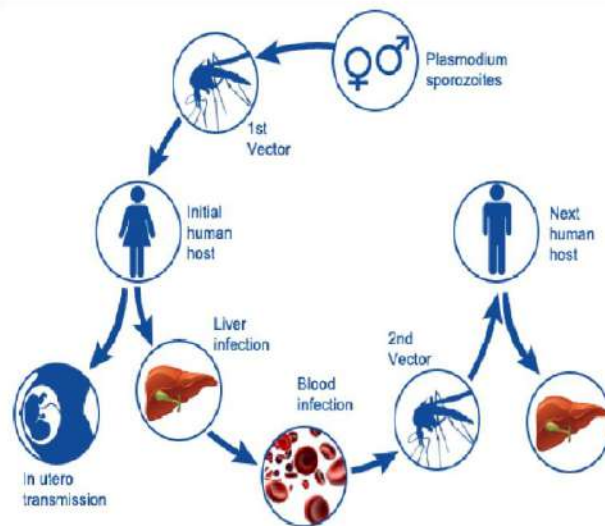
20. Besides the mental and bodily loss due to their presence, insects transmit disease organisms from one person or animal to another

21. Just as in the transmission of plant diseases the insect may be an accidental agent or an essential carrier

22. A few of the more important insect-borne disease in organisms are

- a. Malaria
- b. Bubonic plague
- c. Typhoid
- d. Typhus
- e. Yellow fevers.





23. Allergy (hay fever, asthma, etc.) are frequently caused by exposure of susceptible persons to dried insect scales and hairs
24. Not only is the loss of life because of insect-borne diseases a very serious matter but the total loss of productive labor through illness is tremendous

Disease	Causative agents	Vectors	Methods of infections
Malaria (commonest)	Plasmodium	Anopheles mosquitoes	Bite
Dengue fever	Virus	Aedes mosquitoes	Bite
Encephalitis	Virus	Culex mosquitoes	Bite
African sleeping sickness	trypanosomes	Tse tse fly	Bite
Dysentery (amoebic)	Protozoan	Housefly	Contamination of food
Dysentery (bacillary)	Bacterium shigella sp.	Housefly	Contamination of food
Cholera	Vibrio cholerae	Housefly	Contamination of food
Onchocercosis	Parasite worm, onchocerca volvulus	Black flies	Bite
Plague	Bacterium, pasteurella pestis	Oriental rat flies and other fleas	Bites of contact with infected rodents
Typhoid	Salmonella typhi	Houseflies	Contamination of food
Typhus	Rickettsia prowzeiki	Human louse flies	Contamination or bite
Yellow fever	Viruses	Aedes mosquitoes	bite

## 68-69-INSECT BENEFITS

- The benefits to man from their activities are frequently overlooked in summing up the economic importance of insects
- Although in many cases it is impossible to say how much good is derived from insects

### 1-Attack on injurious species

- ▶ Reliable statistics are easily obtained relative to the production of useful insect products
- ▶ Those insects which attack injurious species probably form the most important group ▶ They are divided into two sections:
  - ▶ 1-The parasites that live in or on the different stages of other insects, then called hosts
  - ▶ 2-The predators that capture and devour other insects
- ▶ Parasites usually, though not always, live in or on a single host insect during their entire development
- ▶ Whereas a single predator may derive its nourishment from many victim insects.
- ▶ Parasites are of many species, frequently so specialized in their habits that one kind of parasite attacks only one or a few host species
- ▶ In some cases the parasites work only in insect eggs and thus prevent any feeding loss by the host insect
- ▶ Other parasites attack early stages of the pests, in some instances killing them soon
- ▶ In others not until the pests have completed their feeding in spite of being parasitized.
- ▶ In the latter the benefit is less, but at least there are fewer adults to produce the next generation
- ▶ All stages are known to be attacked in different species by one parasite or another

## 70-INSECT BENEFITS

### Pollination

- ▶ Some plants, as the Smyrna fig, clovers, melons, tomatoes, beans, peas and most of the common fruits, require the visits of insects before the seeds or fruits can form
- ▶ Another highly important group of insects includes those which pollinate flowers during their visits for nectar and pollen, thus enabling the plants to produce seeds
- ▶ The value of these crops which require the services of insects in the United States amounts to over two billion dollars

### 3-Commercial Products

- ▶ A third group of insects is responsible for a number of commercial products
- ▶ 1-Silk
- ▶ 2-Honey
- ▶ 3-Beeswax
- ▶ 4-Shellac

### 4-Diet of certain birds, mammals

- ▶ Insects provide the entire diet of certain birds, mammals, etc., and an important part of the diet for many others

### 5-Serve as Food

- ▶ Even man in some parts of the world consumes large quantities of grasshoppers, crickets, ants and other insects
- ▶ The great value of some insects and the great losses, sometimes enormous, caused by others make it obviously important to encourage the beneficial forms while striving to prevent or at least to reduce the losses caused by the injurious ones

## 71-Insect Pest Management

- ▶ The study of principles and experimental approaches to the science that underpins the development of working integrated pest management systems

### Types of insect control

- ▶ **A-NATURAL CONTROL**
- ▶ **B-ARTIFICIAL CONTROL:** Measures for the artificial control of insects may be divided into six groups:
  - ▶ (1) mechanical control
  - ▶ (2) cultural control
  - ▶ (3) biological control,
  - ▶ (4) legislative control
  - ▶ (5) physical control
  - ▶ (6) chemical control.

## 72-A-NATURAL CONTROL

1. Under the heading of natural control fall those various factors which affect the distribution and welfare of insects
2. But do not depend upon man for their success

They include

3. (1) **climate include:**
  - a. Temperature
  - b. Humidity
4. Air movement
5. (2) **Topography include**
  - a. Land and water barriers
  - b. Soil, texture and composition
6. (3) **Parasites and predators**
  - a. Include insects and other animals
7. (4) **Diseases caused by**
  - a. Fungi or bacteria, etc.
8. Where no disturbing influence is introduced by man or any other agency, the insect population tends to be more or less completely held in balance by these natural factors



## 73-74-Climate

1. Climate, including temperature, moisture, etc.
2. Climate is probably the most important factor affecting the distribution of insects.
3. **I- Temperature:** No insect can live and develop at **temperatures** higher or lower than a certain range
4. The temperature at which development is most rapid, is about midway of this range; at other points either higher or lower the development is proportionately slower
5. **II- Moisture:** The same statements hold true for air moisture although variation due to moisture differences is usually less marked
6. The favorable range of either temperature or moisture varies with different insect species, often even during the stages of development
7. **III- Weather Conditions:** It is easy to understand from these facts why some insects are prevented by winter temperatures from living in the northern United States, and why some can live only there
8. After several favorable winters
9. An insect pest may become very numerous, then disappear suddenly when a severe winter occurs
10. One combination of weather conditions in summer may favor one type of insect pest; another set of conditions may suppress the first pest but favor others equally serious
11. Not only the annual temperature range but the fluctuations that occur within short periods are often important in limiting the range of an insect
12. Frequent small showers have a different effect from infrequent cloud bursts; the latter may produce the greater total rainfall but actually supply less air moisture
13. Wipds may carry some insects for considerable distances, and they may also bring moisture from large bodies of water or in other localities have a drying effect
14. Sunshine has much to do with insect flight, hence with the speed of insects

## 75-Topography

1. **Mountain ranges and large bodies of water** are more or less effective barriers to the spread of animals (including insects) and plants
2. Low lands are barriers to the spread of mountain types, because any region unsuited to the development of an insect presents a barrier to the spread of that species if the area is extensive enough
3. Because so many insects are dependent upon plant life for their food, either directly or indirectly
4. Those factors which limit plant development may indirectly form barriers to insect spread
5. It must be understood that most insects are limited to certain plants, many to only one kind or a few closely related plant species
6. In seasons unfavorable to the growth of its food plant an insect will be reduced in numbers, either by starvation or by the inability of the adult females to find food plants upon which to lay their eggs
7. Sometimes such numbers of an insect occur that the food plant is consumed almost completely and many of the insects starve as a result

## 76-Parasites and Predators & Diseases

- ▶ Not only do mountains, oceans, climate and plant life control the size and distribution of insect populations
- ▶ But **insect parasites, birds, various diseases, etc.**, are vital factors in limiting the numbers of insects
- ▶ The more abundant an insect becomes, the more food is available for its parasites
- ▶ Finally the parasites become so numerous that practically all the hosts will have been found and killed
- ▶ The next generation of parasites consists, of course, of many more individuals, but most of these will die for lack of food
- ▶ Under such conditions, a "**balance of Nature**" develops
- ▶ Though the scales may tip first to one side and then to the other, this balance is preserved within certain limits of fluctuation

