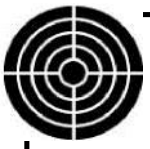
LESSON TEN: HOMOPTERA

10.1 Introduction

Order Homoptera include aphids, whitefly, scales, leafhoppers, and mealybugs. They are plant-sucking, and many excrete honeydew, a liquid high in sugar, which attracts ants and is used as a substrate for sooty mold fungus, which interferes with plant photosynthesis. Some are soft bodied, slow moving, or sedentary, forming colonies with wingless forms. Others are active. Adults have wings held roof-like over the body; the antennae are often short and bristle-like (as with leafhoppers). With sucking piercing mouthparts, many are vectors of plant viruses.Some secrete molted skins or a waxy, powdery substance that covers the body. Many are spread by the wind or carried by ants that feed on the honeydew and protect the insects from natural enemies.

10.2 Lesson Objectives



At the end of the lesson the students will be able to

1. Identify insect pest in the order homoptera
2. Describe their biology

10.3 Family *Aphididae*

Figure 7: Aphids

10.3.1 Cabbage aphid (brevicoryne brassicae)

Common name; cabbage aphid
Scientific name: *brevicoryne brassicae*
Host crops: it's a serious pest of the cruciferae grup (cauliflower, sukuma wiki, cabbage, broccoli, Brussels sprout)

Damage
Feeding prevalence is on young succulent growth. Heavy attack on young plants can check their growth beyond recovery. Attacked plants are characterized by contamination with caste skins, honey dew and fungal growth leading to loss in market value. It's a pest that sucks sap from the plant and a vector of viruses.

Biology
Cabbage aphids live in colonies thus forming clusters when feeding. Sexual forms are produced either by winged or wingless forms. Winged females are most commonly encountered. They are greenish in color covered by white mealy powder. Male cabbage aphids have not been encountered in the tropics and consequently one is not expected to see eggs in this species. Normally the aphids are wingless (apterous) but up on experiencing pressure due to large numbers and limited food resources due to competition, they develop wings (pterous) and fl to other crops where they are attached and develop new colonies.

Figure 8. Cabbage infested by aphids

Life cycle

A single wingless female produces 2-3 daughters a day. The daughters reach maturity after 8-10 days after which they remain productive for about 15 days. They have a post reproductive period of about 2-3 days. The rate of reproduction is high in aphids and intense colonization of host plants occur within a short period of time. The mortality rate of females increases after completion of reproduction.

Control

Use of chemicals such as Dimethoate, Diazinon, Pyrethrin, Formothion, Ambush etc.

10.3.2 Green peach aphid *Myzus periscae*

- Common name: Green peach aphid
- Scientific name: *Myzus periscae* Sulzer
- Host crops: it feeds on hundreds of host plants in over 40 plant families. Vegetables in the families' solanaceae, chenopodiaceae, compositae, cruciferae and curcubitaceae.
- Vegetables include; artichoke, asparagus, bean, beets, broccoli, Brussels sprout, cabbage, carrot, cauliflower, cantaloupe, celery, corn, cucumber, fennel, kale, kohlrabi, turnip, eggplant, lettuce, mustard, okra, parsley, parsnip, pea, pepper, potato, radish, spinach, squash, tomato, turnip, watercress and melon.
- Field crops such as tobacco, sugar beet and sunflower are also attacked.
- Numerous flower crops and other ornamental plants are suitable for green peach aphid development. Stone fruit crops such as peach are sometimes damaged before the aphids leave for summer hosts.

Figure 9. Peach leaf infestation by aphids

Damage

- High densities on young plant tissue, causes water stress, wilting, and reduced growth rate of the plant.
- Prolonged aphid infestation causes appreciable reduction in yield of root crops and foliage crops.
- Contamination of harvestable plant material with aphids, or with aphid honey dew, also causes loss.
- Blemishes to the plant tissue, usually in the form of yellow spots, may result from aphid feeding.
- Leaf distortions are not common except on the primary host.

Life cycle

Eggs

Eggs are deposited on *prunus spp* trees. The eggs measure about 0.6mm long and 0.3mm wide, and are elliptical in shape. Eggs are initially yellow and green, but soon turn black. Mortality rate of the eggs sometimes is quite high.

Nymphs

Nymphs initially are greenish, but soon turn yellowish, greatly resembling viviparous (parthogenetic nymph-producing) adults. They undergo 4 instars with the duration of each averaging 8 days. Females give birth to offspring 6-17 days after birth. The length of reproduction varied considerably, but averaged 14.8 days. The average length of life was about 23 days, but this was under caged conditions where predators were excluded. The daily rate of reproduction averaged 1.6 nymphs per female. The aphids have a mean reproductive period of 20 days, mean total longevity of 41 days, and a mean fecundity of 75 offspring.

Adults

Winged aphids have black head and thorax, and a yellowish abdomen with a large dark part dorsally. They measure 1.8 to 2.1mm in length. Winged green peach aphids seemingly attempt to colonize nearly all plants available. They often deposit a few young and again take flight. This highly dispersive nature contributes significantly to their effectiveness as vectors of plant viruses.

Control

Aphids can be controlled by use of;

- Natural enemies such as lady beetles (coleopteran: coccinellidae), flower flies (Diptera: Syrphidae), lacewings (Neuroptera: mainly Chrysopidae), parasitic wasps (Hymenoptera: braconidae) and entomopathogenic fungi (mainly Entomophthorales). Most are general predators, moving freely among green peach aphid, other aphids and even other insects.
- The ephemeral nature of aphid infestation in many crops is believed to prevent the beneficial organisms from consistently locating the aphids and reproducing in a timely manner. Nevertheless, there is a strong association between the high aphid densities and sudden population decrease following the appearance of lady beetles, wasp parasitoids, or entomopathogenic fungi. For example, green peach aphid infesting spring- harvested spinach crops in Arkansas and Oklahoma is suppressed late in the growing season by *Erynia neoaphidis* fungus. Unfortunately, the disease is epizootic often occurs too late to keep aphids from attaining high numbers, and fungus-infected aphids remain attached to foliage, providing a serious contaminant of spinach foliage (McLeod et al. 1998). Various

studies that selectively excluded or killed beneficial organisms have demonstrated the explosive reproductive potential of these aphids in the absence of biological control agents, thus demonstrating their value in reducing damage potential. In greenhouse crops, where environmental conditions and predator, parasitoid and pathogen densities can be manipulated, biological suppression is more effective and consistent.

- Use of parasitoids such as *aphidoletes semiflavus* Howard (Hymenoptera: Encyrtidae) and *Diaeretiella rapae* (mcintosh) (Hymenoptera: Braconidae)
- Use of pesticides
- Predatory midge aphidoletes aphidimyza (diptra: Cecidomyiidae) for greenhouse grown vegetables, especially in Europe (Gilkeson and Hill 1987, Milner and Lutton 1986)
- Cultural manipulations may benefit predators and parasitoids
- Cultural practices
- Among the natural enemies of the *M. periscae* areboth predators and parasitoids, including;
    - Beetles such as the ladybirds the two spotted ladybird (*Adalia bipunctata)*
    - Seven spotted ladybird (*Coccinella septempunctata*)
    - Ten spotted ladybird (*Adalia decempunctata*)
    - True bugs such as the *anthocorids*
    - Pirate bugs of the genera *Orius* and *Anthocoris*
    - Neuropterans such as the green lacewings of the genera *Chrysopa* and *Chrysoperla,* hoverflies such as *Syrphus, Scaeva, Episyrphus.*
    - Gall midgets as *Aphidolestes*
    - Aphid parasitoids such as *Aphidius*, and parasitic wasps of the family *Braconidae*
    - They are also colonized and killed by insect pathogenic fungi of the order *Entomopthrolrales*.

