



# Handbook on Groundnut Insect Pests Identification and Management

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**Abstract:** Groundnut or peanut (*Arachis hypogaea* L.) is an important oilseed crop in Asia and Africa. Being a leguminous crop it enriches the soil through nitrogen fixation and the haulms are a good source of nutritious fodder. Groundnut is attacked by many insects at different stages of plant growth, but only a few of the over 100 insects associated with this crop are economically important. This bulletin provides short descriptions of the insect species most important to groundnut, their biology, distribution, and damage symptoms. Color photographs are provided for easy identification of the pests, and appropriate management practices are suggested.

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**Cover:** Tobacco caterpillar (*Spodoptera litura* F.) damage on groundnut.

**Photos:** ICRISAT

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GV Ranga Rao and V Rameshwar Rao

Information Bulletin No. 39

Revised

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**International Crops Research Institute  
for the Semi-Arid Tropics**

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2013



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## Author's Note

This handbook is published to help agricultural scientists, extension workers and students identify the common insect pests of groundnut. A number of insects found on the groundnut crop are not pests; many are even beneficial, because they assist in the suppression of pest species. Illustrations of a few of these beneficial insects are also included to emphasize their importance and to determine the role of useful insects found on crops rather than to assume that all insects are harmful. Brief descriptions of the distribution, hosts, and biology of the pests are given, together with appropriate control measures. Chemical control should be used only where essential and preferably with the advice of a plant protection specialist. The absence of insects at damage sites, often make it difficult to identify the causal agent unless one is familiar with their feeding behavior and damage symptoms. Hence, readers are urged to collect and preserve insects found on their crops to seek help from professional entomologists in identifying them, and to maintain specimen collections for future reference. This publication is a revision of Information Bulletin No. 39 published in 1993, and carries the latest available knowledge on groundnut pests and their management. We have also included information on upcoming pests in different regions. The authors gratefully thank many scientists at ICRISAT and from the State Agricultural Universities for sharing their wealth of knowledge towards this publication. We would also like to thank Dr CLL Gowda, Director, Grain Legumes, ICRISAT for his critical review and for making it possible to publish this handbook.

ICRISAT would like to receive feedback on the impact of the recommendations made in this bulletin, particularly as insect response to control measures is likely to vary in different varieties, environments and farming systems. Please send your comments to [g.rangarao@cgiar.org](mailto:g.rangarao@cgiar.org)

## Preface

Groundnut (*Arachis hypogaea* L.), is grown globally for its food and edible oil in about 30 million ha. China being the leading producer followed by, India and USA of the world while millions of smallholder farmers in sub-Saharan Africa and Asia grow groundnut as a food and cash crop. This crop is known for its multiple uses across the world with an average productivity of 1.5ton ha<sup>-1</sup>. Presently about 1.25 million tons of groundnut pods are being exported mainly from the USA. Countries such as India, Vietnam and several African regions periodically enter the world market depending on market demand. From a nutritional point of view, groundnuts are very important in the lives of the poor as they are very rich in protein (26%) and edible oil content (45-50%). In addition to protein, groundnuts are a good source of calcium, phosphorus, iron, zinc and boron.

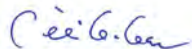
Smallholder farm households both consume and sell groundnut products to meet their daily nutritional requirements and enhance their livelihood. The multiple role of groundnut as a raw material for a wide range of processed products can add value and income generating opportunities for the poor, especially women. As a human food and livestock fodder and feed, groundnut has high demand in both local as well as export markets.

The main constraints hampering higher yields and quality in the developing countries are intermittent drought and seed contamination with aflatoxin, a carcinogenic mycotoxin produced primarily by the fungus *Aspergillus flavus*. In addition, a plethora of biotic stresses from insect pests, foliar fungus diseases (leaf spots and rust) and virus diseases (rosette, peanut bud necrosis and stem necrosis), also influence crop productivity in different regions.

In the past, groundnut was grown mainly as a secondary crop in subsistence farming conditions, but in recent years the crop has gained importance due to the shortage of edible oil particularly in Asia and African countries. Today, farmers consider groundnut as a high-input high-risk crop because of the large seed requirement, the scarcity of good quality inputs and appropriate production technologies. Moreover, insect pests are often considered to be a major constraint to groundnut production worldwide.

It is abundantly clear that most pest outbreaks are induced by the adoption of inappropriate management strategies such as ineffective crop rotations, excessive application of insecticides, etc. While most groundnut pests are of localized importance, they often reach epidemic proportions.

Monitoring and early recognition of potential threats will be very useful in developing timely pest management programs. This information bulletin, supported by color photographs, sufficient information on pest biology, host range, the extent of damage it causes, and feasible control options, will help scientists, students, extension workers and farmers develop appropriate management strategies.



**William D Dar**  
Director General  
ICRISAT



## Introduction

Groundnut (*Arachis hypogaea* L., Fig. 1) is grown on nearly 30.47 million ha worldwide with the total production of 37.9 million tons and an average yield of 1580 kg ha<sup>-1</sup> in 2010. This is a major oil-seed crop in Asia and Africa. In Asia, India (4.9 million ha), China (4.54 m ha), Myanmar (0.82 m ha), Indonesia (0.6 m ha) and Vietnam (0.23 m ha) are the major groundnut growing countries. In Africa, Nigeria (2.6 m ha), Senegal (1.2 m ha), Sudan (1.15 m ha), Niger (0.79 m ha), Burkina Faso (0.4 m ha), Mali (0.33 m ha) and Malawi (0.26 m ha) are the important groundnut producers. Production is concentrated in Asia (50% of global area and 64% of global production) and Africa (46% of global area and 28% of global production), where the crop is grown mostly by smallholder farmers under rain-fed conditions with limited inputs associated with low yields.



Figure 1. A healthy groundnut crop on a broad bed and furrow system.

Groundnut, being a leguminous plant, enriches the soil through nitrogen fixation and is therefore valuable in crop rotations. It is often intercropped with a wide range of short-duration crops such as sorghum, millets, maize (Fig. 2) and even other legumes such as pigeonpea.

In general, insect pests cause 10-20% crop loss. Most groundnut insect pests are sporadic in occurrence and distribution. However, there are instances of total crop loss caused by a single pest species. Although many insect species live and feed on the groundnut crop, only a few causes significant damage that result in large reductions in pod and haulm yields.

Although there is wide variation between genotypes, groundnut shows considerable natural resistance to insects. This resistance is due to the production of anti-insect chemicals in the leaves and pods, the presence of long and/or dense hairs on the leaves, and the ability of established crops to withstand substantial defoliation with minimal reduction in pod yield due to the presence of more photosynthetic surface than its requirement.



*Figure 2. Groundnut intercropped with maize.*

The major groundnut pests can be classified as specific to this crop eg, aphids, leaf miner and pod borers; or general feeders that attack a wide range of crops eg, tobacco caterpillar (armyworm), gram pod borer, hairy caterpillars and other defoliators; and soil inhabiting species such as white grubs and termites.