### B-ARTIFICIAL CONTROL

- ▶ **Factors of insect outbreak:** In the course of the development of agriculture, man has increased the number and magnitude of his **entomological problems**
- ▶ **I- Introduction of new plant species:** Before the settlement of this country there were, of course, native insects attacking the various plants growing here

## 77-Factors of insect outbreak

### Factors of insect outbreak

1. New plants were introduced by the settlers and grown in greater abundance than the wild and scattered ones
2. An insect finding in any of these an acceptable food had at once a more abundant supply and rapid multiplication thus became possible and resulted in increase of the pest to injurious numbers
3. **II- Accidental introduction insect:** A second factor has been the accidental introduction of many insect pests from foreign countries
4. In the United States such forms have often failed entirely to maintain themselves
5. Unfortunately on the other hand some others have frequently found conditions favorable to a rapid increase
6. These multiply unchecked by their natural enemies which in most cases have not accompanied them to this country
7. **III- Destruction of insectivorous birds:** A third factor is that with the increasing occupation of the country, insectivorous birds have been destroyed or frightened away
8. Although some birds have adjusted themselves to the new conditions it is not likely that their increase makes up for the loss of other species

## 78-Artificial Control

1. Why Artificial Control ?

2. Nature tends to re-establish a balance after some new influence has upset the old state of affairs, although the process may require many years
3. Even then there will be certain years when the population, of a species will be large as the result of normal fluctuation
4. Man cannot wait a number of years for Nature to adjust matters, nor can he afford avoidable crop failures every few years
5. He requires artificial measures by which he can protect himself and his crops from the ravages of injurious insects
6. Measures for the artificial control
7. Measures for the artificial control of insects may be divided into six groups:
  - a. (1) mechanical control
  - b. (2) cultural control
  - c. (3) biological control
  - d. (4) legislative control
  - e. (5) physical control
  - f. (6) chemical control
8. Whatever the method and its effectiveness, the cost of control must be a deciding factor
9. It is evident no financial profit to an individual owner will be gained by attempting control when the cost is greater than the probable loss
10. Sometimes, however, the profit to the community over a period of years may warrant treatment controlling more than the loss for anyone year
11. Often it is not profitable to use any known method of control for insects injuring crops of small value

## 79-MECHANICAL CONTROL

1. Under mechanical control are included those methods by which insects are controlled directly by hand
2. **I- As in hand-picking from infested plants**
3. **II- By mechanical devices such as**
  - a. window screens
  - b. fly traps
  - c. bands on trees
4. Frequently egg masses or nests of larvae may be cut from plants and destroyed as an important aid in the small-scale control of an insect pest
5. Where labor is cheap enough to make the method profitable over larger areas
6. Deep furrows, lines of creosote or low fences of sheet metal or paper are used as barriers against the migration of nonflying insects
7. Sticky bands on trees are utilized to capture climbing insects
8. Burlap and paper bands serve as localized hiding places from which the insects may be taken and destroyed



9. Paper collars are sometimes placed as insect barriers around individual plants, and the trunks of trees may be wrapped to ward off insect attack
10. Besides hand methods, traps and barriers, machines are used sometimes for actually crushing or grinding the insects

## 80-82-83-CULTURAL CONTROL

- Cultural control has been defined as including "regular farm operations performed so as to destroy insects or prevent their injuries"
- Frequently a vigorous, healthy plant is not only better able to withstand insect injury

### Methods of Cultural Control

1. But also less liable to attack than one weakened by lack of proper nourishment or by disease
2. 1- Intelligent cultivation and use of fertilizers is well as pruning to remove injured or diseased parts will aid in insect control
3. 2- The destruction of vegetable trash and weeds, frequently called clean culture, is also an important factor, especially in the control of hibernating insects
4. Weeds not only interfere with successful crop growth by crowding, but they may reduce the vigor of the crop by competing for plant food in the soil
5. In winter they provide hiding places for hibernating pests
6. A pest appearing in the spring before its crop food plant is available may find certain weeds palatable until the crop has appeared
7. Other pests move to late summer and fall weeds after their particular crops have been harvested
8. 3- Decaying fruits and vegetables also harbor insects and should be disposed of in such a manner that the insects will be destroyed
9. Dead grass and leaves may be burned to kill insects that would find protection under them
10. But the loss of soil fertility should be weighed against the possible value in insect control
11. 4- The destruction of weeds and brush along fences is of advantage in the reduction of insects
12. But it results in the elimination of nesting and hiding places for insectivorous and game birds
13. 5- A third farm operation useful in insect control is the rotation of crops
14. Often an insect pest may be reduced to unimportance if the crop which it affects is alternated with other crops not eaten by it
15. The various grains are related to, in fact actually are, grasses and are eaten by many of the same insects
16. Only a few general grass feeders are also injurious to clovers and other legumes.
17. It is therefore common practice to rotate grasses and legumes, cultivated crops also often being added to the rotation
18. How far this principle can be put into practice depends upon many factors besides the insect phase
19. 6-Time and method of plowing and cultivating form a fourth factor in the cultural control of insects
20. Many insect pests overwinter in larval or pupal cells in the ground

21. These cells can often be broken up by fall plowing so the insects will not survive the winter
22. Cultivation in the summer frequently breaks up pupation cells
23. But plowing or cultivation to be effective must be timed according to the life history of the insect that is being controlled, otherwise it is useless
24. For the control of some insects it is necessary to **refrain from cultivation** at certain times
25. The **depth of plowing** varies sometimes according to the habits of the insect.
26. **7-** As in tillage practice the **time of planting and of harvesting** are also of importance in protecting crops against insect pests
27. It is sometimes possible to avoid the time of **egg laying**, to push young plants to the stage where they are not likely to be badly injured or even to mature a crop before the insects appear in dangerous numbers
28. The timing of wheat planting to **avoid infestation** by the hessian fly is the best example of the success of such practices
29. **8- Varieties or strains of some plants** have been found more resistant to insect attack than others
30. To develop resistant strains and to prove their value, however, frequently require long, expensive research in plant genetics
31. Instances in which some success has been obtained will be mentioned under the insect pests concerned

## **84-85-86-87-BIOLOGICAL CONTROL**

1. **Parasitic and predaceous** insects as well as diseases of insects have already been discussed
2. As vital factors in the **natural control** of injurious insects
3. It is possible, however, for man to encourage such beneficial forms by introducing them into new areas
4. By growing them artificially for liberation whenever they become scarce in nature
5. Until recent years most of this work dealt with the introduction of parasites
6. From abroad to **combat those foreign insect pests** brought to this country accidentally but without their **natural enemies**
7. Certain **native parasites and predators** are now being reared in large numbers for liberation in areas badly infested with their host species
8. Probably the first introduction attempted from a foreign country was the now classic case of a **ladybeetle brought from Australia** to attack the **cottony cushion scale**
9. Which had already reached California and was endangering the existence of the citrus industry
10. Following this successful attempt many other parasites and predators have been imported
11. Which in many instances have proved valuable in reducing the numbers of foreign pests
12. Parasites should not be expected to kill off all their hosts
13. They will merely reduce the population to greater or less extent
14. Other control measures must also be used if the insect is to be exterminated

15. The discovery and introduction of parasites are expensive
16. However, since a successful parasite perpetuates itself, the initial high cost of establishment may be spread over a period of many years
17. Many dangers are involved in bringing parasites into a new country
18. These insects may attack not only the pest that is to be controlled
19. But also other parasites of the pest
20. In such cases the introduction may be of little value
21. There is always the chance also that their own secondary parasites may be imported along with the primary ones
22. Only thoroughly trained entomologists
23. Therefore, should be permitted to bring parasites and predators to this country if we are to avoid the introduction of undesirable insects along with the desirable ones
24. The liberation of insect diseases is not so generally successful as variations in natural conditions limit the growth of the disease
25. Many of the disease organisms are widely distributed and appear spontaneously
26. When suitable conditions prevail, even without any encouragement
27. The most systematic use of diseases in artificial insect control in the United States appears to be the annual distribution by the state of Florida of fungi that live on the **whiteflies that attack citrus**