10.3.3 Bean aphids *Aphis fabae*

Common name: bean aphids
Scientific name: *Aphis fabae*
Host crop: beans

Life cycle
Give birth to live nymphs and complete life cycle in 7 days. Found on the lower leaf surface, petioles, flowers and pods. The aphids are usually wingless but when they are under pressure due to large numbers in a colony, they develop wings and fly to other plants where they continue with their life cycle. They live in colonies and have a very short life cycle**.**

Damage
It is a serious pest of beans especially during the dry season. Aphids live in colonies.
They cause plants to get stunted, leaf curling and puffy leaves.
They transmit viral disease such as the common bean mosaic virus.
The aphids excrete sugars that lead to the development of the sooty mould that reduces the photosynthetic potential of the beans.

Control

1' Uproot infested plants and bury them
1' Overhead irrigation assists on reducing aphid populations
1' Use pesticides such as dimethoate, formothiom, diazinon, ambush, pyrethrum, endosulfan.

Figure 10. *Aphis fabae* on bean pod

10.3.4 Potato aphid (*Aulocorthum solani)*

- Common name:Potato aphid
- Scientific name: *Aulocorthum solani* (Kaltenbach)
- Host crop: potato

Life cycle
The female gives rise to young ones. They live in colonies mainly on the underside of the leaves. They are pale green in colour and have conscipicuous cornicles on the abdomen. They may be winged or wingless. Both forms produce pale green nymphs. One generation takes about 2 weeks under favourable conditions.

Damage

- It is a sporadically serious pest of potatoes in the field.Like other aphids they feed by piercing and sucking sap from the young shoot and on the underside of the leaves.
- Infested leaves maybe distorted and may have a yellowish appearance.
- Necrotic spots,veined necrosis along the vein on the underside spreading of numerous necrotic to petioles and reaches the main stem.Leaves ma become complexly necrotic and die prematurel and remain hanging to the stem
- Top most leaves remain green in appearance. Infested plants are greatlystunted with short internodes,have bristles leaves
- The pest transmits 14 varieties of virus which causes leaf roll. **Control +** Control oxychloride (ridomil) for the virus diseases

+ Dimethoate,Formothion,pyrethrum,menazon

10.3.5 Cotton aphid

+ Common name: cotton aphid
+ Scientific name: *Aphis gossypii* Glover
+ Host crop: Cotton +
Alternative hosts:

Biology and life cycle
Outbreaks are common on young plant in spells of dry weather which clears up rapidly with the onset of rain. Plants may be badly damaged during aphid attack. The aphids vary in size from 2-5mm. Their reproduce very fast pathenogenetically and a single female reproduce 2 or 3young ones every day up to a total of 100 or more. The aphids mature in 7 days and may live for 2-3weeks

Cotton aphids

Cotton infested with aphids

Figure 11. Cotton Aphids and cotton plant infested by aphids

Damage
Their feeding mechanism (sap sucking) has an effect n the growth of the plants. They have the ability to transmit viral diseases (virus mosaic and leaf curl virus). The aphids secrete wax to keep the insect dry and repel enemies. They produce honey dew fro which saprophytic fungi develop.
Symptoms of the viral disease include
+ Twisted elongated barren plants
+ Dwarfed and curled leaves
+ Vein clearing and necrosis
+ Progressively smaller curled leaves and flowers

Control
The pests can be controlled by using the following insecticides
+ Malathion and Dimethoate

10.3.6 Maize Aphids

Common name: Maize aphid
Scientific name:*Rhopalosiphum maidis* Fitch
Host crop:Maize
Alternative host:Sorghum,millet, sugar cane, wheat and on numerous associated wild hosts

Damage
The aphids are common and serious pest of maize. Young plants are most at risk. Aphids build up large numbers in colonies, on leaves and tassels. The plant become distorted, chlorotic and stuted. Heavily infested tassels may become sterile. Honey dew secreted by the aphids encourages growth of sooty moulds and cover the seeds in astrictly residue which makes processing difficult. These aphids transmit virus diseases of maize, such as leaf fleck and sugar cane mosaic

Life cycle
Aphids reproduce asexually (pathogenesis). Pathenogenic females give birth to living young and a generation can be completed in 8 days. They reproduce continuously throughout the year The aphids varying colour from yellow green to dark blue_green. They may also be covered with a thin layer of white wax or shed skins. Both winged and wingless forms may be found on the same plant

Figure 12: Maize aphids

Control

- Vigorous plants are usually tolerant of aphids attack
- Natural enemies may provide sufficient control and should be encouraged
- Very heavy infestations may be controlled by applying an aphicides, such as pirimcarb or a systemic general insecticide such as dimethoate

10.4 White fly *(Aleyrodidae)*

- Common name: White flies
- Scientific name: *Bemisia tabaci* Pargande
- **Host plants:** The pest has been recorded from more than 600 plants species. Crops that support large numbers of whitefly include cotton, okra, cabbage and other Brassica crops, cucumber, sesame, beans, peanuts, sweet potato and cassava.
- It attacks cut-flowers such as Poinsettia, African daisy, roses carnations and morbydisk. It also infests ornamentals plants such as euphorbia, hibiscus, lantana and chrysanthemum.
- Fruits such as grape, citrus, taro, pawpaw, lettuce and frangipani also harbor whiteflies.
- Weeds such as mustards (Brassica), *Ipomoea* spp. And nightshade.
- Large number of alternative host plants makes it difficult to control the pest.

Biology
Whiteflies are tiny, the adult resemble white moths and the adults have white wings and yellow body. The immature stages look like scale insects, adults' wings are covered with a white, waxy powder, making them difficult to wet. The adults are about 1mm long and appear as narrow white wedge-shaped insects. When an infested crop is tapped these tiny insects can be seen to flutter out and rapidly resettle. The common species is *Bemisia tabaci.*

Life cycle
The females lay eggs on the undersides of young leaves. The eggs are white at first but turn brown before hatching. The larval or immature stages are greenish white, scale like and oval in outline. The pupal or resting stage is yellow, slightly pointed at one end and 1-2mm long. The life cycle takes 18days depending in temperatures. Upon emergence, the adult whiteflies remain on the leaf for several hours as they coat themselves with wax. The adults can live for about 60 days. Whiteflies can fly for several hours and wind assistance can traverse long distances. A female can lay up to 160 eggs during its life cycle.