On the basis of currently available information, it is unwise to rate insects such as the ash weevil and non-viruliferous thrips as being economically important. Data on yield loss caused by jassids (leaf hoppers) are not always convincing, although these minor insects can undoubtedly reduce productivity when they are present in large numbers. Virus vectors and soil insects pose different and difficult problems. The former can cause significant yield losses if a virus-carrying population invades a field, even at low densities. Soil insects can also cause considerable damage by reducing plant population, but on the other hand are difficult to detect before the damage occurs. Post-harvest losses in groundnut range between 10 to 25% of the production in Asia, and higher levels of damage under long-term storage situations is not uncommon. In India, farmers, seed agencies and oil extraction units store about 65% of the groundnut produce for 6-9 months before final use. Sometimes, the damage incurred to the produce in the store can be high, and there is no compensation mechanism for damage done by storage pests, as is the case for field pests.

In this bulletin, root and pod feeding insects, foliage feeders (defoliators), virus vectors (sucking insects) and insects of post harvest importance (storage insects) are discussed under separate headings. Special attention has been given to various integrated pest management (IPM) options and a few novel pest management initiatives.

## Root and Pod Feeders

Several kinds of insects feed on roots and pods of groundnut. The root feeders are always dangerous to a crop because plants suddenly die, especially during periods of drought. In the case of groundnut pod borers, the damage is detected only when the crop is harvested, and it is not always easy to ascertain which insect caused the damage unless one is aware of the damage they cause, especially when the pods have rotted. It is therefore difficult to make recommendations for the control of pod borers, because they are sporadic and extremely difficult to detect before the damage is done.

### White grubs or chafer larvae

***Lachnosterna (=Holotrichia) consanguinea*** (Blanch.)

***Lachnosterna serrata*** (Fab.)

***Leucopholis lepidophora*** Blanch

***Maladera*** spp.

***Lepidiota signata*** (Fabricius)

***Adoretus cribosus*** Harris

***Anomala transvaalensis*** Arrow

***Schyzonycha africana*** Cast

***Schyzonycha*** spp.

(Coleoptera: Scarabeidae)

Several hundreds of species of white grubs are known to occur in Asia, Africa, Australia and USA of which 26 are known to attack groundnut. Of the 126 species of the genus *Lachnosterna* (= *Holotrichia*), 89 have been recorded in India. The most important ones are *L. consanguinea* and *L. serrata* infesting groundnut. Though present in the southern states of India, their importance is restricted to a few pockets with sandy soils. *L. serrata* is found throughout India, but more commonly in the heavier soils of southern India. Most of the white grubs have a similar life cycle,

except for *Maladera* that has more than one generation per growing season, especially in irrigated conditions. Another species, *Leucopholis lepidophora* Blanch., in India and *Lepidiota signata* (Fabricius) in Vietnam has a larval period of more than one year (about 18 months). *L. lepidophora* is reported to have severely damaged the summer groundnut crop in riverbed areas of Kolhapur district (Maharashtra), India and *L. signata* in red riverbed areas of the North and uplands of Mekong delta in South Vietnam. Eleven species of white grubs are known to be associated with groundnut in parts of sub-saharan Africa, of which genus *Adoretus*, *Anomala*, *Eulepida*, *Schyzonycha* (Fig. 3) and *Trochalus* are the most common. The predominance of *Schyzonycha* species in West and southern African groundnut fields showed the importance of the genus as a groundnut pest.

The adult beetles of *Lachnosterna* (called cockchafers) are 18-20 mm long and 7-9 mm wide (Fig. 4). Mating takes place at the feeding sites. After feeding, the adults re-enter the soil to hide and lay eggs. A single female lays 20-80 white, roundish (2.0-2.5 mm diameter) eggs, often in clusters (Fig. 5). Eggs hatch in 9-11 days. The young grubs are translucent, white, and 5 mm long when they hatch. Fully grown grubs (Fig. 6) are larger than a human thumb, and weigh 3-4 g in case of *Lachnosterna* spp.,



Figure 3. *Schyzonycha* species adults.

and 10-12 g in case of *Lepidiota signata*. The biggest adult white grub *Lepidiota signata* is 25 mm wide and 50 mm long (Fig. 7). These species have one generation per 12-18 months. Pupation takes place in the soil (40-70 cm deep), where the insects remain as pupae until the following year.

The adult beetles emerge with the first monsoon showers and feed at dusk on the foliage of trees such as neem



Figure 4. *L. serrata* adults.



Figure 5. *L. serrata* eggs.



Figure 6. *L. serrata* grub.



Figure 7. *L. signata* (Fabricius) adult.

(*Azadirachta indica*), acacia (*Acacia* spp.), gigyphus (*Ziziphus jujube*) and others. The larvae initially feed on soil organic matter for a few weeks and then eat roots. They also damage pods (Fig. 8). Severely infested fields have large patches of dead plants (Fig. 9) and the surviving plants are often stunted and show signs of wilting.



*Figure 8. Pod damaged by white grub larvae.*



*Figure 9. Field severely infested with white grubs.*



## Termites or white ants

***Microtermes*** spp.

***Odontotermes*** spp.

***Macrotermes*** spp.

***Ancistrotermes latinotus*** Holgren

(Isoptera: Termitidae)

Termites (Fig. 10), mainly *Microtermes* spp. and *Odontotermes* spp., can cause damage to groundnut plants in several ways – (i) They enter the root system and burrow inside the root and stem (Fig. 11), which usually kills the plant; (ii) They bore holes in the pods and damage the seed (Fig. 12); (iii) They remove the soft corky tissue from between the veins of the pods. This is known as scarification (Fig. 13). Damage to root and pod is direct, while the pod scarification renders the pods more susceptible to infection by *Aspergillus* spp., which results in the production of aflatoxin, a potent carcinogen, in the infected seed tissues.



Figure 10. Termites (*Microtermes* spp.).



Figure 11. Termite damage to stem and root.

Termites are widely distributed in all groundnut-growing areas in Asia. They favor red and sandy soils, and are less of a problem in postrainy season groundnut crops, particularly those followed by rice in Vertisols. Among the twenty species of termites that are known to infest groundnut in Africa, *Microtermes* and *Odontotermes* are the most damaging, while *Macrotermes* spp., are occasional. Members of the genus *Macrotermes* in Africa and *Odontotermes* in Asia build conspicuous mounds, and most others have scattered chambers in the soil.



Figure 12. Pods damaged by termites.



Figure 13. Pods scarified by termites.

As the groundnut crop matures, termite damage becomes more pronounced and appears in various forms. Most often, termites invade the root system and hollow out the tap root around 45 days after planting. The tunnels so created are filled with soil. This type of damage is typical of the small-sized *Microtermes* spp., which is the most abundant and widely distributed termite pest of groundnut. In West Africa, termite damage shows standing plants covered by soil sheet, is usually caused by *Odontotermes* spp. and by *Ancistrotermes* in southern Africa. *Macrotermes* spp. damage plants by cutting the base of the stem. The plants thus attacked disappear rapidly due to removal of plant tissues by termites and the high rate of decay under tropical climatic conditions; however groundnut damage by *Macrotermes* is not widespread in West Africa.