## 88-89-LEGISLATIVE CONTROL

1. Various laws and regulations both Federal and state have been enacted to prevent the introduction of foreign pests:
  - a. **To prevent their spread within the country**
  - b. **To enforce control and extermination**
  - c. **To ensure that chemicals used for controlling insects are neither adulterated nor misbranded**
2. These laws and regulations take the form of absolute quarantines, the inspection of plants to be shipped
3. The obligatory treatment of growing and harvested crops and the testing of insecticides.
4. Plants entering the country or crossing state boundaries must at least be inspected, and in some cases shipment is barred absolutely
5. If any pest in a state is the subject of a Federal quarantine, a limiting line may be fixed within that state by Federal authority to prevent shipment to points outside the quarantined area
6. Various regulations are in force controlling particular cases
7. But in general, plants, especially nursery stock, carried from one region to another must be passed by an authorized state or Federal inspector as free from insect pests and plant diseases
8. Before shipment will be permitted.
9. Because insects will spread by flight and by wind carriage and because many escape discovery during inspection



10. It is reasonably certain that in spite of quarantines these pests will gradually spread over such parts of this country as they are able to inhabit
11. The chief gains from legislation, then, are
  - a. (1) to delay the spread of pests and protect un-infested localities from their attacks as long as possible
  - b. (2) to prevent new pests from entering the country
12. It is believed that the tremendous expense involved in thus delaying the spread of new insect pests is far outweighed by the crop losses avoided
13. The time gained for preparing the country to control those pests which will eventually spread over it

## **90-91-92-93-94-Physical Control**

- ▶ The extremes of both **temperature** and **humidity**, either high or low, are not only effective barriers in the natural control of insects
- ▶ But they are also useful in artificial control
- ▶ Light and electricity are other factors that come under this heading

### **Physical Factor Controlling Insects**

- ▶ 1- Heat
- ▶ 2-Cold
- ▶ 3-Moisture
- ▶ 4-Light ▶ 5- Electricity

### **1- Heat**

- 2- Most insects cease reproduction and soon die at temperatures from **100 to 110°F**
- 3- The temperature of their surroundings should be raised to **120° or higher** to kill them with heat artificially **within a few hours**
- 4- The length of period for effective treatment is more dependent upon the
  - a. time to heat the **grain**
  - b. **clothing**
  - c. other material in which the insects are located
- 5- Than upon the heat resistance of the pests themselves
- 6- Because no insect can survive more than an hour if actually exposed to a temperature of **120°F**
- 7- Bales and bags are difficult to heat through

### **2- Cold**

1. Although **low temperatures** are not so effective as high ones in killing insects
2. Many insect pests of stored products such as **furniture, rugs, clothing and seeds** become inactive at **40 to 45°F**.

3. Under these conditions infested materials suffer no further damage or increase in infestation
4. And materials free from insects when put into cold storage will remain so.
5. Those insects which hibernate outdoors withstand temperatures far below zero
6. Most insect pests of stored products, however, are unable to become dormant in the true sense and are killed in a relatively short time even at temperatures considerably above zero
7. The use of low temperatures in the artificial control of insects, there fore, is of two types
8. The more important is cold storage, as for furs, at temperatures just low enough to protect the stored materials from injury
9. The other use of cold actually to kill insects is feasible only on a large scale in zero weather in the north
10. Here as in the case of the heat-treatment much more time is required to chill grain, flour, clothing and other products than is usually realized

### 3- Moisture

- ▶ A conspicuous example of the manipulation of moisture to control insects
- ▶ Is the drying of grain to reduce the likelihood of weevil injury

### 4- Light

- ▶ It is well known that many insects are attracted to bright lights
- ▶ This fact has been used extensively to trap insects, sometimes for the purpose of studying their distribution, sometimes as a control measure
- ▶ Although considerable research is still required in this field it is apparent that insects are attracted more by lights of some colors than by those of others

### 5- Electricity

1. Devices are available for electrocuting insects
  - a. I-Some in the form of **electrical window screens** for flies
  - b. II-Others as **electric light traps** for moths and beetles
2. These are so arranged that an insect striking parallel wires of the device completes an electrical circuit and is killed by the shock
3. A machine for the electrical treatment of insect-infested grain and cereal products has been used successfully for several years
4. In which the insects are killed when the product is passed through a field of high frequency between two electrodes

## 95-CHEMICAL CONTROL

- ▶ The chemical control of insects includes control not only with **insecticides** in the true sense as discussed in the following chapters
- ▶ But also with various materials used to **attract** and **repel** insects without actually killing them

### Attractants

1. Sometimes called **atrahents** are materials used to lure insects to traps and poisoned baits

2. The use of geraniol in **Japanese beetle traps**, **sugar sirups** for ant baits, and **fermenting sirup** solutions for trapping various moths are good examples.

## Repellents

1. Repellents are those materials used to keep insects away from crops, animals and man
2. Various **coal-tar** and **pine** products are rather general insect repellents.
3. **Naphthalene** is a clothes moth repellent and oil of citronella is a common ingredient of preparations used to keep mosquitoes away from people

## 96-97-98-99-Insect Classification Classification

- 1- Scientific Classification is a system used to classify all living things through a breakdown starting with the largest grouping called a Kingdom
- 2- And continuing down to the smallest grouping called species
- 3- Insects can be placed into groupings based upon their physical characteristics
- 4- Insects with similar characteristics, number of wings, mouthparts, etc. are placed in a group
- 5- Identification of insect orders aids in prevention and management plans
- 6- Insects belong in the Phylum **Arthropoda**
- 7- The Phylum **Arthropoda** is characterized by having segmented bodies and jointed appendages

## 5 Classes of Arthropods

1. **Class #1- Hexapoda:** Insects, six, jointed appendages
2. **Class #2- Chilopoda-** Centipedes, one pair of legs per body segment, multiple body segments
3. **Class #3- Diplapoda-** Millipedes, two pairs of legs per body segment, multiple body segments
4. **Class #4- Crustacea-** Crayfish, five pairs of jointed appendages
5. **Class #5- Arachnida-** Spiders, four pairs of jointed appendages

## Classification

6. There are 31 different orders of insects in the **class Hexapoda**
7. Sixteen of which are considered of economic importance to agriculturists

## Orders of Insects

### ► The sixteen orders are:

- 1- Orthoptera
- 2- Hemiptera
- 3- Homoptera
- 4- Coleoptera
- 5- Lepidoptera
- 6- Diptera



- ▶ 7- Hymenoptera
- ▶ 8- Odonata
- ▶ 9-Neuroptera ▶ 10-Thysanura
- ▶ 11-Isoptera
- ▶ 12-Siphonaptera
- ▶ 13-Phthiraptera
- ▶ 14-Thysanoptera
- ▶ 15-Dermaptera
- ▶ 16-Blattodea

## 1-Orthoptera

1. **This order includes:** Indian House Crickets, Field Cricket, Short-horned, Grasshoppers, Katydid (Long-horned Grasshoppers)
2. **Mouthparts:** Chewing
3. **Metamorphosis:** Incomplete Metamorphosis
4. **Damage:** Chewing leaves, Crop grains
5. Over 20,000 species worldwide

## 2- Hemiptera – True Bugs

1. **Examples:** Assassin bugs, Kissing bugs, Leaf-footed bug, Lygus bug, Stink bug, Minute pirate bug, Big-eyed bug, Damsel bug
2. **Mouthparts:** Piercing-Sucking
3. **Metamorphosis:** Incomplete Metamorphosis
4. All of the true “bugs” are in this order
5. Most have a common v shape on their shield

## 3-Homoptera

1. **Includes:** Cicadas , Aphids , Armored scales , Cottony cushion scale, Cochineal scale, Leafhoppers, Treehoppers, Whiteflies
2. **Mouthparts:** Sucking
3. **Metamorphosis:** Generally incomplete

## 4-Coleoptera

- ▶ **Includes:** Beetles and Weevils

1. Blister beetle
2. Boll weevil
3. Collops beetle
4. Darkling beetle
5. Dermestid beetle
6. Dung beetle
7. Fig beetle,
8. Flea beetle
9. Lady beetle
10. Long-horned beetle
11. Palo Verde root borer
12. Metallic wood borer