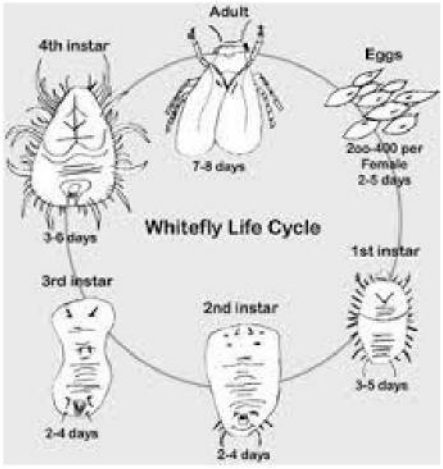



Figure 13: Life stages of a whitefly and damage on tomato

Damage

- Adult stages are the most damaging stages. Whitefly adults and immature stages suck sap, causing plants to collapse. With high populations plants may die.
- Presence of sooty mould and infestation of high value crops affects their marketability.
- The pests produce copious honeydew that leads to growth of sooty mould. He produce may look unsightly and the mould can reduce rate of photosynthesis of infested plants.
- The damage can results from toxins produced by the feeding activities of feeding of immature insects.
- Cucurbit species, squash, zucchini and butternut can develop a silvering of the leaves along the upper surface known as squash silver leaf and also a whitening of the leaf stalks and stems. The silver leaf starts as a lightening of the veins of new foliage growth.
- Infestation on tomatoes causes blotchinesss or irregular ripening rendering them unmarketable. Feeding activities of the immature stages of broccoli and other brassicas result in development of a phytoxic disorder called "white streaking**".**
- The pests also transmit several viruses including strains of tomato yellow leaf curl virus and tomato mottle virus. Worldwide, whitefly is capable of transmitting viruses that cause more than 40 crop diseases**.**

Symptoms

- Feeding of whiteflies causes yellowing of infested leaves.
- Whiteflies excrete honeydew, a clear, sugary liquid. This honeydew covers the lower leaves and supports the growth of black sooty moulds, which may coat the entire plant.
- Where plant viruses are transmitted, plants show the typical symptoms of the virus diseases.
- Presence of whiteflies can also be recognized by a cloud of tiny whiteflies flying up when the plants are shaken. The whiteflies resettle soon on the plants.
- The affected stages include; seedling, vegetative growing and flowering stage where the leaves gets affected.

Whitefly detection

There are many ways that the insect may be detected;

- The pest can be detected either as the fluttering adults or as the immature scale-like insects on the underside of older leaves.
- When whitefly insects are observed building-up on alternative host plants.
- Another good indication of the presence of whitefly is the silver leaf appearance on the upper leaf surface. Farmers need to note that only a few immature stages are necessary to cause the silver leaf reaction.
- Any sudden build-up of small whitish fluttering insects on plants should be investigated as a possible infestation.

Management and control

There are very few insecticides registered which will give effective control of whitefly and every effort should be made to prevent the infestation of crops by whitefly. Scout for presence of adults or the scale-like immature stages on the underside of the leaves. Use insecticides such as insect growth regulators, insecticidal (potassium) soaps, petroleum and vegetable oils.

Cultural practices

Monitoring and decision making

- For early detection, inspect for adults and eggs. They are usually found on young leaves. It is important to identify the whitefly and the type of damage caused, as well as the stage of the crop for making decision. Small numbers of whiteflies do not cause major direct plant damage to healthy, mature plants and therefore do not justify any chemical interventions.
- Control measures can be justified if large numbers of whiteflies are present during the early stages of the crop. However, where virus transmission is involved, as in the case of tobacco whitefly on tomatoes, sweet potato or cassava, even smaller numbers of whiteflies need to be controlled
- Yellow sticky traps can be used to monitor the presence of whiteflies for the timing of interventions

Providing conditions for growing healthy plants

- Ensure adequate growing conditions for the crop such as good soils, adequate water supply, proper feeding (avoid application of high dose of nitrogen fertilizer, since it favours development of the pest), proper spacing and good nursery management to start the crops with healthy, vigorous plants.

Mixed cropping systems

- Intercropping can be used to manage whitefly populations. For instance, intercropping tomatoes with capsicum or cucumber reduces whitefly numbers when compared to tomatoes alone or tomatoes planted with eggplant or okra.
- Planting of border rows with coriander, which is non host of *B. tabaci*, serves as windbreaks, and are favorable for natural enemies and also whitefly repellants.
- Growing African marigold discourages whiteflies.

Planting date

Avoid the season when whiteflies are more likely to occur.

Host plant resistance

- Growing resistant varieties is particularly useful for management of diseases caused by viruses transmitted by whiteflies.
- Tomato varieties resistant to tomato yellow leaf curl (TYLC) virus are available and can be bought in Tanzania and Kenya.

Weeding

Weeds play an important role in harbouring whiteflies between crop plantings. They also often harbor whitefly transmitted viruses. Therefore, weeds should be removed in advance of planting. Fields should also be kept weed free.

Biological pest control

Natural enemies

- Use of natural enemies such as parasitic wasps *Eretmocerus spp*, predatory mites *Amblyseius spp* and *Typhlodromus spp*, predatory thrips, lacewings, rove beetles and ladybird beetles. The dusty lacewing *Conwentzia Africana* is considered to be one of the most important predators of ***B. tabaci*** in east and southern Africa.
- Parasitic wasps are very important for control of whiteflies. *Encarsia Formosa* in particular, has been widely used for control of whiteflies worldwide.
- Several fungi *verticillim lecanii, Beauveria bassiana, paecilomyces fumosoroseus* attack whiteflies and can be useful control agents in situations where the crop is grown in high humidity conditions. Commercial preparations are available.
- Natural enemies commercially available in Kenya include the parasitic wasp *Encarsia Formosa*, produced by Dudutech and pathogen *Beauveria bassiana* under the trade name Bbplus® by Juanco SPS Ltd.

Biopesticides

Neem (*Azadiracta indica)*

Neem based pesticides are reported to control young nymphs, inhibit growth and development of older nymphs, and reduce egg laying b adult whiteflies. They also reduce significantly the risk of transmission of TYLC virus.

Physical methods

- **Yellow sticky traps** are usually used to monitor the presence of whiteflies for timing of interventions, have also been used as a control method for low density infestations in enclosed environments.
- **Spraying with soap and water** reportedly controls whiteflies, however, care should be taken, since the use of strong soaps at high concentrations can scorch the plants.

10.5. Mealy bugs *(Pseudococcidae)*

Mealybugs are cottony looking insects with piercing/sucking mouthparts. They can be found on almost any part of the host plant including leaves, stems, roots and fruits. The pest affects different crops.

Figure 14: mealybugs

10.6 THE RED SPIDER MITES

Common species: *T. urticae* (two spotted spider mite), *T. evansi* (tobacco spider mite)

Tetranychus evansi Baker & Pitchard, is the most common in Africa and was introduced into southern Africa in the 1970s from Brazil, South America and spread northwards from zimbabwe, reaching Zambia, Malawi and Kenya. *T. urticae is* the second most important spider mite pest.

Common names

Red spider mite, two spotted spider mite, tobacco spider mite

Features

- Plant feeding mites found in dry environments and pest of field and greenhouse crops. Common in greenhouses and tropical temperate zones spinning a web on or under the leaves.
- Generally considered related to ticks, more distantly to spiders and scorpions.
- Are extremely small, visible with the naked eye as reddish or greenish spots on leaves and stems.
- Adults measure about 0.5mm and vary in colors.
- Red spider mites are extremely polyphagus, sucking hundreds of plants including most vegetables, food crops (peppers, tomatoes, potatoes, beans, corn, strawberries, ornamentals (roses etc), commercial crops (cotton), wild host plants include castor bean (*Ricinus communis*)

Biology and behavior

- They lay small, spherical, initially transparent eggs on the leaves. *T. evansii* lays 0.1mm eggs on the underside of leaves which hatch after 4-7 days into six-legged larvae (pinkish and slightly larger than the egg). This stage lasts 3-5 days.
- There are two nymphal stages, they have four pairs of legs and are reddish in color. The total nymphal stage lasts 6-10 days.
- Adult *T. evansii* females are oval, orange red with an indistinct red blotch on each side of the body and 0.5mm long. Males are smaller and straw to orange colored.
- *T. urticae* has a greenish brown appearance with two darker spots in summer, but as winter approaches it gains a strong color. Some populations are permanently greenish or reddish.
- The adult female may live for 7 days and lay up to 200 eggs.
- All active stages feed together on the lower sides of the leaves.
- Fertilized eggs produce diploid females. Mated females may avoid fertilization of some eggs to produce males. Unmated, unfertilized females still lay eggs that result in exclusively haploid males.