Damage to mature pods is common and widespread in many parts of Africa. Pod damage is frequently caused by *Microtermes* and to a lesser extent by *Odontotermes*. The empty spaces created after the consumption of kernels are filled with soil. Scarification of pods is by far the most common type of termite damage at plant maturity, a factor often aggravated by delayed harvest. This involves the removal of the soft corky layer between the fibrous

veins, caused mostly by *Microtermes* spp. in western Africa and by *Ancistrotermes* and *Odontotermes* spp. in southern Africa. Scarification does not affect groundnut directly but promotes colonisation by fungi such as *Aspergillus flavus*, which produces the carcinogen aflatoxin in groundnut.

Alates (winged forms) emerge from the soil at the onset of the monsoon. Mating occurs after a short dispersal flight and pairs then seek nest sites in the soil. In a few months the foraging caste starts moving out of newly founded colonies in search of food. Soldier termites, which have large mandibles, defend their colony from intruders. The mound size varies with species (Fig. 14). Colonies can extend several meters underground. They can be dug up after considerable effort, but cannot be considered destroyed until the large (50 mm long) queen is destroyed (Fig. 15). Nests can often be detected by their familiar earth mounds and ventilation ducts.



Figure 14. Termite mound in nature.



Figure 15. Termite queen (*Odontotermes* spp.).

## Jewel beetle

### *Sphenoptera indica* (Gory)

(Coleoptera: Buprestidae)

*S. indica* is widely distributed in Asia infesting several legumes including groundnut, and known to infest pigeonpea in Africa. The adult is a shiny beetle, 10 mm long and 3 mm wide. The eggs are laid singly on the main stem. The grubs, on hatching, bore into the stem and tunnel into the root (Fig. 16), causing the plant to wilt and die. The larvae are slow movers, and can easily be identified by their globular head and elongated, dorsoventrally flattened body. They grow to a length of 2.5 cm, but often go unrecognized. Pupation takes place in the larval tunnel. The life stages are shown in Figure 17. One generation takes about 6-8 weeks. Normally this species infest groundnut at a late stage of the crop (around 60 days after emergence) and the damage can be seen in 75 day old crops.

Infested crops show wilting of plants in patches. The grub burrows into the stem close to the soil surface and kills the plant. Infested fields show dead and dying plants, and the

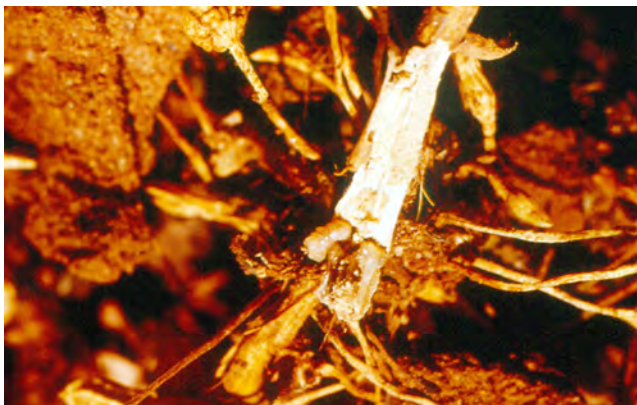


Figure 16. Roots damaged by *S. indica* (Gory).



*Figure 17. Various life stages of S. indica.*

grub/pupa can be seen in the hollowed stems of plants. Though it is of minor importance currently, one should keep a close watch on the distribution and abundance of this species, considering the root feeding habit, the resultant plant mortality and wide host range.

## Earwig

***Anisolabis stali*** Dohrn

(Dermaptera: Labiduridae)

The Groundnut earwig *A. stali* is common in India and is known to occur in a few other Asian countries, Israel, Europe and the Americas. The adult is an elongated, wingless, dark brownish to black insect and measures 30-35 mm in length. Earwigs can be easily recognized by their unique forked abdominal tip. The eggs (20-100) are laid in clusters on pods or in the soil (Fig. 18). Their incubation period is 3-11 days. There are five nymphal instars, and the nymphal period lasts between 30-60 days. Both nymphs and adults bore into tender pods and feed on the kernels. They also feed on vegetative material, onion bulbs, cotton bolls, and sorghum stems. Adults survive as long as 250 days and one generation takes 56-101 days. In general these are not considered as economically important, however pod damage is relatively high in summer groundnut and



Figure 18. Earwig *A. stali* with eggs.

heavier soils (Fig. 19). Infested pods are prone to *A. flavus* infection.

Also, it is important to note that earwigs are important predators of garden insects, including pests such as aphids.



Figure 19. Pod damaged by *A. stali*.



## Wireworms

(Coleoptera: Elateridae)

## False wireworms

*Gonocephalum* spp.

(Coleoptera: Tenebrionidae)

Wireworms (click beetle larvae) and false wireworms (tenebrionid larvae) occasionally cause damage to groundnut pods. The adult *Gonocephalum* spp. (false wireworm) is common in Asia and Africa (Fig. 20). Adult wireworms (dusky brown beetles) occur on foliage and flowers; some species apparently do not feed on crops. Wireworm and false wireworm larvae are white or cream, shiny, hard bodied, and virtually indistinguishable and special expertise is required for their identification. They feed on groundnut roots and pods (Fig. 21). Fully grown larvae are 2.5–3.5 cm long and 2 mm thick. Pupation



Figure 20. Adult *Gonocephalum* spp. feeding on germinating plants.

takes place in the soil. The biology of the wireworms and false wireworms that attack groundnut is not fully known. *Zophosis* sp. (Tenebrionidae) adults were frequently recorded in groundnut fields in West and southern Africa. They are more likely to be found in clayey soils.



*Figure 21. Pod damaged by wireworms.*

## Subterranean, doryline, blind or red ants

*Dorylus orientalis* Westwood

*Dorylus labiatus* (Shuckerd)

(Hymenoptera: Formicidae)

Subterranean, doryline, blind or red ants are widely distributed in Asia (India, Sri Lanka, Myanmar, Thailand, Vietnam, Mongolia, China, Japan, and Bhutan) causing considerable damage to mature groundnut pods. They are about 5 mm long, red-brown, and are rarely seen alone or above the soil surface. *D. orientalis* is one of the few ant species that attack the underground parts of crop plants (in Asia) - the tubers of potatoes (across northern India and Nepal) and developing pods of peanuts.

They make several neat, round holes, 0.5-2.0 mm in diameter, and eat the seed completely, without leaving any soil inside the empty shell (Fig. 22); termites, in contrast, refill the pod cavity with soil. They eat roots of many plants, but this is likely to go unnoticed. It is not known how common this species is in other crops in Asia. It completely destroyed an isolated crop at ICRISAT Center during the 1989 postrainy season, indicating its potential as a serious pest.



Figure 22. Pod damaged by *D. orientalis*.

## Groundnut hopper

***Hilda patruelis*** (Stal)

(Tettigometridae : Hemiptera )

Hilda is widely distributed in Africa covering Angola, Congo, Ethiopia, Kenya, Malawi, Madagascar, Mozambique, Namibia, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Zaire, Zambia and Zimbabwe, and is known to infest groundnuts, sunflower, cashew and figs in Africa.

It is about 5mm in length, brown or green in color with white marks and stripes on the wings. The nymphs resemble the adults, but without fully developed wings. These insects live in clusters or colonies (Fig 23), and are attended by ants that feed on the honeydew excreted by the hoppers. These sucking insects attack groundnut plants at the base of the stem, usually below ground level. The toxic saliva injected while feeding causes the plant to wither, turn yellow and die. The first sign of infestation is the presence of black ants.