► **Mouthparts:** Chewing, Weevil- Piercing Sucking

► **Metamorphosis:** Complete Metamorphosis

## 5- Lepidoptera

► **Includes:** Butterflies and Moths

► **Examples:** Bagworm, Two-tailed Swallowtail

Budworm/Bollworm, Pink Bollworm, Grape-leaf Skeletonizer Salt Marsh Caterpillar, Tomato Hornworm, Sphinx Moth

Monarch, Checkered skipper

► **Mouthparts:** Chewing – Caterpillars, Siphoning – adult

► **Metamorphosis:** Complete Metamorphosis

## 100 Insect Classification

### 6- Diptera

**Includes:** Flies, Midges, Mosquito

**Examples:** House fly , Crane fly , hover fly , Bee fly , Tachinid fly, Bot fly, Deer fly, Mosquito, Gall Midge

► **Mouthparts:** Sponging, Piercing sucking- Mosquito

► **Metamorphosis:** Complete Metamorphosis



## 7- Hymenoptera

- ▶ **Includes:** Bees, Wasps, Ants
- ▶ **Examples:** Horntail wasp, Sawfly, Gall wasps, Honey bee

Leaf-cutter bee, Carpenter bee, Bumble bee, Harvester ant, Leaf-cutter ant, Fire ant, Velvet Ant, Paper wasp, Ichneumon wasp, Thread-waisted wasp, Tarantula hawk

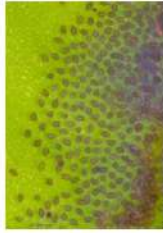
- ▶ **Mouthparts:** Chewing-Lapping
- ▶ **Metamorphosis:** Complete Metamorphosis



## 8- Odonata

- ▶ **Includes:** Dragonfly, Damselfly
- ▶ **Mouthparts:** Chewing-Lapping
- ▶ **Metamorphosis:** Complete Metamorphosis
- ▶ Live in the water the first year of their lives
- ▶ After leaving the water they only live a month

- ▶ Have been around 300 million years



## 101 Insect Classification

### 9-Neuroptera

- ▶ **Includes:** Green Lacewing, Antlion
- ▶ **Mouthparts:** adults have hypognathous (directed downward) mouthparts and unique piercing-sucking larval jaws composed of the mandibles (directed downward) plus maxillae
- ▶ **Metamorphosis:** Complete Metamorphosis
- ▶ Both are beneficial insects
- ▶ Antlions create a sand pit to capture unsuspecting prey



### 10- Thysanura

- ▶ **Includes:** Silverfish, Firebrat
- ▶ **Mouthparts:** Chewing
- ▶ **Metamorphosis:** Incomplete Metamorphosis
- ▶ Like to lay their eggs in books and wall paper because of the paper and glue Live 3-5 years Most primitive of all insects



### 11- Isoptera

- ▶ **Includes:** Dry-wood termite, Subterranean termite
- ▶ **Mouthparts:** Chewing Mouthparts
- ▶ **Metamorphosis:** Incomplete Metamorphosis
- ▶ Live for 15 years.



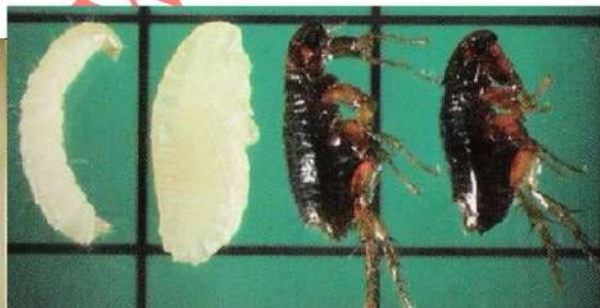
- Lay 1 egg every 15 seconds
- Eat wood. Can destroy a house in 2-3 years ► Found in every US state except Alaska.
- Recycle wood in the soil



## 102 Insect Classification

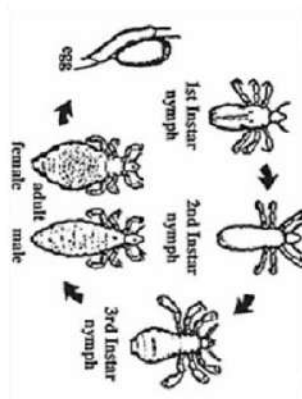
### 12- Siphonaptera

- Includes: Cat and dog flea
- Mouthparts: Piercing Sucking
- Metamorphosis: Complete Metamorphosis
- Fleas can live 100 days without feeding
- Can jump 100 times their own length



### 13- Phthiraptera

- Formally Anoplura and Mallophaga
- Includes: Lice, Chewing Louse, Sucking Louse
- Mouthparts: Chewing and Piercing-Sucking
- Metamorphosis: Complete Metamorphosis



## 14- Blattodea

- **Includes:** Cockroaches, American Cockroach, Brown-banded cockroach

Desert Cockroach, Turkish Cockroach, German Cockroach

- **Mouthparts:** Chewing Mouthparts
- **Metamorphosis:** Complete Metamorphosis



## 103 Insect Classification

### 15- Dermaptera

- **Includes:** Earwigs
- **Mouthparts:** Chewing Mouthparts
- **Metamorphosis:** Complete Metamorphosis
- Live humid and dark areas
- Oldest known fossil dates back to Jurassic period



## 16- Thysanoptera

[www.vuways.com](http://www.vuways.com)

**Includes: Thrip**

- ▶ **Mouthparts:** Rasping-Sucking Mouthparts
- ▶ **Metamorphosis:** Complete Metamorphosis
- ▶ Common Pests on flowers, citrus and onions



## 104 Integrated Pest Management (IPM)

- ▶ A pest management philosophy that utilizes all suitable pest management techniques and methods to keep pest populations below economically injurious levels
- ▶ Each pest management technique must be environmentally sound and compatible with producer objectives

**Utilizes all suitable pest management Ways**

- ▶ Pesticide Control
- ▶ Cultural Control
- ▶ Mechanical Control
- ▶ Sanitary Control
- ▶ Natural Control
- ▶ Biological Control ▶ Host Plant Resistance

### Pesticide Control

- ▶ Pesticides can to be used in an IPM program, however only as a last resort
- ▶ Pesticides are to be used when there is no risk of environmental damage or when benefits outweigh the risks
- ▶ Use pesticides only when other control practices aren't available, economical or practical
- ▶ Important aspect to use pesticides:
  - ▶ Must monitor pest populations in the field.
  - ▶ Identify the pest
  - ▶ Compare pest population and the economic threshold





- ▶ Life stage susceptible to pesticide?
- ▶ Crop stage and preventable loss

## 105 Integrated Pest Management (IPM)

### What is “Cultural Control”

Agronomic practices that are designed to:

- ▶ 1-Optimize growing conditions for the crop
  - ▶ 2-Anything that increases a crop’s competitive edge will result in increased tolerance to pests often resulting in reduced pesticide use
  - ▶ 3- Create unfavorable conditions for the pest
- What is Mechanical Control?**
- ▶ Uses machinery and/or other tools to control pests
  - ▶ 1- Tillage: Tillage is the agricultural preparation of soil by mechanical agitation of various types, such as digging, stirring, and overturning
  - ▶ 2- Physical barriers



### What is Sanitary Control?

- ▶ **Methods to avoid introducing a pest into a field by**
  - ▶ 1- Cleaning field equipment
  - ▶ 2- Planting certified seed
  - ▶ 3- Quarantines
- What is Natural Control?**
- ▶ Enhancement of naturally occurring pest management methods by introducing
  - ▶ 1- Beneficial insects
  - ▶ 2- Beneficial diseases

## 106 Integrated Pest Management (IPM)

### What is Biological Control?

- ▶ **Manipulation of biological organism to control pests by:**
  - ▶ 1- Release of predators/parasites/disease of an insect or weed Can be time consuming, expensive and difficult
- What is Host Plant Resistance?**
- ▶ Manipulating the crop to withstand or tolerate pests by

- ▶ 1- Natural breeding method
- ▶ 2- Genetically modified plants
- ▶ **Examples:** Glandular-haired Alfalfa, Bt Corn,