- Adults spin fine strands of web to form an open web above the leaf surface to help protect the colony from predators; hence the name 'spider mite'.
- Population build up is common in hot, dry conditions

Damage

- It poses a threat to host plants by sucking cell contents from the leaves cell by cell, leaving very tiny, pale spots or scars where the green epidermal cells have been destroyed. Feeding causes small yellow patches on the upper side of the leaf especially between the main veins, near the leaf stalk. Later, the affected area spreads, the whole plant turns yellow to bronze colored, then brown leaves, leaves are dropped and the plant eventually dies.
- Individual lesions are very small but since they attack in hundreds or thousands they cause thousands of lesions significantly reducing the photosynthetic capability of plants, greatly reducing their production of nutrients.
- Spider mites may also cause spots on fruits.'
- Can also spread plant viruses.
- The mites can spread by wind and experience learned that the infestation often starts on the outside (border rows) of a plot.
- Other adjacent (tomato) crops, wild plants and weeds can serve as source of infestation.
- The mites can also be spread passively by irrigation water, dust storms, clothing and implements.

CONTROL

Natural enemies

Include thrips (predators of eggs and mites), minute pirate bugs (Orius sp), big-eyed bugs and the entomopathogenic fungus *Neozygites floridana.*

Biological control

Done by predatory phtyoseid mites e.g. *Phytoseiulus persimilis* is the most used method in greenhouse cultivation because in nature there is usually a balance between pests and their natural enemies. When the natural enemies are not present the balance is disturbed and the pest can become a serious problem.

Botanicals

Such as neem and *Tephrosia sp* have been evaluated in Malawi, Zimbabwe and Kenya. Others tested include; chilli, garlic and soap extracts are used and a mixture of buttermilk and flour.

Cultural practices

Several cultural practices that can reduce the mite population such as regular scouting of the pest and level of infestation in an early stage for integrated pest management (IPM). Burning of infested crops can be successful during the early stages of infestation when the mites concentrate on a few crops. The separation of infected crops and newly planted crops or nursery areas and the burning or removal of infected crop residues and weeds also helps minimize the problem. Since mites favor dry and hot conditions, influencing the microclimate by reducing the planting distance and overhead irrigation can repress the mite populations. Avoidance of water and nutrient stress reduces mite populations. Applying mulch and incorporating organic matter into the soil can improve the water holding capacity and reduce evaporation, thus avoid water stress. Avoiding the hot summer months for tomato cultivation is useful. At the moment there are no resistant tomato varieties available**.**

Chemical control

It involves the use of specific miticides (acaricides) but care should be taken because some of the available systemic pesticides have show to increase red spider mite reproduction. Formulae and their cost-effectiveness are required. Some red spider mite species rapidly develop resistance against the commonly used pesticides and acaricides, hence rotation of acaricides with different chemical compositions is recommended. Weekly spraying should be done and at an early stage of infestation to be effective. Different acaricides specially designed for the control of red spider mites include sulphur, comite, bifenthrin and abamectin. These should be used as a last resort.

10.7 Hemiptera or Heteroptera

Order: Hemiptera

Family: Pentatomidae

True bugs have piercing and sucking mouthparts formed into a slender beak. Some are plant feeding, some are predatory. Green stinkbugs are pests in beans, tomato, cabbage and macadamia nut.

Black stinkbugs are small, rounde and shiny black with pale stripes; they are an occasional pest on beans and some other legumes. Lace bugs cause strippling of leaves similar to other sucking insects. Others bore into seeds. Assassin bugs are important predators of other insects.

10.7.1 Stink bug

Common name: stink bugs

Scientific name: *Nezara viridula*

They produce the evil-smelling defensive fluid that is associated with all bugs of this family. The bugs themselves are shades of green, and about 15mm by 8mm in dimensions. The long, piercing proboscis lies, when at rest, between the forelegs underneath the body. The nymphs are different from the adults, lacking the green wings. Their bodies are at first colored in a series of black, yellow and white dots, and they are more rounded in shape. Later they are more predominantly green, but still with the colored spots.

Figure 15. Images of stinkbugs

Host plants

Green stinkbugs are cosmopolitan insects, and have a wide host range. They feed on fruits, crops, vegetable and garden ornamentals, cotton, deciduous fruit, tomatoes, legumes, soyabeans and garden beans, wheat abd nut crops such as macadamia are amongst recorded hosts.

Damage

The bugs feed on developing fruit. Their feeding punctures cause local necrosis, presumably due to a toxin in their salivary juices, with resulting fruit spotting, deformation or even shedding, if inflicted early enough. Sharp indentations are quite commonly seen on still green peaches, and the bugs can inflict damage on soyabeans, causing discolouration of the developing seeds. Obviously the level of plant damage depends on the population level.

Life cycle

Begs are laid in batches of 50-60, stuck together in rafts on the underside of the leaves. They soon hatch into tiny first instar nymphs, which cluster by the eggs and do not feed. There are five instars, with the preferred food being developing seeds or fruit, until, after some eight weeks, the

bugs reach adulthood. After mating, they disperse and feed by piercing soft plant tissues and sucking the sap.

Control

Control of stinkbugs in a field crop is seldom necessary. Stinkbugs are sap- suckers, do not succumb rapidly to systemic insecticides, because their large size and short feeding period (often not in the main sap stream) probably mean that they do not pick up enough chemical. This means that stinkbugs must be controlled with a chemical that has contact properties such as;

- Monocrotophos
- Trichlorfon
- Carbaryl
- Synthetic pyrethroids
- Endosulfan

10.7.2 Cotton stainer

Order: Hemiptera/ Heteroptera
Family: Pyrrhocoridae Genus;
Dysdercus

Identification

They are brightly colored in black and red and reach 10-15mm in length. In general, they have reddish heads, reddish thorax and underside of the body, brownish-orange wings with a black transverse bar about halfway down and a black section at the distal end. They have long bent antennae, red legs and a strong beak projecting forward from the front of the head, with which they pierce the plant tissue. The nymphs, lacking the wings that hide their bodies, are usually recognized by their bright red color.

Stained cotton lint | Adult Cotton stainer | Immature cotton stainer

Figure 16. Stained cotton and cotton strainers.

Host plants

The main hosts are cotton and other Malvaceae, but are also found feeding more generally on the baobab fruits.

Damage

Cotton strainers are the most destructive cotton pest. They cause mechanical damage by inserting their long proboscis into developing bolls to feed on the seeds. They may render the seed sterile or at least reduce germination percentages by their feeding, but this would not be serious unless the crop was grown as a seed crop. They cause indirect damage by injecting spores of a fungus known as Nematospora. Leading to bolls dropped by the plants, or staining of the lint thus affecting their quality. Pale cotton strainers feed on developing and mature cotton seed. Seed weight, oil content and seed viability decline as a result of cotton stainer feeding. Loss of seed viability can be substantial so should be a careful consideration in pure seed crop. Staining of cotton lint has occurred as a result of feeding in young bolls. The bugs transmit a fungal pathogen during feeding causing a reddening of the lint.