Small white elongated eggs are laid on the stem below soil level or on the underground pegs and pods. A cycle of one generation lasts about six weeks. There are 5 nymphal instars, both nymphs and adults suck sap from the roots causing plants to wilt. Breeding occurs continuously on subterranean and aerial parts of food-plants throughout the year, however the life cycle takes longer to complete in cooler seasons. There are indications of a dispersal flight at the end of the dry season, and when food-plants became unsuitable.

Periodical infestation by Hilda in groundnut crops is usually discovered too late for taking control/management measures. Also, there are indications that a relationship between infestation and drought exists. The encyrtid *Psyllechthrus oophagus* Ghesq. is known to parasitize



Figure 23. Groundnut roots infested by *Hilda*.

eggs on both subterranean and aerial sites. No common or specific predators were recorded, but adults of the coccinellid *Hyperaspis* were observed feeding on the eggs of *H. patruelis*.

### **Management of root and pod feeders**

Soil insects are difficult and expensive to control with insecticides. Applying carbofuran (3 G) granules in the furrow @1 kg a.i. ha<sup>-1</sup> can be an effective prophylactic measure. A seed treatment (with any insecticide) that is sufficient to protect a crop from all soil insects for the complete cropping period has not yet been found; however, chlorpyrifos 20 EC @ 12.5 mL kg<sup>-1</sup> as seed treatment can provide effective control of soil insects in the first 30 days.

To control white grub adults, spray their feeding trees with carbaryl 50 WP (2 g L<sup>-1</sup> of water) 3-4 times until mid-July, ideally using a community approach. In endemic areas, deep plowing after harvesting the crop can also reduce the population, mainly through bird predation and the destruction of pupae.

There is scope for community action for reducing the general population of white grubs by collection and destruction in a farming area when the beetles are above ground in the nights to mate and feed.

Since seed treatment provides control only at the seedling stage of the crop, soil drenching with chlorpyrifos @ 5 ml liter<sup>-1</sup> of water at the base of the plant around 50 days after emergence of the crop, can protect the crop until harvest. Since soil drenching requires a huge quantity of water and chemical, this is mostly recommended in hybridization plots, seed multiplication and other high input cultivation systems.

The cultural operations such as clearing off termite mounds near groundnut fields and applications of chlorpyrifos into the mounds (5 ml liter<sup>-1</sup> of water, and application of 2 to 3 liters of spray fluids mound<sup>-1</sup>) can effectively minimize the termite population in cropping areas. Harvesting groundnut at optimum maturity and removal of debris from the field was also found effective in reducing the termite problem.

Hilda can be managed by spot application of Dichlorvos @ 2 ml litre<sup>-1</sup> and drenching the soil wherever ants are observed.

In Thailand, peanut farmers place baits of coconut flesh mixed with chlorpyrifos in *Doryline* infested fields. Conventional spraying of the soil during crop development with chlorpyrifos is recommended in endemic areas and for important experiments.

## Foliage feeders

Many species of leaf-eating caterpillars are found on groundnut plants, but few are of economic importance. Most defoliators are polyphagous and sporadic in occurrence. It is evident from literature that groundnut crops can tolerate considerable defoliation. Natural control processes usually keep defoliators at densities well below their economic threshold levels. However, the indiscriminate use of insecticides can cause pest outbreaks that have the potential to inflict total crop loss.

### Tobacco caterpillar/tobacco armyworm

*Spodoptera litura* (Fab.)

### Cotton leaf-worm

*Spodoptera littoralis* (Boisduval)

(Lepidoptera: Noctuidae)

The two old-world cotton leafworm species *S. litura* and *S. littoralis* are allopatric, their ranges covering Asia and Africa, respectively. Many authors have regarded them as the same species.

*S. litura*: Widespread in Asia and Oceania (American Samoa, Australia) and in Hawaii, (USA).

*S. littoralis*: Widespread in Europe, Africa and west Asia.

Both species are highly polyphagous. The host range of each species covers over 100 plant species of economic importance. Among the main crop species attacked in the tropics are cotton, *Colocasia*, flax, groundnuts, jute, lucerne, maize, rice, soya beans, tea, tobacco, vegetables (aubergines, *Brassica*, *Capsicum*, tomato, cucurbit vegetables, *Phaseolus*, potatoes, sweet potatoes, *Vigna*

etc.). Other hosts include ornamentals, wild plants, weeds and shade trees (eg, *Leucaena leucocephala*). *S. littoralis* in most of the Europe and Mediterranean region, is the principal pest of ornamentals and vegetables in glass houses.

The adults are light brown moths with a wing span of about 30 mm, and mottled forewings (Fig. 24 and 25). Eggs are laid in clusters of several hundred, usually on the upper



Figure 24 . *S. litura* adult.



Figure 25 . *S. littoralis* adult.





Figure 26. *S. litura* egg masses.

surface of leaves. These egg masses, which measure about 4 x 7 mm, appear golden brown because they are covered with the body scales of the female (Fig. 26). The eggs take 2- 3 days to hatch; the larvae disperse quickly from the egg batch. Young larvae are light green. There are six larval instars. The later instars are dark green to brown on their backs, lighter underneath, and have prominent black spots on the thorax. There are often thin, light colored lines along the body (Fig. 27 and 28). Larvae can be 50 mm long before they pupate. The pupae are reddish brown and



Figure 27. *S. litura* larva.



Figure 28. *S. littoralis* larva.

are found in the soil close to the plants.

The presence of newly hatched larvae can be detected by the 'scratch' marks they make on the leaf surface (Fig. 29). The older larvae are mostly nocturnal in habit and are usually found in the soil around the base of plants during the day. They chew large areas of the leaf, and at high



Figure 29. Damage caused by young *S. litura* larvae.

population densities, can strip a crop of its leaves (Fig. 30). In such cases, larvae migrate in large groups from one field to another in search of food. In areas where groundnut is grown on light soils the caterpillars have been seen boring into the pods (Fig. 31).

In Andhra Pradesh, India, the insect has 12 generations a year, each lasting slightly



Figure 30. Damage caused by later instar larvae of *S. litura*.



Figure 31. Pods damaged by *S. litura* larvae.



Figure 32. *S. exigua* adult.

tips of branches. The eggs are greenish to white in colour, and are covered with a layer of whitish scales that give the egg mass a fuzzy or cottony appearance. Eggs hatch in two to three days during warm weather. There are normally five larval instars. The first and second instars are pale green or yellow in colour but acquire pale stripes during the third instar. During the fourth instar, larvae are darker dorsally and possess a dark lateral stripe. Larvae during the fifth instar are quite variable in appearance, tending to be green dorsally with pink or yellow colour ventrally and a white stripe laterally. A series of dark spots are often present dorsally and dorso-laterally (Fig.33). Sometimes larvae are very dark in colour. The larval period lasts about 15 days in warm conditions. Pupation occurs in the soil.



Figure 33. *S. exigua* larva.

The pupae are light brown in colour and measure about 15 to 20 mm in length. Duration of the pupal stage is six to seven days during warm weather. The total life cycle can be completed in 24 days.