### Important Steps of IPM

1- To Keep Pests Below the Economic Injury Level

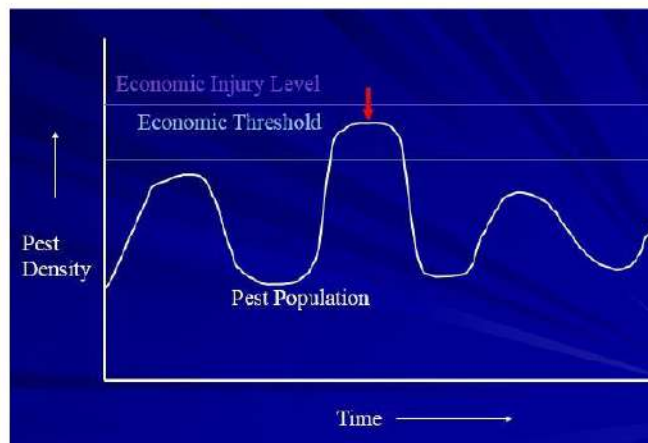
- ▶ Economic Injury Level:

**Cost of control = \$ amount of damage caused by the pest**

- ▶ Includes amount of pest damage
- ▶ Cost of each control practice
- ▶ Economic Injury Levels are determined through extensive research
- ▶ Economic Injury Level is the information that is necessary to develop an **Economic Threshold**, which is used by crop advisors

### 107 Integrated Pest Management (IPM)

- ▶ **Economic Threshold:**
- ▶ "Pest Population at which a grower must take action to prevent a pest populations from reaching the economic injury level"
- ▶ Economic threshold is slightly below the economic injury level
- ▶ And pest populations must be increasing
- ▶ This graph explains the relationship of the Economic Injury Level to the Economic Threshold
- ▶ The red arrow may indicate a pesticide application which was applied at the economic threshold and did not allow the pest population to reach the Economic Injury Level



### Four Basic Principles of IPM

- ▶ 1) Thorough understanding of the crop, pest, and the environment and their interrelationships
- ▶ 2) Requires advanced planning
- ▶ 3) Balances cost/benefits of all control practices
- ▶ 4) Requires routine monitoring of crop and pest conditions



### **1a. Understanding Crop Growth and Development**

- ▶ How do you grow a healthy crop?
- ▶ When is the crop most susceptible to pest damage?
- ▶ When is the crop under stress?

## **108 Integrated Pest Management (IPM)**

### **1b. Understanding the Pest**

- ▶ Proper identification of pest Understanding of Pest Life cycle When is it present
  - ▶ When is it most susceptible to control-"Weak Link"
    - 2) Requires Advanced Planning
  - ▶ The IPM approach suggests that we focus on preventative management practices before relying on rescue treatments (i.e. pesticides)
  - ▶ This inherently requires advanced planning
  - ▶ you must have a thorough understanding of the crop, pest and environment,. Use this information to anticipate pest problems and to plan preventative management practices such as crop rotation, row cultivation, variety selection, etc.

### 3) Balances cost/benefits of all control practices

- ▶ To accomplishment the desire objective, crop advisors balance the cost/benefits of all management practices
- ▶ It can be possible through the use of economic injury levels and economic thresholds, but we must also have to apply that philosophy to other IPM techniques as well
- ▶ If one of management practices is to use row cultivation to control weeds,
- ▶ we must determine the cost of equipment, fuel and labor before we know if it is an economical practice
- ▶ If a grower is considering using a genetically modified corn hybrid for European corn borer control, they have to consider if the high cost of the hybrid will offset the amount of damage

## 109 Integrated Pest Management (IPM)

### 4) Requires routine monitoring of crop and pest conditions

- ▶ The backbone of any IPM program requires routine monitoring of pest populations and crop conditions
- ▶ Without this information you can not make an intelligent pest management recommendation
- ▶ **If you are not monitoring pest populations**
- ▶ How do you know if you are at the economic threshold?
- ▶ How do you know when is the best crop stage to treat?
- ▶ How do you know if you have pests at all?
- ▶ Maybe you will have high pest populations and not even realize until it is too late
- ▶ Pest Monitoring, sometimes call **field scouting**, is an activity that can be accomplished by anyone with a little advanced training
- ▶ In the simplest sense, a field scout must be able to tell a healthy plant from an unhealthy plant
- ▶ Realistically, a field scouting must know:
  - ▶ How to properly identify pests and their damage
  - ▶ How to get an accurate assessment of pest populations
- ▶ A field scouts objective is to provide an accurate and unbiased objective of pest populations ▶
  - What tools and procedures do you use for alfalfa weevil for potato leafhopper, etc.
- ▶ Both of these examples are pests on alfalfa, however, the sampling procedure is different.





## 110 Integrated Pest Management (IPM)

### 4) Requires routine monitoring of crop and pest conditions

Alfalfa weevil are not easily dislodged with an insect sweep net and therefore require that we monitor the amount of foliage they consumed and make a damage recommendation based on that observation

- ▶ Potato leafhopper, on the other hand, do not chew on the alfalfa leaves, but instead suck plant sap.
- ▶ We can not monitor their damage, nor are they easily counted on alfalfa foliage because they are small and easily fly when disturbed
- ▶ Instead, we must use an insect sweep net and count the number of adults and nymphs caught
- ▶ For second generation corn borers on sweet corn, we count the number of eggs laid on the leaves
- ▶ Different pests require different scouting practices

### Benefits of an IPM Program

- ▶ Protects environment through elimination of unnecessary pesticide applications
- ▶ Improves Profitability
- ▶ Reduces risk of crop loss by a pest
- ▶ Peace of Mind

### Disadvantages of an IPM Program

- ▶ Requires a higher degree of management
- ▶ More labor intensive
- ▶ Success can be weather dependent

## 111 Pests of Cotton

- ▶ Cotton is a soft, fluffy staple fiber that grows in boll, or protective
- ▶ Cotton (*Gossypium spp*), the king of fibers, usually *commercially referred as* white gold and one of the important commercial crops, plays a pivotal role in human civilization, economic, political and social affairs of world.
- ▶ The four cultivated species of cotton viz. *Gossypium arboreum*, *Gossypium herbaceum*, *G. hirsutum* and *G. barbadense* belong to *Malvaceae* family
- ▶ The plant is a shrub native to tropical and subtropical regions around the world, including the Americas, Africa, and India

### Economic importance of cotton

It is chiefly grown for its fiber which is used for manufacturing of clothes for mankind

- ▶ **Cotton lint:** It is the most important vegetable fiber and is woven into fabrics either alone or combined with other fibers
- ▶ **Fuzz:** It is used in production of mattresses, surgical cotton, photographic film and paper.
- ▶ **Cotton seed:** Depending on varieties, it contains 20-25% semi-drying edible oil which is used for cooking.

- ▶ **Cotton seed cake:** Seed cakes contain 40% protein and serves as a important concentrated feed for livestock
- ▶ **Cotton stem:** The stem can be used as organic manure or fuel.

## 112 Pests of Cotton

**American bollworm/Fruit borer: *Helicoverpa armiger***

Family: Noctuidae

- ▶ **Order:** Lepidoptera
- ▶ It is one of the important major insect of cotton crop



Fig. Feeding injury

### ▶ Symptoms of damage

- ▶ Bolls showing regular, circular bore holes
- ▶ Larvae seen feeding on the boll by thrusting their heads alone inside and leaving the rest of the body outside
- ▶ Presence of granular faecal pellets outside the bore hole.
- ▶ A single larva can damage 30-40 bolls.



Fig. Circular bore hole

## Management

- ▶ Avoid continuous cropping of cotton both during winter and summer seasons in the same area as well as rationing
- ▶ Avoid monocropping. Growing of less preferred crops like greengram, blackgram, soyabean, castor, sorghum etc., along with the cotton as intercrop or border crop or alternate crop to reduce the pest infestation

- ▶
  - ▶ Removal and destruction of crop residues to avoid carry over of the pest to the next season, and avoiding extended period of crop growth by continuous irrigation.
  - ▶ Optimizing the use of nitrogenous fertilizers which will not favor the multiplication of the pest.
  - ▶ Judicious water management for the crop to prevent excessive vegetative growth and larval harbourage
  - ▶ Releasing predator *Chrysoperla carnea* @ 1, 00, 000/ha at 6<sup>th</sup>, 13<sup>th</sup> and 14<sup>th</sup> week after sowing.
  - ▶ During bolling and maturation stage, apply any one of the following insecticides (1000 l of spray fluid/ha):
  - ▶ **Phosalone 35 EC 2.5 l/ha**

- ▶ Quinalphos 25 EC 2.0 l/ha
- ▶ Carbaryl 50 WP 2.5 kg/ha
- ▶ Pyraclofos 50 EC 1.5 l/ha
- ▶ Endosulfan 35 EC 2.5 lit/ha ▶ Cypermethrin 10 EC 600-800ml/ha

## 113 Pests of Cotton

**Pink bollworm: *Pectinophora gossypiella***

- ▶ **Family:** Gelechiidae
- ▶ **Order:** Lepidoptera
- ▶ It is a notorious pest of cotton in all cotton growing areas.
- ▶ It is a major chewing insect of cotton crop.