Life cycle

After mating, during which adult remain coupled together for a few days, quite large orange hued oval eggs are laid singly or in small loose clusters or batches of up to 100 in moist soil or decaying vegetable matter. Further mating may take place and egg laying can continue for a couple of months. Hatching takes place after 5days at 27c and 8 days at 23c. There are five nymphal stages or instars, with the first remaining underground without feeding near the place they hatched. They do, however, require moisture to survive. After moulting, the second instar nyumphs go in search of seeds on or near the ground, still congregating to feed and moult. Later instars spread further a field hunting for fruits and seeds on which to feed. The duration of eachof the first four typically four to five days, but the fifth stage commonly takes twice as long. All five stages require from 21 to 35 days to complete. The total nymphal period takes about a month in warm temperature, but may be considerably longer towards the winter months. The nymphs are generally red. The fourth and fifth instars have dark wing pads, and the dividing lines between abdominal segments become very distinct as maturity is approached. The nymphs feed gregariously on the open cotton bolls near the ground. Later they wonder freely on the plant sucking sap from the seed and fruits. Adults are strong flyers and migrate to suitable hosts by this means. This adult is narrow, around 3/5 inch long, long legged, has a bright red thorax, and brown wings crossed with yellow. There is a pre-oviposition period of 5-14 days and the female may live for 70 days. On the plants, they have the habit of dropping to the ground when disturbed.

Control

A crop is not often sprayed specifically to control cotton strainers, as the normal bollworm spray programme of contact insecticides keep them under control. In small

plots they may be hand-picked or destroyed. Strict adherence to cotton crop destruction dates assists in keeping the pest numbers down between growing seasons. A range of natural enemies such as Tachinids (parasitic flies) and predatory bugs (e.g. assassin bug). However, they have mainly exerted pressure when cotton strainers have been feeding on native hosts rather than in cropping situations.
The pest can be controlled by

- Carbaryl
- Lindane
- BHC
- Fenthion
- Cotton dust

The pest in general can be controlled by;

- Close season
- Insecticide dusts
- Complete sprays
- Insecticide use
- Implements used
- Timing of application
- Variations in pest incidence

10.8 Coleoptera

The coleopteran (beetles and weevils) are the largest insects order, including pests and beneficial insects. The adults have a hardened, sometimes horny outer skeleton, usually with two pairs of wings, the outer pair thickened, leathery, or hard and brittle, usually meeting in a straight line down the middle, and the inner pair membraneous (mostly). Adults usually have a noticeable pair of antennae, variously shaped. Both adults and larvae have chewing mouthparts. Beetle larvae also known as grubs have a head capsule, 3 pairs of legs on the thorax, and no legs on the abdomen. Weevils' larvae lack legs on the thorax.

Foliage feeders, including Chinese rose beetles feed at night and heavy infestation causes lace-like appearance of leaves. Rose beetles are common and damage many different plants including; roses, grapes, beans, egg plant, corn, cucumber, ginger and ornamentals.

Tobacco flea beetles are tiny brown beetles whose feeding damage causes shot-hole appearance of leaves.

They are found on eggplant and tobacco. Stem borers include long horned beetle, whose adults have long antennae and larvae bore into stems and wood; pinhole borers that leave pin-hole in

branches, and wood; orchid weevils, whose larvae bore into orchid stem and tissue; black twig borers, whose adults bore through stems of coffee and other economical and ornamental plants and whose larvae feeds on fungus cultured by the adult female.

Root-borers include banana root borers, whose grubs bore into the banana corm causing damage and poor growth and sweet potato weevil, whose grubs feed inside the stems and tubers often followed by decay organisms. Fruit weevils include pepper weevils, the adults and grubs of which infest peppers and cause internal damage and premature drop, and mango seed weevil whose grubs bore into the seed, preventing fresh fruits to be exportable.

Household pests include confused flour beetle, rice weevil, cigarette beetle and carpet beetles; they may infest stored grain products and other household belongings.

Beneficial beetles include ladybird beetles, also called ladybugs which feed on homopteran insects such as aphids, scales, mealybugs, whiteflies, and psyllids, and scavenger beetles which help to remove carcasses from the environment.

10.8.1 Weevils

10.8.1.1 Cowpea weevils

Cowpea weevil *Apion pullus* is a major pest for cowpeas. The pest causes considerable damage on peas in coastal province on cowpea seeds and lower parts of machakos and kitui on green grams.

Damage

Actual damage by adults appears to be negligible except in the case of heavy infestation where the weevil can cause significant perforations in the young cowpea plants. The female cuts in the skin of the young developing pods and inserts her eggs through each cut. The cut normally heals over completely and become invisible to the naked eye. The incubation period lasts between 3-5 days.

Life stages

Larvae are the primary source of damage to the seeds. Upon emergence, the larvae eat their way to the young developing cowpea seeds. Growth of larva is rapid except with the last two Instars where there is no increment in body size. There are 4 larval instars. The larval stage lasts 9-1 days. The larval instar is quiescent (dormant) for 2-3 days before pupation occurs. The larva spends its entire cycle in the seed. Up to 15of the seed are destroyed. **Pupa** period ranges from 4-7days. Pupationoccurs within the pod and by the time the adult emerges, the cowpeas are fully mature and exist holes are conscicous on dry pods. The entire development period ranges from 13-18 days.

Cow pea weevil

Cow peas infested by weevils

Figure 17. Cow pea weevil and infested cow peas

Control

Since the weevil lays its eggs in the young developing pods, it is very important that the application of insecticides should be made immediately the plant initiates flower buds. It may also be nessary to have a second application of insecticides when there is 50% flowering. Later application will not be effective in controlling the pest.

Chemical

- Diazinon
- Ambush
- Malathion

10.8.1.2 Mango weevil Sternochetus mangiferae

The major problem associated with mango production in Kenya is infestation by mango weevil. The weevils damage the crop considerably by burrowing into the seeds. The weevils frequently affect the appearance of the fruit by causing the decay of the fruit from the seed outwards. Weevils' injury also hastens the ripening fruits to fall prematurely. The adult is dark brown measuring 6-8mm in length.

It usually emerges from the fruit after it has been harvested or fallen from the tree. The female makes a shallow depression with her ovipositor on the surface of the skin of the fruit in which she lays her eggs. She then produces brownish excrement from the ovipositor which completely covers the oviposition site. Using her mouth parts she punctures the skin of the fruit just above the oviposition site. The puncture results in a flow of sap which in time hardens or solidifies and covers the egg with a protective coating. NB. Only one egg is laid per oviposition site. There is a pre-oviposition period of 25 days and oviposition period of 75 days.

Figure 18. Mango beetles

One female adult may lay up to 190 eggs during her life cycle. The incubation period ranges from 4-8 days. The larva is a white grub with a brown head. The newly hatched larva bores throng the pulp of the fruit and into the developing seed where it feeds in the seed within the stone of the fruit.

The newly hatched larva feed by mining tunnels laterally in the soft testa of the seed. As the larva develops, it penetrates the testa and feeds on the cotyledon of the mango seeds. As it grow in size it feeds more vigorously and excrement accumulates and fills the parts of the seed which of the seed which the fruit which has been eaten. A fully developed larva constructs a pupal cell just before pupation. It then transforms to pupa in this cell. The minimum period required for the development of larva stage is 19-30 days. Pupal period lasts from 6-8days.

Control

It is difficult to control this weevil due to the fact that mango trees are very tall thus making it difficult to apply insecticides should be applied during flowering and fruit setting. Later application will not be effective because already hatched larvae will have penetrated the testa and migrated to the seed.

Chemicals

+ Diazinon +
Dimethoate

10.8.2 Beetles

10.8.2.1 Tobacco flea beetles

They are tiny brown beetles whose feeding damage causes shot-hole appearance of leaves. They are found on eggplant and tobacco. Stem bores include long-horned beetles, whose adults have antennae and larvae bore into stems, and wood; pinhole borers that leave pin-holes in branches, and wood; orchid weevils, whose larvae bore into orchid stem and tissue;

black twig borers, whose adults bore through stems of coffee and other economical and ornamental plants and whose larvae feed on fungus cultured by the adult female.