Larvae feed on both foliage, flowers and fruit and are regarded as a serious defoliator, though much of the injury is induced by insecticide use that interferes with natural enemy activity as was evidenced in the southern states of India. Young larvae feed gregariously and skeletonise foliage. As they mature, larvae become solitary and make large irregular holes in the foliage.

### Hairy caterpillars

***Amsacta albistriga*** Walk.

***Amsacta moori*** Butler

(Lepidoptera: Arctiidae)

Several species of hairy caterpillars attack groundnut. Two important ones are the red hairy caterpillars: *Amsacta albistriga*, found in southern India, and *A. moori* in the northern states of India and Australia. Both can be devastating, but are highly sporadic. About a decade ago they were considered to be the key pests of groundnut during the rainy season, but their status has now changed as they are unpredictably important in isolated pockets.

Historic information showed that both the species have one generation a year, but recent observations indicate the occurrence of second generation in *A. albistriga* in southern parts of India. The adults emerge from the soil at the onset of the southwest monsoon (usually in June in the southern parts of India). They are brownish-white moths with a 40-50 mm wing span (Fig. 34). The forewings are completely white in *A. moori* and brown in *A. albistriga*. Females lay 800-1000 eggs in clusters of 50-100 on the

host plants. The larvae are initially light brown, but turn reddish as they grow (Fig. 35). Their 'hairiness' makes them conspicuous, especially the larger ones, which are up to 5 cm long. They are gregarious and often migrate from field to field in search of food after devastating the foliage in the field where they hatched.



Figure 34. *A. albistriga* adult.



Figure 35. *A. albistriga* larva.

The larval period lasts for about a month and pupation takes place in the soil. The adults from these pupae do not emerge until the next rainy season.

### Bihar hairy caterpillar

*Spilosoma (Diacrisia) obliqua* (Walk.)

(Lepidoptera: Arctiidae)

This species is widely distributed in South Asia covering northern Pakistan (also reported from southeastern Afghanistan), India, Bhutan, Bangladesh and Myanmar. It is well known in several states of India covering Andhra Pradesh, Assam, Bengal, Bihar, Haryana, Madhya Pradesh, Maharashtra, Punjab and Uttar Pradesh on a number of crops, particularly vegetables and cereals. In recent years, it has become an important groundnut pest in the northern states. There are several generations in a year. The adult is a brown moth with a 40-50 mm wing span, and a red abdomen (Fig. 36). The forewings have black spots. Eggs are laid in clusters of 50-100 mostly on the upper surface of the leaves. The larvae at maturity can measure up to 5 cm long and are covered with yellowish to black hairs (Fig. 37). Their feeding behavior is similar to that of other species of hairy caterpillars. Pupation takes place in leaf litter close to the host plants.



Figure 36. *S. obliqua* adult.



Figure 37. *S. obliqua* larva.



## Gram pod borer

***Helicoverpa armigera*** (Hubner)

Corn earworm

***Helicoverpa zea*** (Boddie)

Tobacco budworm

***Heliothis virescens*** (Fab.)

(Lepidoptera: Noctuidae)

*H. armigera* is widely distributed throughout the tropics and subtropics. *H. zea* and *H. virescens* are widespread in the USA. These species are highly polyphagous and attack a number of crops, as in case of other lepidopteran defoliators, including groundnut.

Corn earworm, *Helicoverpa zea* is found throughout North America. It is known to survive as far north as about 40 degrees north latitude, or about Kansas, Ohio, Virginia, and southern New Jersey, depending on the severity of the winter weather. However, it is highly dispersive, and routinely spreads from southern states into northern states and Canada.

The tobacco budworm, *Heliothis virescens* is a native species of USA and is found throughout the eastern and southwestern United States. It generally overwinters successfully only in southern states. Tobacco budworm disperses northward annually, and can be found in New England, New York, and southern Canada during the late summer. It also occurs widely in the Caribbean, and sporadically in Central and South America.

The adults of these species have a wing span of about 40 mm, and dull brown forewings (Fig. 38, 39 &40). The creamy eggs are laid singly on young leaves and flower buds (Fig. 41). The larvae are morphologically similar to the tobacco caterpillar and pass through six instars, but do not have black spots on the thorax. Most larvae are



Figure 38. *Helicoverpa armigera* adult.



Figure 39. *Helicoverpa zea* adult.



Figure 40. *Heliiothis virescens* adult.

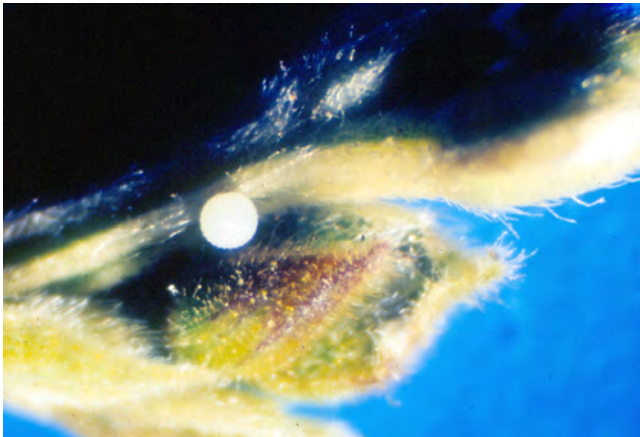


Figure 41. *H. armigera* egg.

dark greenish brown, but they can also be pink, cream, or almost black (Fig. 42, 43 & 44). Larvae develop through six growth stages (instars) and become fully grown in 2-3 weeks in summer or 4-6 weeks in winter. Development is more rapid at higher temperatures, up to 38 °C, after which development slows. Larval activity and feeding stops when temperatures fall below 12°C.



Figure 42. *H. armigera* larvae.



Figure 43. *H. zea* larva.



Figure 44. *H. virescens* larva.

These can be distinguished from tobacco caterpillars by their conspicuous setae on the body. Also, they do not hide in the soil during the day as is the case of tobacco caterpillars.

The damage caused by larvae to groundnut foliage is similar to that caused by the tobacco and hairy caterpillars, and they also prefer to feed on flowers and buds.

Pupation takes place in the soil. *H. armigera* is considered an important pest of groundnut in coastal Andhra Pradesh, Tamil Nadu and Karnataka, particularly in areas where cotton is extensively grown and insecticide application is heavy. It is believed that in these areas the *H. armigera* migrates to groundnut from nearby cotton fields.

## Groundnut leaf miner

***Approaerema modicella*** (Deventer)

(Lepidoptera: Gelechiidae)

The groundnut leaf miner is a common pest of groundnuts in South and southeast Asia and a major pest in India, and it has recently invaded Africa. It was first found in Uganda in 1998 and is now also recorded in Mozambique, Malawi, Democratic Republic of Congo and South Africa. In all African countries where this leaf miner has been found, the pest has reached epidemic form and severe yield losses have been observed on groundnut. It has a limited range of hosts *Amaranthus viridis* (slender amaranth), *Arachis hypogaea* (groundnut), *Boerhavia diffusa* (red spiderling), *Borreria hispida* (Thaarthaaval), *Cajanus cajan* (pigeonpea), *Cullen corylifolium* (black-dot), *Glycine max* (soybean), *Indigofera hirsuta* (hairy indigo), *Lablab purpureus* (hyacinth bean), *Medicago sativa* (lucerne), *Teramnus labialis* (blue wiss), *Trifolium alexandrinum* (Berseem clover), *Vigna radiata* (mung bean) and *Vigna umbellata* (Rice-bean) of which soybean is the most favoured after groundnut.