Fig. Larva



Fig. Adult

**Symptoms of damage**

- ▶ Rosetted flowers
- ▶ The holes of entry plugged by excreta of larvae which are feeding inside the seed kernels.
- ▶ Discolored lint and burrowed seeds.



- ▶ They cut window holes (interlocular burrowing) in the two adjoining seeds thereby forming "double seeds"
- ▶ The attacked buds and immature bolls drop off.



## Management

- ▶ Clean cultivation and destruction of crop residues (fallen leaves, twigs etc.) before the onset of season
- ▶ Plough deeply to expose the hibernating larvae / pupae
- ▶ Avoid late sowing of the crop. Early sowing helps in early maturity facilitating escape
- ▶ Withholding irrigation water to avoid prolonged late boll production/formation to reduce the build up of over-wintering population
- ▶ Acid delinting of cotton seeds
- ▶ Release of egg parasitoids *Trichogramma chilonis* or *E. johnstoni*
- ▶ Spray triazophos 40 EC 2.5l/ha and Quinalphos 20% AF in alternation even after 100 DAS

## 114 Pests of Cotton

**Spotted bollworms: *Earias vittella* Spiny bollworm: *Earias insulana***

- ▶ Family: Noctuidae
- ▶ Order: Lepidoptera
- ▶ It is also a chewing insect pest of cotton that causes great economic loss to cotton crops.

### Symptom of damage

- ▶ Drying and drooping of terminal shoots during pre – flowering stage
- ▶ Shedding of squares and young bolls
- ▶ Flaring up of bracts during square and young boll formation stage
- ▶ Holes on bolls and rotting of bolls



Fig2. Bore holes and rotting · Drying - terminal shoots

## Management

- ▶ Collect and destroy all the shed fruiting parts ▶ Planting trap crop of bhendi, uprooting and burning
- ▶ Don't extend the crop period.
- ▶ Set up pheromone traps
- ▶ Conserve and encourage the activity of spiders *Thomisus sp.*, *Neosiana sp.*
- ▶ Spray the following insecticide

## 115 Pests of Cotton

### Armyworm /Tobacco Cutworm: *Spodoptera litura*

- ▶ Family: Noctuidae ▶ Order: Lepidoptera. ▶ It is a major and important chewing insect pest of cotton crop.



Adult

#### Symptoms of damage

- ▶ Scrapping the epidermal layer, leaving the skeleton of veins of leaf
- ▶ During severe attack, only the stem and side shoots will be standing in the field without any leaf or bolls
- ▶ Larvae feed the leaves by making small holes.



Larva

#### Management

- ▶ Use of light trap
- ▶ Set up the sex pheromone trap Pherodin S.L. at 12/ha
- ▶ Growing castor along border and irrigation bunds.
- ▶ Removal and destruction of egg masses in castor and cotton crops.
- ▶ Removal and destruction of early stage larvae found in clusters
- ▶ Collection and destruction of shedded plant parts
- ▶ Hand picking and destruction of grown up caterpillars.

- ▶ Spray any one of the following insecticides
- ▶ chlorpyrifos 20 EC 2.0 l/ha;
- ▶ dichlorvos 76 WSC 1 lit/ha;
- ▶ fenitrothion 50 EC @ 625 ml.

## 116 Pests of Cotton

### Cotton aphid – *Aphis gossypii*

- ▶ Family: Aphididae
- ▶ Order Homoptera
- ▶ An important sucking insect of cotton crop.



### Symptom of damage

- ▶ Infesting tender shoots and under surface of the leaves
- ▶ Curling and crinkling of leaves
- ▶ Stunted growth
- ▶ Blighted appearance when infestation is severe
- ▶ Development of black sooty mould due to the excretion of honey dew giving the plant a dark appearance



### Management

- ▶ Seed treatment with imidacloprid 70 WS at 7 g/kg protect the crop upto 8 weeks
- ▶ Release predator *Chrysoperla carnea* or *coccinella sp.*
- ▶ Monitoring the activities of the adult by setting up yellow sticky traps

- ▶ **Spray any one of the following insecticides (500 l spray fluid/ha)**
- ▶ Imidacloprid 200 SL at 100 ml/ha
- ▶ Methyl demeton 25 EC 500 ml/ha
- ▶ Dimethoate 30 EC 500 ml/ha
- ▶ Phosphamidon 40 SL 600 ml/ha
- ▶ NSKE 5% 25 kg/ha

## 117 Pests of Cotton

### **Thrips: *Thrips tabaci***

- ▶ These tiny yellow to black, slender insects are annual pest in cotton field.
- ▶ They are active in spring.
- ▶ It is a major sucking insect of cotton crop
- ▶ Family Thripidae
- ▶ Order Thysanoptera.

### **Symptom of damage**

- ▶ Shriveling of leaves due to scrapping of epidermis and desapping
- ▶ Attacked terminal buds – have ragged edges
- ▶ Silvery shine on the undersurface of leaves



**Fig. Adult thrip**

### **Management**

- ▶ Seed treatment with Imidacloprid 70 WS @ 7 g/kg protects the crop up to 8 weeks.
- ▶ **Spray any one of the following insecticides (500 l spray fluid/ha)**
- ▶ Imidacloprid 200 SL at 100 ml/ha
- ▶ Methyl demeton 25 EC 500 ml/ha
- ▶ Dimethoate 30 EC 500 ml/ha
- ▶ Phosphamidon 40 SL 600 ml/ha
- ▶ NSKE 5% 25 kg/ha



# 118 Pests of Cotton

Whitefly: *Bemisia tabaci*

- ▶ Family: Aleyrodidae
- ▶ It is important sucking insect pest of cotton crop



## Symptom of damage

- ▶ Chlorotic spots on the leaves which latter coalesce forming irregular.
- ▶ yellowing of leaf tissue which extends from veins to the outer edges of the leave
- ▶ Severe infestation results in premature defoliation ▶ Development of sooty mould .
- ▶ Shedding of buds and bolls and poor boll opening.
- ▶ It also transmits the leaf curl virus diseases of cotton.

## Management

- ▶ Growing cotton only once a year either in winter or summer season.
- ▶ Adopting crop rotation with non-preferred hosts such as sorghum, ragi, maize etc.
- ▶ Removal and destruction of alternate weed hosts like *Abutilon indicum*, *Chrozophore rottlari*, *Solanum nigrum*
- ▶ Timely sowing with recommended spacing
- ▶ Preferably wider spacing and judicious application of recommended dose of fertilizers
- ▶ Late sowing may be avoided and the crop growth should not be extended
- ▶ Field sanitation may be given proper attention.
- ▶ **Spray any one of the following in mid and late stages (1000 l spray liquid/ha)**
- ▶ Phosalone 35 EC at 2.5 l/ha
- ▶ Quinalphos 25 EC at 2.0 l/ha
- ▶ Triazophos 40 EC 2.0 l/ha
- ▶ Acephate 75 SP 1.30 kg/ha



## 119 Pests of Cotton

### Red cotton bug: *Dysdercus cingulatus*

► Family : Pyrrhocoridae

► Order : Hemiptera

#### Symptom of damage

- Red stained lint and rotting bolls.
- Inner boll wall with warty growth or water soaked spots
- Young bolls abort and turn dark brown
- The bacterium *Nematospora gossypii* enters the site of injury and stains the fiber.

#### Management

- Plough the field to expose the eggs.
- Spray Phosphamidon 100 EC@250 ml/ha

### Dusky cotton bug: *Oxycarenus hyalinipennis* ►

#### Symptom of damage

- Sucks the sap from developing seeds in open bolls and stains the lint black.
- Seeds discolored and shrunken

#### ► Management

- Spray Phosphamidon 100 EC@250 ml/ha



## 120 Pests of Cotton

**Mealy bugs:** *Phenacoccus sp.*, *Ferrisa sp.* and *Maconellicoccus sp.*

- ▶ Family: Pseudococcidae
- ▶ Order: Hemiptera
- ▶ They are considered pests as they feed on plant juices and act as vector of various diseases.