10.9 Diptera

The dipteral (flies, fruit flies, leafminers,and midges) adults have only one pair of wings and have sucking mouthparts that may be modified. Their larvae are called maggots,are legless,and may lack a well defined head capsule, with only hook-like mouthparts. The order is importantin medical and veterinary entomology and include fruit flies, mosquito, house flies, horse flies and blow flies.

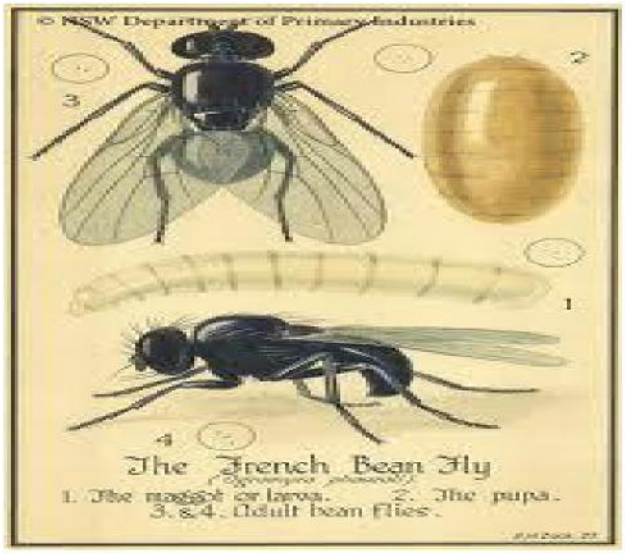
10.9.1 Bean fly Ophiomyia phaseoli

This is a serious pest all over Kenya. Attacks wide range of legumes.
Egg. Slender white eggs about 1mm long. Laid singly in holes made on the upper surface of the young especially at the end nearest to the petiole or on the midrib. They hatch in 3-5 days.

Larva. small white grub or maggot which burrows down inside the stem where it feeds just above the ground level. In older plants the maggots does not move all the way down the plant. Instead it migrates to the base of the petiole where it settles down and feeds.the petioles become swollen and usually have light yellow or brown colour in appearance. The leaves often turns yellow giving a plant a droughtly appearance. The stem usually longitudinal cracks.

Pupa. Pupation takes place near the surface of the stem where the larvae have been feeding. The pupae are pupae are barrel shaped and are black or dark brown. They are about 3mm long.

Adult is a shiny black measuring about 2mm long. The total life history takes about 2-3 weeks.



Lifecycle of bean fly

Bean fly on bean leaf

Leaf damage by bean fly

Figure 19. Bean fly lifecycle and damage on leaves

Damaged bean plant

The damaged plant has both destroyed stem and phloem tissues. Xylem tissues conduct dissolvedsalts and also provide mechanical support for the plant. Dissolved salts and organic materials are transported in the plant sap. Destruction of xylem and phloem tissues implies that plant sap will not be transported to the plant parts. This will in turn interfere with the plants growth. Leaves are very important organs of the plant and if destroyed especially at the base where the bean fly larvae concentrateon their feeding of leave petiole this will interfere with plant growth. The bases of the stem become thickened and cracked, many plants will die while other become stunted and yellow. Damaged can be prevented by seed dressing with aldrin and dieldrin. Early planting, crop rotation and removal of crop residues and volunteer plants are usually cultural protections

Symptom include

+ Yellow stunted young plants +
Dead young seedlings
+ Thickened and cracked stem just above the soil level

Control

+ Diazinon
+ Trichlophan
+ Fenthion

10.9.2 Potato tuber moth *Phythorimae operculella*

The pest attacks wide range of crops including tobacco, tomato and Solanaceae family. Infestations arise in the field and continue during storage of tubers. There is a serious risk of transportation from one area to another or from one country through infested tubers.

Eggs are laid on the underside of the leaf or in the tubers around the eye. Females may lays between 150-250 eggs during her lifespan. Incubation period last 3-5 days.

Larvae. Up to hatching the 1st instar larva bore into the leaf where they make mines. The caterpillar is greenish in colour. The attacked leaves have silvery blotched caused by the young larvae which mines in the leaves, left veins and petioles and stems. The mines increase in size as they approach the base of the stem. This is followed by wilting of the plants and plants become affected by fungi or bacteria. In tobacco the mined leaves have blotches and become unusable or the grade of the crop is lowered. Full grown caterpillars vary in size ranging from between 8-10mm. larval period lasts 9-26 days. The larvae may fasten two leaves and then feed between them. In tubers the larvae makes black tunnels which are generally filled with faeces.

Pupation. Takes place in the cocoon at the surface of the litter or just under the surface of the tuber.

Pupa Period lasts between 6-26 days.

Adult are short lived and have wingspan of about 15mm. one generation takes 3-4 weeks and there can be up to 12 generation in a year depending on the weather.

Control

Cultural control- Plant potato deeply in the soils. Harvest potatoes early in the morning because the pest lays eggs last in the afternoon. Potatoes in the field should be covered with soil to prevent the moth from laying eggs on them.

Chemical insecticides should be applied after every 14 days after the mines have been spotted on the leaves. Use the following insecticides.

+ Dicrotophos
+ Dimethoate
+ Malathion +
Fenitrothion +
Thiodan

10.9.3. Fruit flies

Tephritid fruit flies at present include four economically important species in Hawii:
Mediterranean fruit fly,Oriental fruit fly, melon fly, and solanaceous fruit fly. The maggots infest fruit and fruiting vegetables and thus prevent many fruit and vegetables from being exportable without disinfestations treatment.

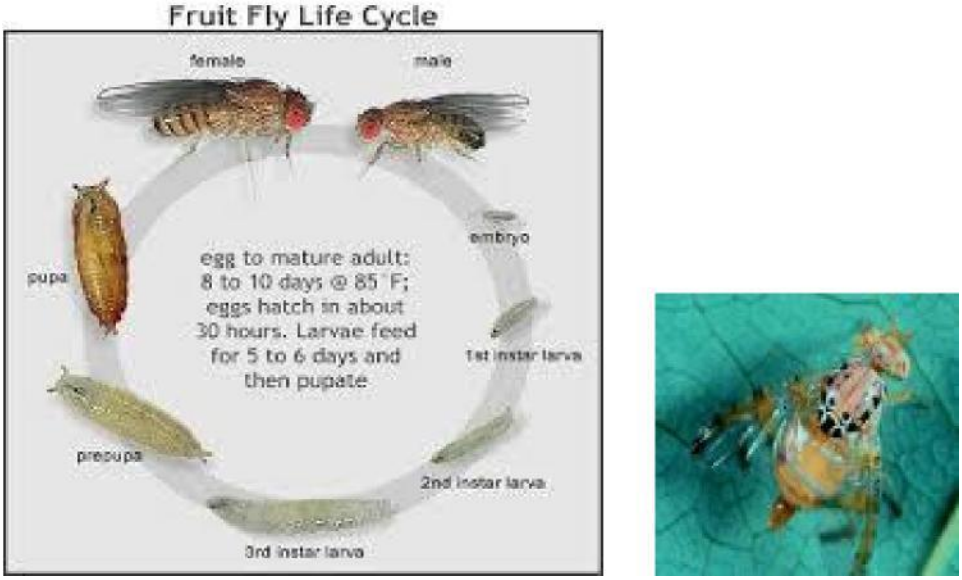


Figure 20. Life stages of fruit fly and a mature fruit fly

10.9.4. Leaf miners

Leafminer ,*Liriomyza* spp

Leafminers are important agricultural pest. Two species of leaf miners have been introduced in Kenya. They include *Liriomyza trifolii* and *L. huidobrensis.* The adults are small measuring less than 2mm in length, the head is yellow with red eyes, thorax and abdomen and mostly gray and black although ventral surface and legs are yellow. *Liriomyza. Trifolii* is smaller than *L. huidobrensis*

Leaf miner larva

Adult Leaf miner

mines on leaf

Figure 21. Leaf miner and damage on leaf

The small adults lay eggs on plant tissues and the larvae bore into the tissues and create tunnels or mines. The tiny white eggs are inserted into upper surface of the leaf, which hatch into the larva in 2-7 days. The larva undergoes three instar stages and takes 4-7 days to fully develop. The larva are legless, white to yellow (2mm long), with dark a head. Pupae are golden brown darken with time. Pupal stage last 7-14 days and it is found in the ground beneath the host plant. Adults live for 15-30 days, female take longer than males.