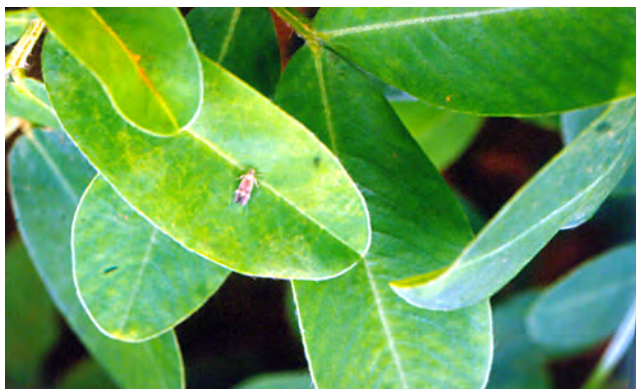


Figure 45. *A. modicella* adult.

The adult is a brownish-gray moth, only 6 mm long, with a 10-mm wing span (Fig. 45). Shiny white eggs are laid singly, usually on the underside of the leaflets, close to the midribs, and are just visible to the naked eye (Fig. 46). Each female lays about 200 eggs. The young larvae mine into the leaves as soon as they hatch (Fig. 47). This means that an infestation is usually detected by the presence of small brown blotches on the leaf. The mines are about 1 mm long when first noticeable. If a mine is opened, the

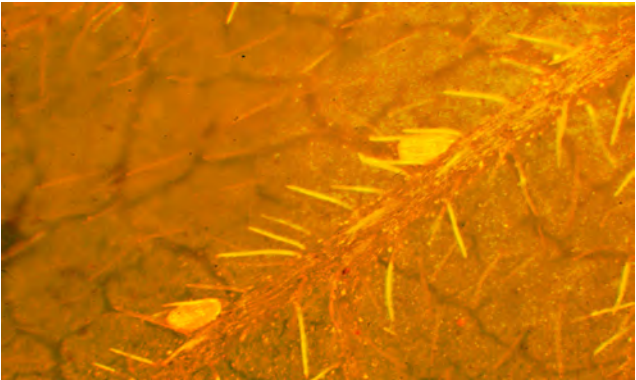


Figure 46. *A. modicella* eggs.



Figure 47. *A. modicella* larva inside a mine.

minute caterpillar can be seen inside. The first instar has an average length of 0.56 mm. At pupation, they rarely exceed 8 mm in length.

The mines enlarge as the larvae grow. When they become too large to occupy the mine, the larvae come out and web adjacent leaflets together, and continue to feed on leaf tissue from inside the webbed leaves. There are five larval instars. They live and feed in the shelter they have constructed. Pupation takes place inside the webbed leaflets.

A severely attacked field looks 'burnt' from a distance (Fig. 48). Epidemics can result in total crop loss. In southern India this species completes 3-4 generations in a crop season. Leaf miners are favored by the hot dry conditions.



Figure 48. Field damage by *A. modicella*.

## Legume Pod borer

***Maruca vitrata (testulalis)*** (Fabricius)

(Lepidoptera: Pyralidae)

The legume pod borer, *M. vitrata* Fabricius (Syn: *M. testulalis*), is distributed through the tropical and subtropical regions of the world. Although the Indo-Malaysian region is considered to be the most probable region of origin for the genus *Maruca*, including *M. vitrata*, the geographic range of this insect extends from northern Australia and East Asia through sub-Saharan Africa to the Caribbean, Central America and Hawaii. Although there were some reports from Texas (USA), it has now been eradicated.

*M. vitrata* is a serious pest of grain legumes in the tropics and subtropics because of its extensive host range, destructiveness and distribution. It is a serious pest of cowpea, pigeonpea, black gram, green gram, beans and soybeans in Asia and Africa. In the absence of host plants in the off-season the populations can survive on alternative plants such as wild leguminous shrubs and trees. The larvae feed on 39 host species, the majority of which belong to family leguminaceae.

*M. vitrata* females normally lay eggs on floral buds and flowers, although oviposition on leaves, leaf axils, terminal shoots and pods has also been recorded. A female may lay up to 400 eggs in batches of 2-16. Eggs are light yellow, translucent and measure 0.65 x 0.45 mm. The incubation period ranges from 2 to 4 days. Mature larvae are 15-20 mm long. The head capsule is light to dark brown, with irregular brownish black spots. The larvae pass through five instars during 8-16 days. Early instars are dull white, but the later instars are black-headed, with irregular brown or black spots on the dorsal, lateral and ventral surfaces of



each body segment. Pupation takes place within a cocoon within the web or inside the soil and lasts 5-10 days. Pupae are 11.5 x 2.5 mm, within a silken cocoon. The adult moth has light brown forewings with white patches, and white hind wings with an irregular brown border. It often rests with the wings outspread measuring up to 25 mm (Fig. 49). They are inactive during the day and can be found at rest with outspread wings under the lower leaves of the host plants. The life cycle is completed in 18-35 days depending upon temperature.



Figure 49. *M. vitrata* adult.

After hatching, the young larvae of *M. vitrata* (1st, 2nd and 3rd instars) injure the terminal shoots and the flower buds, whereas the older larvae (4th and 5th larval instars) damage the open flowers and the pods of leguminous crops. In case of groundnut, the young larvae initially feed on the young foliage (Fig.50) and around third instar stage bore into the terminal shoot resulting in stem tunnelling (Fig. 51). In case of severe incidence all the branches are tunnelled and the crop suffers considerable reduction in growth. Although its economic importance is not known on groundnut considering its importance on other crops, it is necessary to keep track of this species on groundnut.



Figure 50. *M. vitrata* damage on groundnut foliage.



Figure 51. *M. vitrata* stem tunneling on groundnut.

## Groundnut bud borer

***Anarsia ehippias*** (Meyrick)  
(Lepidoptera: Gelechiidae)

The groundnut bud borer occurs in northern India, and is normally considered to be a minor pest of legumes including groundnut, cowpea and garden pea. Fully grown larvae are chocolate brown in color (Fig. 52) and 10-15 mm long. Larvae prefer to bore into terminal buds and shoots (Fig. 53). Reports from Punjab (India) indicate severe stem tunneling by this species. It is also known to infest wild trees such as *Acacia* spp.

In groundnut the tender leaflets emerging from the central spindle will initially show shot-hole symptoms. In severe infestation, emerging leaflets will have only the midribs or several oblong feeding holes.



Figure 52. *A. ehippias* larva.



Figure 53. Damage caused by *A. ehippias* larva.