### Symptom of damage

- ▶ Heavy clustering of mealy bugs usually seen under surface of leaves as a thick mat ▶ with waxy secretion.
- ▶ Excrete copious amount of honey dew on which the fungus sooty mould grow.
- ▶ Affected plants appear sick and black, resulting reduced fruiting capacity.

### Management

- ▶ Spray application of any following insecticides viz.
- ▶ Carbaryl 50 WP @ 1kg/acre,
- ▶ Thiodicarb 75 WP @ 250 g/acre
- ▶ Profenophos 50 EC @ 500 ml/acre
- ▶ Acephate 75SP @ 800 g/acre.

### Cotton Stem Weevil: *Pemphres (Pempherulus) affinis*

- ▶ **Family:** Curculionidae
- ▶ **Order:** Coleoptera
- ▶ It is a serious pest of cotton crop.

#### Symptoms of damage

- ▶ Swellings on the stem just above the ground level
- ▶ Young plants are invariably killed
- ▶ Older plants that survive, lack vigor and strength, and when strong winds blow, these plants sometimes break at the nodes.

### Shoot weevil: *Alcidodes affaber*

- ▶ **Family:** Curculionidae ▶ **Order:** Coleoptera.
- ▶ **Symptoms of damage**
  - ▶ Terminal shoots with galls
  - ▶ Bore hole surrounded by raised margins
- ▶ **Management**
  - ▶ Soil application of Carbofuran 3 G @ 30 kg may be done on 20 days after sowing and earthed up.
  - ▶ Basal application of FYM 25 t/ha or 250 kg/ha of Neem cake.

## 121 Pests of Sugarcane

Insect pest	Scientific name	Family	Order
EARLY SHOOT BORER	<i>Chilo infuscatellus</i>	Pyralidae	Lepidoptera
INTERNODE BORER	<i>Chilo sacchariphagus indicus</i>	Pyralidae	Lepidoptera
TOP BORER	<i>Scirpophaga nivella</i>	Pyralidae	Lepidoptera



<b>ROOT GRUB</b>	<i>Holotrichia serrata</i>	Melolonthidae	Coleoptera
<b>TERMITE</b>	<i>Odontotermes obesus</i>	Termitidae	Isoptera
<b>SUGARCANE SCALE</b>	<i>Melanapis glomerata</i>	Diaspididae	Hemiptera
<b>SUGARCANE MEALY BUG</b>	<i>Ripersia sacchari</i>	Pseudococcidae	Hemiptera
<b>SUGARCANE LEAF HOPPER</b>	<i>Pyrilla perpusilla</i>	Lophopidae	Hemiptera
<b>WOOLY APHID</b>	<i>Ceratobvacuna lanigera</i>	Aphididae	Hemiptera
<b>WHITE FLY</b>	<i>Aleurolobus barodensis</i>	Alerodidae	Hemiptera

## 122 Pests of Sugarcane

### Sugarcane Shoot Borer

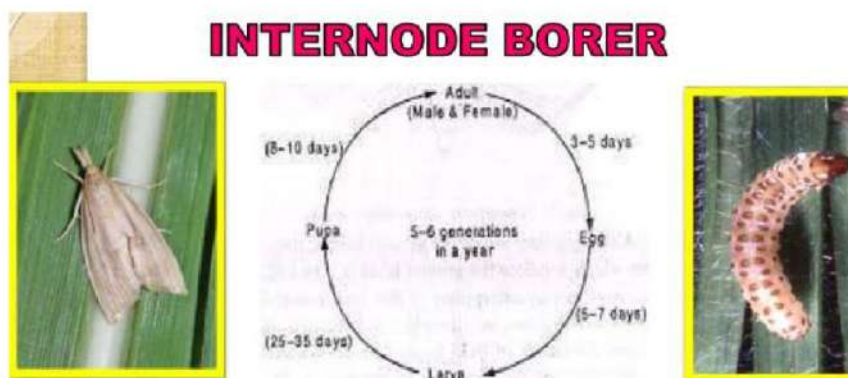


### SYMPTOMS OF DAMAGE

- ▶ Attack 1-3 month old crop and cause
- ▶ Dead heart , which can be easily pulled out
- ▶ Rotten portion of the cane colored dead heart emits an offensive odour.

- A number of bore holes at the base of the shoot just above the ground level **Internode**

#### Borer



#### SYMPTOMS OF DAMAGE

- Constricted and shortened internodes, with a number of boreholes filled with excreta at nodal region
- Reddening of affected tissues inside the cane
- Fresh borer attack is mostly found in the top five immature internodes and its activity continues till harvest.

## 123 Pests of Sugarcane

#### Sugarcane Top Borer



#### SYMPTOMS OF DAMAGE

- Parallel rows of short holes in the emerging leaves causes a white streak which later turns reddish brown
- Dead heart in grown up canes reddish brown in color which cannot be easily pulled
- In tillering phase of the crop, the attacked shoots die, side shoots (tillers) develop Parallel rows of short producing a bunched top appearance

#### IPM for Sugarcane borers( Cultural Control)

- Time of planting
- Early planting during December –January to escape the shoot borer incidence.
- Detrashing

- ▶ Internode borer and Stalk borer
- ▶ Manuring
- ▶ Avoid excess use nitrogenous fertilizers.
- ▶ Stalk borer and internode borer.
- ▶ Trash mulching and earthing up
- ▶ Removal and destruction of infested cane
- ▶ Early shoot borer
- ▶ Collection and destruction of eggs
- ▶ Internode borer and Top borer

## 124 Pests of Sugarcane

### Biological Control

- ▶ For Early shoot borer :
- ▶ *Trichogramma chilonis* ▶ For Top borer :
- ▶ *Trichogramma chilonis* or *T. japonicum*, *Isotima javensis* ▶ For Internode borer :
- ▶ *Trichogramma chilonis*
- ▶ Cultivation of resistance variety
- ▶ Irrigation at closer intervals for managing
- ▶ Early shoot borer
- ▶ Practice deep harvesting to destroy stubbles
- ▶ Removal of water shoots to destroy
- ▶ Top shoot borer



## Chemical Control

Insecticide and formulation	Dosage	Method and time of application
<b>SHOOT BORER</b> Chlorpyrifos 20EC	1 kg a.i ha <sup>-1</sup> (5 litre)	Soil drenching at planting and if need be at 45 days after planting.
Cypermethrin 10% EC	260-304 ml in 200-280 l of water/acre	Sprayed around the base of plants at 30 days and if need be at 60 days after planting.
Fipronil 5% SC	1500-2000 ml/ha	Properly sprayed on crop canopy as well as basal part of the plant after 30-45 days of planting
NSKE 5 %	25 Kg/ha	Sprayed on soil as well as on crop to prevent larval feeding
<b>TOP BORER</b> Carbofuran 3 G or Phorate 10 G	1 kg a.i./ha (33 kg) or 3 kg a.i./ha (30 kg)	Soil application during last week of June or first week of July against third brood of the pest in sub-tropical India.
<b>INTER NODE BORER</b> Monocrotophos 36 SL	3 kg a.i./ha (7.5 lit.)	Both foliar and Soil application during July-August.

## 125 Pests of Sugarcane

### White Grub

#### ► SYMPTOMS OF DAMAGE

- Both grub and adult cause the damage
- Grub feeds on fine rootlets and then girdles of the main roots .
- Yellowing and wilting of leaves and finally dries out
- Affected canes come off easily when pulled



### IPM for White grub

#### ► Cultural Methods

- Collection and destruction of adult beetles from host trees.



- ▶ Picking of grubs manually from field
- ▶ Repeated ploughing & exposing various stages of grub to their natural enemies.
- ▶ The use of light trap.

## Biological Methods

### ▶ Biological Methods

- ▶ *Bacillus popilliae* (Bacteria)
- ▶ *Beauveria bassiana* (Fungus)

## Chemical Methods

- ▶ The adult can be controlled by -
- ▶ Carbaryl 0.1%
- ▶ Monocrotophos 0.05%
- ▶ Chlorpyrifos 0.05% ▶ The grub can be controlled by - ▶ Phorate 10 G @25 kg per ha.
- ▶ Carbofuran 3G @35 kg per ha.