Damage

The pest feed on the oviposition puncture, the larva mines the leaves .Extensive mining may cause premature leaf drop. Wounding of the foliage by larva allow entry of bacterial and fungal diseases

Detection: the leaf miner may be detected by the following

1. Adults are detected flying closely around infected plants
2. Presences of feeding miners
3. Feeding punctures of epidermis of the leaves
4. Presence of leaf miners with frass
5. Larvae at the end of the mine
6. Puparia on the ground beneath the plant
7. Use of sticky traps

Host plants

Leaf miners are Polyphagus. Their host plants include vegetables, ornamentals, legumes, flowers (roses, carnations and chrysanthemums), and fruits. They are major pests of grasshouses and protected cultivation. Leafminer attack numerous ornamental and vegetable crop plus many native species.

Management and control

Cultural control: Destruction of weeds, deep plowing of crop residues, Gamma irradiation of eggs and 1st larvae stages, remove or burn infested leaves, avoid planting alternate crops around nurseries or fields.

Biological control: Mass rearing of the parasitoid *Diglyphus isae*, which control the insect pest.

Pesticide control: Pyrethroids are effective in control of leaf miners. However some strains are resistant to most insecticides. Other pesticides that can be used to control the pest include imidacloprid, cyromazine and diflubenzuron (Insect Growth Regulator).

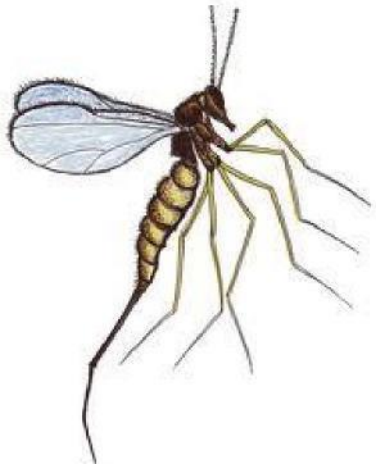
It is advisable to practice rotation among the classes of insecticides to delay the pest from developing resistance. Reduce the dosage level and frequency of insecticide application in pest control. Use of Bacillus thuringiensis is recommended for control of lepidopteran pests as it allow survival of the leaf miner parasitoids.

10.9.5 Midge

Midge adults are small, delicate, gnat-like flies. Midge pest include mango blossom midge, chrysanthemum gall midge, and a blossom midge on pikake, plumeria, and orchids.

Beneficial flies include parasitic flies like the tachinid flies and predators like the syrphid fly larvae and aphid flies; others are important as scavengers.

Sorghum midge



Mango midge

Leaf galls caused by midge

Figure 22. Midge species and their damage on mango leaf

10.11. Lepidoptera

Lepidoptera (butterflies and moths) have a caterpillar (larval) stage that causes the most damage by chewing and boring, while the adult, fruit piercing moth may be a pest on some ripe fruits. Most adult Lepidoptera have long, siphoning, tube like mouthparts to feed on plant nectar. Larval (caterpillar) stages have chewing mouthparts; most have three pairs of thoracic legs and five or less pairs of abdominal prologs. Most larvae feed on leaves by leaf mining or bore into stems and fruits. Some Lepidoptera have successfully used to control weeds, such as some cactus species. Some pupae forms are distinctive of the species or family.

10.11.1 Moths

The adults are active at night and often are attracted to light. Moths include common pest such as

Armyworm

Cabbage looper

Cutworm

Diamondback moth

American bollworm

10.11.1.1 Diamondback bollworm

Diamondblack moth plutellaxyloatellaL, is a major pest of the Brassica family of all species and a wide range of wild range of wild and cultivated cruciferae plants.

Eggs are usually laid on the upper leaf surface singly or in groups. The newly hatched larvae caterpillars crawl to the underside of the leaf and penetrate the epidermis and during the 1st instar they mine in the leaf tissues and feeds on the leaf. The 3rd instar feed on the underside of the leaf making large holes right through the leaf, leaving a windowing effect.

Plant leaf infested by diamondback bollworm

Adult moth

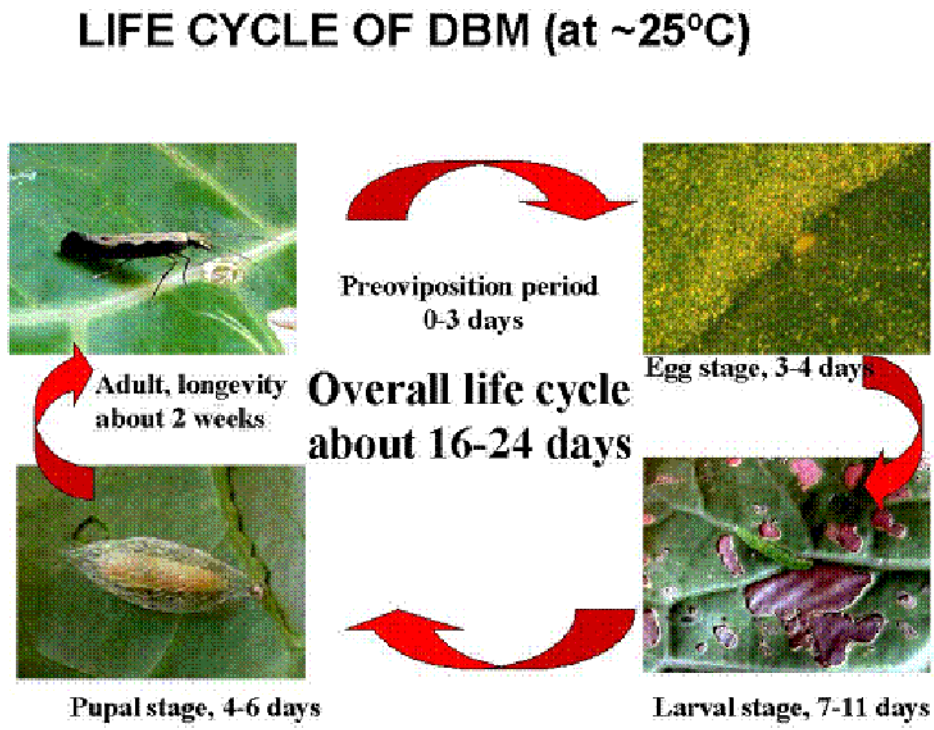
Windowing effect on cabbage

Serious attack usually occurs during the dry season when the stress and its not able to able outgrow the damage caused by the pest. The adults are small grey moths with a wing span if 15mm. They have three diamond-shaped pale spots down the middle of the wing at the back hence the diamondback moth. The adult lay from 50 to 180 eggs. The life cycles vary depending on the weather. During the hot season, the cycles are short while during the cold season they are long. In a year 20overlapping generations have been recorded.