## Tussock caterpillars

*Euproctis subnotata* Walker

*Euproctis lunata* Walker

(Lepidoptera: Lymantriidae)

Tussock caterpillars are widely distributed in Asia and Africa, the larvae of *Euproctis* spp., feed on groundnut leaves, buds, and flowers. *Euproctis* adults are medium-sized moths with a 20 mm wing span (Fig. 54). The caterpillars are easily recognized by the presence of prominent, compact tufts of short hair on the back, near the head. (Fig. 55). The members of this genera are polyphagous and feed on cereals, legumes and orchard crops such as mango. The adult is a yellow moth with pale transverse lines and black spots on the forewings. The larvae are blackish brown hairy caterpillars, with red colored heads surrounded by white hairs. The abdomen has tufts of hairs and a long pre-anal tuft.



Figure 54. *Euproctis* adult.

Females lay about 200 eggs in clusters on the host leaves and covers them with brown hairs. Life-cycle consists of six larval instars with a total larval period of around 24-28 days. Pupal period takes about 8-10 days.

On groundnut these populations are seldom large enough to warrant pesticide application.



*Figure 55. Euproctis larva.*

## Gray weevils

***Myllocerus undecimpustulatus*** Faust

***Myllocerus*** spp.

(Coleoptera: Curculionidae)

*M. undecimpustulatus* Faust, a species native to southern India and spread over southeast Asia, the Indian subcontinent, Africa, Asia (including China and Japan), Indonesia and Australia. This species is one among the most serious weevil pest in India and Pakistan, where they attack more than 20 crops. Recently, this species is known to occur along the east coast of Florida from the Keys to Volusia County.

The adult measures 5 - 6.5 mm in length with broad snout. The larvae resemble small white grubs, and mature grubs measure 9.5 mm in length. The eggs are laid on the foliage close to the soil, in masses of 12-130 and are white in color. On hatching, the young grubs enter the ground and start feeding on the roots. The development from egg to adult ranges from 60-120 days. There are 6 larval instars. Larvae feed and pupate underground. A female lays about one thousand eggs during her 160 day life span.

The range of larval hosts and the developmental biology is not clearly known, but looking at its distribution and host range it can be noted as potential pest.

Gray (or ash) weevils eat on foliage of groundnut and wide a variety of hosts, notching or scalloping the edges of leaves (Fig. 56 ). They are generally of minor importance, but may pose problems in hybridization blocks because they also feed on flowers. These insects are not known to have attained demonstrable pest status in farmers' fields.

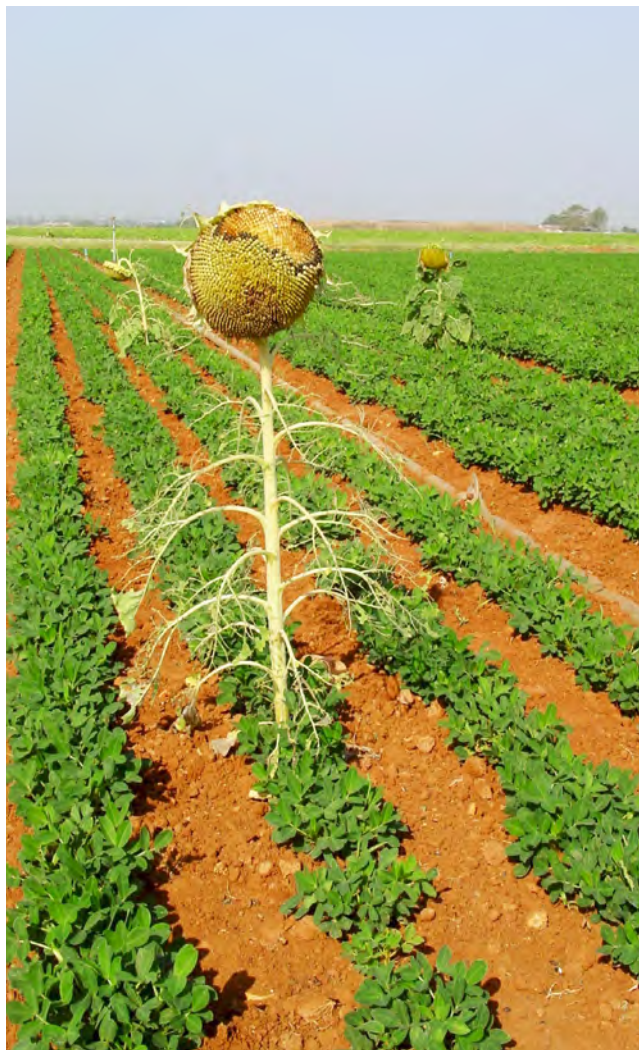


Figure 56. Groundnut foliage damaged by *M. undecimpustulatus*.

## Management of foliage feeders

The groundnut crop can tolerate considerable defoliation without causing any economic yield loss. However, the indiscriminate use of insecticides can cause outbreaks to inflict severe crop losses. These defoliators inflict economic losses only when the foliage damage exceeds 25%, or if one or more larvae plant<sup>-1</sup> are observed during the first 50 days after emergence (DAE). Defoliation can be ignored once the crop passes the vegetative phase (>50 DAE).

The concept of trap crops was put into practice to suppress populations of the two most important defoliators of groundnut (*S. litura* and *H. armigera*) that prefer sunflower over groundnut for oviposition and larval feeding (Fig 57). A significant difference in larval behavior was noticed between sunflower and groundnut -- the newly hatched larvae disperse immediately from the egg sites on groundnut, whereas on sunflower they stay for a week to ten days on the same plant. These larvae start to skeletonize the leaves of sunflower before moving to groundnut. At this stage the damage on the trap crop is clearly visible and useful for collection and destruction of the larvae without chemical application.



*Figure 57. Sunflower as trap crop to avoid defoliation in groundnut.*



Insecticide resistance has been detected in *Spodoptera* and *Helicoverpa* species. In any case, large larvae may not be killed by insecticides. Crop monitoring is advisable, and farmers should be prepared to apply insecticide if pheromone trap catches exceed 100 moths night<sup>-1</sup>, averaged over a week, or if there are more than 1-2 *Spodoptera* egg masses per meter row of crop (7-12 plants). Note that the crop can withstand considerable levels of defoliation after the seeds start developing in the pod without significant reductions in crop yield.

There are a number of ancillary control measures such as village or community-level decisions about the best crop combinations, pesticide application, and the optimum sowing time to avoid pest attack. Crop surveillance, pheromone trapping (Fig. 58), and the relevant decision making processes should also be fully understood by farm advisors.



Figure 58. Pheromone trap used to monitor *S. litura* and *H. armigera* moths.



Figure 59. Spider preying on *S. litura* larva.

More importantly, there are a number of predators (eg, spiders, Fig. 59; birds, Fig. 60; and ladybird beetles), parasites and diseases) that can keep the pest population within manageable levels provided they are not disturbed by any interventions.

The IPM strategies to reduce the incidence of these pests include: (i) growing sunflower or castor on borders or as an intercrop, (ii) destroying the egg masses by hand on groundnut and trap crops, (iii) encouraging larval predation by providing perches for birds (10-15 ha<sup>-1</sup>), and (iv) application of insect pathogens such as nuclear polyhedrosis virus (NPV). Under moderate levels of attack,



Figure 60. Insectivorous bird (*Drongo, Dicrurus adsimilis*) in a groundnut field.

only NPV or neem fruit powder extract should be applied. Insecticide application is recommended only as a last resort .