## 126 Pests of Sugarcane

### Termite

#### ▶ SYMPTOMS OF DAMAGE

- ▶ They enter through cut ends of setts & feed on the soft tissue.
- ▶ The tunnel is filled with the soil.
- ▶ The termites attack setts, shoots, canes and also stubbles ▶ Entire shoot dries up and can be pulled out easily



### IPM for Termite

- ▶ The use of partially decomposed manure should be avoided
- ▶ Locate and destroy the termite colony near by field
- ▶ Irrigation water with crude oil emulsion.
- ▶ The removal of decaying organic matters cow dung, wood or dry stubbles from the field

- ▶ Setts treatment with Imidacloprid (0.1%) or Chlorpyrifos 20 EC 0.04 % for 5 min.
- ▶ Application of well rotten Neem cake manure @ 60 Cartloads/ ha.
- ▶ Spray Chlorpyrifos 20%EC 750 ml/ha

## Sugarcane Leaf Hopper

### ▶ SYMPTOMS OF DAMAGE

- ▶ Adults and the nymphs suck leaf sap from the under surface of the lower leaves.
- ▶ Leaves become yellow, top leaves get dried up and lateral buds germinate
- ▶ Hoppers exude honeydew, result the leaves are completely covered by the sooty mould. This affects photosynthesis.



## IPM for leaf hopper

- ▶ Burn trashes after harvesting canes
- ▶ Remove lower leaves bearing egg cluster.
- ▶ Ratooning should be avoided
- ▶ Balance Nitrogen should be applied.
- ▶ Dust malathion 5% @ 40kg/ha. or
- ▶ Spray malathion 50 EC @ 1.25kg.a.i./ha.
- ▶ Release of 8,000-12,000 cocoons or 3.2 to 4 lakh eggs of *Epiricania melanoleuca* per ha. during July-August
- ▶ Use *Metarhizium anisopliae* (fungal pathogen)



# 127 Pests of Sugarcane

## Sugarcane Scale

### ► SYMPTOMS OF DAMAGE

- Nymphs and adults feed by sucking the juice and cause shrivelling up and stunting of canes
- Nodal region is more infested than internodal region
- Infested crop losses its vigor, canes shrivel, non-opening of leaves & ultimately cane dries up
- Such canes when slit open appear brownish red



## IPM for Sugarcane Scale

- Stripping of cane leaves may minimize attack
- Select and plant the scale insect free setts
- Avoid water stagnation for the longer period
- Detrash the crop at 150th and 210th day of planting.
- Give hot water treatment before planting
- Presoak the setts in 0.1% solution Malathion 50 EC
- Spray 1.25 liters of Malathion 50 EC or 2 litres of Di-methoate 30 EC in 1250 liters of water per ha
- Spray methyl demeton 25 EC @ 2ml/lit of water

## Sugarcane Mealy Bug

### ► SYMPTOMS OF DAMAGE

- Nymph and adult suck juice from cane in group & reduces vigour of the plant
- It also attack roots
- Honey dew secretion leads to development of Sooty mould which gives blackish appearance to canes.





- ▶ **3-Rice Ear-head Bug**, *Leptocorisa oratorius* (Hemiptera: Alydidae)
- ▶ **4-Rice Hispa**, *Dicladispa armigera* (Coleoptera: Chrysomelidae)
- ▶ **5-Rice Grasshopper**, *Hieroglyphus banian* (Orthoptera: Acrididae)

### 1. Brown Plant hopper

2. It is most destructive pest
3. Both nymph and adult feed on paddy, sugarcane and grasses by sucking cell sap



### Symptoms of Damage

- ▶ Both nymph and adults cause damage by sucking cell sap from the leaves which turn yellow.
- ▶ A heavy infestation produce symptoms of “**hopper burn**” i.e. leaves become dry and brown after insect feeding and patches of burned plants are often lodged.

## 130 INSECT PESTS OF RICE

- ▶ It has been noticed that even at low infestation the tillering is adversely affected and there diminished vigor and decreases in plant height.
- ▶ Under the favorable condition of high humidity, optimum temperature, high nitrogen application and no wind the population increases very rapidly.
- ▶ The insect is known to transmit the grassy stunt virus disease of rice.



### Management

- ▶ Avoid closer spacing of planting

- ▶ Alternate drying and wetting the fields during peak infestation and draining out the standing water from the field 2-3 times
- ▶ Alleys 30 cm wide after every 3 meters of rice planting provide proper aeration to the crop which ultimately restricts the multiplication of the pest
- ▶ Grow resistant varieties IR26, IR36, IR56, IR64, & IR72
- ▶ Spray at economic threshold 5-10 insects per hill, 100 ml imidachloroprid or 625 g of Carbaryl 50WP or 2.0 lit of Quinalphos 25EC in 250 liter of water and repeat if hopper population is persist

## 131 INSECT PESTS OF RICE

### 2. Yellow Rice Stem Borer

- ▶ The yellow stem borer is a specific pest of rice
- ▶ The caterpillar alone are destructive, when full grown, they measure about 20mm and are dirty white or greenish yellow having brown head and pronotum



#### Symptoms of Damage

- ▶ The larval feeding damage may cause death of the central leaf whorl at the vegetative stage, which is known as **dead heart**.
- ▶ Damage at the reproductive stage causes ear devoid of grain, which is known as **white head**.

#### Management

- ▶ The removal and destruction of stubble at the time of the first ploughing after harvesting the crop
- ▶ Ploughing and flooding the field is also effective in killing the larvae
- ▶ Clipping of tips of seedling before transplanting can reduce the carryover of eggs to the field.
- ▶ Use trichocard with 50,000-1,00,000 *Trichogramma* per ha after 3-4 weeks
- ▶ The field showing more than 5% dead hearts should be sprayed 25kg of Cartap hydrochloride 4G or 15 kg of Fipronil 0.3 G per ha in standing water in the field.

## 132 INSECT PESTS OF RICE

### 3. Rice ear- head bug

- ▶ The adult of *Leptocoris oratorius* is green, light brown or mixed yellow in color ▶

The adult are slender and about 20mm long.



### Symptoms of Damage

- ▶ The pest is essentially diurnal with highest activities in the morning and in the evening, seeking shelter during hotter parts of day
- ▶ Many generation are completed in a year
- ▶ Sucking of the grain sap causes empty or partially filled and chaffy grains and enhances subsequent fungal and bacterial infection
- ▶ Adult and nymph both suck the sap of developing rice grains at the milking stage and cause considerable yield loss

### Management

- ▶ The population can be suppressed by killing the bug by using light traps
- ▶ Collection of adult bug using net
- ▶ Destroy weed to remove alternate host
- ▶ Keep on hanging the cattle urine soaked gunny bags or cow dung wrapped cloth in the field to attract the bug.
- ▶ Synchronize rice planting to maintain simultaneous crop maturity in the field in an area for equal distribution of bugs in all fields
- ▶ Conserve predator of rice bug like tiger beetle, *Cicindela sexpunctata* by using chemical pesticide judiciously
- ▶ Spray after at least 10 bug per 100 panicles with pesticide like carbaryl (Carbaryl 5% dust@25kg/ha)
- ▶ Spray Fenvalerate 20 EC 0.5ml/liter of water

## 133 INSECT PESTS OF RICE

### 4. Rice Hispa

- ▶ The adult is a small bluish black beetle
- ▶ Measuring 5mm in length and is recognized by numerous short spines on the body, which give it a characteristic appearance



### Symptoms of Damage

- ▶ Larvae cause damage like leafminer
- ▶ The adults also feed on green matter and produce parallel whitish streaks on the leaves
- ▶ The damage starts in nurseries and spread to the rice fields.

### Management

- ▶ Clipping the infested leaf tip during transplanting
- ▶ Nursery bed is flooded and damaged beetles flooded in water
- ▶ Spray start at economic threshold level(1 adult per hill)
- ▶ Spray 2-5 liter Chlorpyrifos 20EC or 2.0 lit of Quinalphos 25 EC in 250 liter of water per ha and repeat spray after 2 weeks if attack continue

## 134 INSECT PESTS OF RICE

### 5. Rice Grass hopper

- ▶ Various species of grasshopper are widely distributed in Nepal
- ▶ They are polyphagous and feed on leaves of rice, maize, millets, sugarcane, grasses etc



### Symptoms of Damage

- ▶ Both adult and Nymph cause damage causing defoliating

### Management

- ▶ Fish cum Rice farming
- ▶ Larva of the banded blister beetle (*Mylabris phalerata*) attack the eggs of the rice grasshopper
- ▶ Trimming the bund and field sanitation reduces the grasshopper population
- ▶ Spray chlorpyrifos 2.5 lit Chlorpyrifos 20EC in 250 liter of water per ha.