Life cycles

The freshly laid eggs are oval in shape, light yellow in colour and measures approximately 0.49mm in length by 0.26mm in width. The eggs are laid singly or in groups of three or four on the leaves of the host plant. The eggs darken just before hatching and the young larvae can be seen coiled beneath the chorion. The first instar larva hatches after 3 to 5 days wanders for a short distance in search of suitable leaf tissue in which to mine. The larva mines into the spongy

mesophyll leaf tissues where feeding continues until the second instar. The second instar exists from the mines and starts feeding on the underside of the leaf. Third and forth instar larvae, which are pale green and about 9 mm long, also feed on the lower leaf surface. The larvae can be distinguishes from other species their habit of actively dropping from the leaf on silken thread when disturbed. The larval period lasts 8-15 days depending on the temperature. The pupa is brown and encased in a delicate, netlike cacoon on the leaves and the pupal period lasts 3-6 days. Female adult longevity ranges from 7 to 47 days, with an average 16.2 days while male longevity ranges from 3 to 58 days and an average of 12.1n days. Thus, the development from egg-adult from 12 to 20 days depending on environmental conditions.



Control and management

DBM is difficult to control because of its intrinsic biology and ecology. Control by chemical or biological dead equate levels of control, growers can also grow on bacterial insectcides, variety selection, parasitoids and planting schedules.

Interrmittent overhead irrigation provides effective economic control of diamondblack moth by disrupting adult flight, mating and oviposition, and to some extent washes off the larva. The best time for overhead irrigation is late in the afternoon when the moths' activities are high. Unfortunately, diseases tend to become a major problem to crops.

Crop residue destruction immediately after harvest helps prevent the bulid up of diamondblack moth and subsequent migrations to younger plants in the adjacent fields once they are planted.

Parasites and predators play a dominant role in the biological control of DBM. Biological control methods usually used include classical, biological control, augmentation, inoculation, inundation and natural enemy conservation. Some of the parasitoids used in the control of DBM include *the Diadegma, Cotesia and Oomyzus* species.

The pests can be controlled by the following insectcides

+ Ambush +
Marathion +
Carbarly

10.11.1.2 American bollworm

American bollworm *Heliothisarmigera*Hurner (Lepidoptera: Noctudae)

It is a serious world-wide pest. It attacks wide range of crops namely maize, tomatoes, tobacco, pigeon peas, cowpeas. Heavy attacks occur during flower period.

Eggs are laid singly on the upper leaf surface and flowers buds. Eggs are roughly spherical in shape and about 0.5 mm in diameter. They are yellowish when fleshly laid and turn brown as the embryo develops. Hatching takes place after 2-4 days.

Larvae are variable in color but are generally greenish brown and the body is marked with longitudinal bands in alternatively dark. Young larvae feed on flower buds and terminal buds. They feed with the head inside the boll while the rest of the body is outside.

Damage on cotton

Damage on pod

Damage on tomato

Figure 23. Bollworm damage on different crops

Each larva can attack an average of 14 buds. The larva lasts for 14-24 days and this causes considerable damage to crops. Full grown larva is usually about 4cm long. When the larva is full grown, it burrows into the soil and pupates.

Pupa is found on the soil and it is brown in colour and 15 mm long. Pupal period lasts 10-14 days depending on weather.

Adult is brown, night flying moth with a wingspan of 40 mm. egg laying starts 4 days after emergence and may continue for up to 10 days. The female can lay up to 1000 eggs.

Adult moth

Damage

The severity of the damage varies between crops, regions and locations and between seasons. Caterpillars feed on leaves, buds, growth can points, flowers and fruits. Leaf damage reduces leaf area, which can slow plants growth. Feeding on flowers and fruits causes the main damage. Flower feeding can prevent fruit formation. Caterpillars usually bore clean, circular holes through fruits/pods. Excrements (feaces/waste) of the feeding caterpillar are placed away from the damaged plant parts. The holes serve as entry points for secondary infections by diseases causing fruit decay. One caterpillar can damage several fruits/pods. Once they burrow into the fruits/pods they are difficult to reach and control using insecticides.

Crops losses at farm level in Kenya have been estimated at over 50% on cotton pigeon pea. Over 20% on sorghum and millet, and over 2 million stems on cut flowers. In addition, the African bollworm is a quarantine pest. This is important for export crops. If a caterpillar of this pest is detected in a consignment of an export commodity (e.g.flowers, vegetables, etc) shipped to europe, the whole consignment may be rejected.

Affected plant stage

- Vegetable growing stage
- Flowering stage
- Fruiting stage

Affected plant parts

- Leaves
- Growing points
- Inflorescence
- Fruits/pods

Symtoms

Larvae feed on leaves, flowers buds, flowers,grains and bore into pods and fruits

Excrements (feaces/waste) of the feeding caterpillars are evident on damaged plant parts.

Host plants

Cotton, maize, sorghum, zucchini Bean, Plums, Lemon, Orange, Tomatoes and Tobacco. Ornamental plants and flowers attacked include: Pinks, Geranium, Lettuce, Dianthus, Carnation, Nasturtium, Rose, Snapdragon and Zinnia.

Monitoring

The pest can be monitored using the following

1. Plant sampling
2. Random sampling: one should walk through the crop area and randomly examines plant for eggs,larvae, damage or frass.
3. Thoroughly inspect plant from soil and roots to the top of the newest shoot (leaves, buds and flowers).
4. During sampling select different spots each time.
5. Point sampling where damage is noticed for presence of larvae.
6. Regular sampling from pre-fixed point or bays.

Management and control

The pest can be easily managed through scouting of plants, use of light traps for adults and pesticides. Effective chemicals depend on the toughness and the time of application. Thus proper timing is crucial. Application of chemicals should be done when the larva is small (1-8 days). On beans, apply chemical when flowering while on maize when silking.

Some of the pesticides one can use include

- Ambush
- Diazinon
- Indoxacard
- Acephate
- Bifenthrim

- Decis

10.11.2. Moths

10.11.2.1 Potato tuber moth (*Phythirimaea operculelle)*

The pest attacks wide range of crops, including tobacco, tomato, and solanaceae family.

Infestations arise in the field and continue during storage of tubers. There is a serious risk of transportation from one area to another or country to country through infested tubers.

Eggs are laid on the underside of the leaf or in the tuber around the eye. Females may lay 150-250eggs in their lifespan.

Larva. Upon hatching the 1st instar larva bores into the leaf where they make mines. The caterpillar is greenish in colour. The attacked leaves have silvery blotched caused by the increase in size as they approach the base of the stem. This is followed by wilting of the plant and plants become affected by fungi or bacteria. In tobacco, the mined leaves have blotches and become unusable or the grade of the crop is lowered. Full grown caterpillar varies in size ranging between 8-10 mm. Larval period lasts 9-26 days. The larvae may fasten two leaves and then feed between them. In tubes the larvae makes tunnels which are generally filled with faeces.

Pupa

Takes place in the cocoon at the surface of the litter or just under the surface of the tuber. Pupation period last for 6-26 Days.

Adult are short lived **and have wingspan of about** 15mm. One generation takes 3-4 weeks and there can be up to 12 generation in a year depending on weather.

Adult potato tuber moth

Potato tubers damaged by tuber moth

Control

Cultural control – plant potato deeply into the soil. Harvest potatoes early morning because the pest lay eggs late in the afternoon. Potatoes in the field should be covered with soil to prevent the moth from laying eggs on them.

Chemical pesticides should be applied after every 14 days after the mines have been spotted on the leaves. Use the following insecticides

+ Dicrotophos
+ Dimethoate
+ Malathion +
Fenitrothion +
Thiodan