When adult leaf miners are noticed in the field, application of neem fruit powder extract @ 12 kg ha<sup>-1</sup> can provide effective reduction of oviposition. Insecticides, preferably dimethoate @200-250 mL a.i. ha<sup>-1</sup> or Imidacloprid @ 20 mL a.i. ha<sup>-1</sup> should be applied if five or more active larvae plant<sup>-1</sup> are found up to 30 days after seedling emergence (DAE), 10 larvae plant<sup>-1</sup> at 50 DAE, or 15 larvae plant<sup>-1</sup> at 75 DAE or later.

The role of natural enemies must be considered. For instance, if more than 50% of the larvae are parasitized (the parasites that can be seen as minute white specks, no more than 1 mm long, attached to the outside of the larvae), postpone the spray and closely monitor the development of the pest population.



Figure 61. Groundnut variety ICGV 86031 (right), resistant to *A. modicella*.

There are a number of agronomically acceptable pest resistant groundnut varieties and genotypes available in India, eg, ICGV 86031 (Fig. 61). Scientists in the national programs should use available sources of resistance in breeding programs to develop resistant varieties.

Though several cultural methods have been recommended for control of leaf miner, rotation of groundnuts with non-leguminous crops has been suggested as a means of reducing pest populations. Rotation of groundnut with soybean should be avoided to prevent outbreaks of the pest. Lower leaf miner larval densities have been found when groundnut was intercropped with sorghum, millet or cowpea than in monoculture groundnut.

For migrating caterpillars such as *Spodoptera* or red hairy caterpillar (RHC)

- Grow castor/sunflower as border or intercrop in groundnut fields to serve as indicators or trap crops.
- Monitor the emergence of adult moths by setting up light and pheromone traps.
- Collect and destroy egg masses in the cropped area.



Figure 62. Polythene fence to restrict the entry of migrating caterpillars.

- Collect and destroy gregarious, early instar larvae from trap crops.
- Avoid migration of larvae by digging a trench 30 cm deep and 25 cm wide with perpendicular sides around the infested fields or erect polythene fences on the sides (Fig. 62) to trap/restrict them from entering the fields.

If the above management options fail to keep the populations below the economic threshold levels (ETL) then apply any one of the following insecticides against the young caterpillars : Indoxacarb 20 mL a.i. ha<sup>-1</sup> or Spinosad 45 mL a.i. ha<sup>-1</sup> or Fenvalerate @ 100 mL a.i. ha<sup>-1</sup>.

When large caterpillars are noticed, prepare a bait with the following materials to cover one hectare. Rice bran 12.5 kg; Molasses or jaggery 1.25 kg and carbaryl 50 WP 1.25 kg. Mix the ingredients to obtain a homogeneous mixture by adding water gradually and bring the bait to a dough consistency. Distribute the above bait on the soil close to the plants. Wherever possible the chemical pesticide in the bait can be replaced with bio-pesticide such as Nuclear Polyhedrosis Virus  $1.5 \times 10^{12}$  POBs ha<sup>-1</sup>.

While planting trap crops care must be taken to avoid interference with the establishment of the main crop. Hence it is suggested to maintain one sunflower plant for every 20 m<sup>2</sup> of groundnut. Short-statured early maturing sunflower varieties are preferred. Other trap crops such as castor grow slowly under cool conditions and may not serve the purpose during the early stage of the crop for winter season groundnut.

## Sap sucking insects (Virus vectors)

Several species of insects feed on groundnut by sucking the sap of the plant. Jassids, aphids and thrips are common sap suckers in all groundnut-growing areas. Their economic importance as direct pests is not clear, but is probably exaggerated because the damage they cause is inconspicuous. Nevertheless, the potential importance of aphids and thrips as vectors of virus diseases should not be underestimated.

Several virus diseases of groundnut occur in the semi-arid tropics of Asia and Africa and some are economically important. Peanut stripe virus (PStV) is the most widespread and can cause considerable yield losses. Other economically important virus diseases have more restricted distributions. For instance, groundnut rosette is important in Africa, south of the Sahara; peanut clump (PCV) in West Africa and India, bud necrosis and stem necrosis in India and witches' broom (a disease associated with mycoplasma-like organisms) in southeast Asia. For effective management of plant virus diseases it is essential to learn their ecology, vector relationship and economic importance.

### Aphids

***Aphis craccivora*** Koch.  
(Homoptera: Aphididae)

Aphids are found on groundnut plants and other leguminous crops throughout Asia and Africa. *A. craccivora* reproduces without mating. Individual adults are capable of producing about 100 nymphs in their 5-30 day life span. These nymphs are dark brown and turn into shiny-black adults in about 10 days. When the population density in

the colony reaches a certain limit, winged individuals are found among the wingless forms. These fly away to form new colonies.

Nymphs and adults suck sap from the tender growing shoots (Fig. 63), flowers (Fig. 64), and pegs causing stunting and distortion of plants. They secrete a sticky fluid (honeydew) on the plant, which turns black by fungal infection. In the past, aphids were considered important only during the rainy season when the crop is young (below 30 days of emergence) and face drought situations, but in recent years severe outbreaks have been noticed during the post-rainy season at ICRISAT-Patancheru, India. Such outbreaks are sporadic and are

more intense during periods of drought stress.

Heavy rainstorms reduce aphid population densities and favor the development of the fungal diseases that suppress the population build up. Aphids are particularly susceptible to predators such as coccinellids, syrphids, lacewings and a number of parasites.

Although the feeding activity of aphid colonies can retard



*Figure 63. Aphids feeding on tender shoots.*



*Figure 64. Aphids on flowers.*

plant growth, this species is potentially more important as a virus vector. Fortunately, the most important aphid-transmitted viruses (peanut stripe virus, Fig. 65, and the groundnut rosette virus complex, Fig. 66) are either restricted in distribution or do not cause any economic impact in some countries.



*Figure 65 . Symptoms of peanut stripe virus disease.*





Figure 66 . Symptoms of groundnut rosette disease.

Peanut stripe virus, first reported from China in 1983 as producing a mild mottle in peanut was further characterized and named as peanut stripe virus (PStV) in USA. It has since been reported from major groundnut growing areas in southeast Asia, East Africa, South America and southeast USA, and has been found to cause economically significant crop losses. Besides groundnut, it infects soybean (*Glycine max*), cowpea (*Vigna unguiculata*), *Indigofera amoena*, *Pueraria phaseoloides*, *Stylosanthes capitata* and *S. craba* naturally. Symptoms on the foliage include mild dark green mosaic markings. The leaflet margins can be crinkled with inter-venal tissue depression. Chlorotic spots and stunting are also observed. The seed from infected plants are often malformed and discolored. It is seed borne and transmissible mechanically by sap as well as by the aphid *A. craccivora*. The movement of infected seed has resulted in its wide dissemination. No cultivated genotype is known to be resistant to PStV. However, several wild *Arachis spp.* are immune or highly resistant to this virus, and can be used in future breeding programs. The most efficient means of containing the virus at present is the use of virus-free seed.

Rosette is the most destructive virus disease of groundnut in Africa. Losses may be negligible in some years, but in epidemics rosette can cause heavy crop losses.

Rosette disease is caused by a complex of groundnut rosette virus (GRV) together with an associated satellite RNA, and a helper virus called groundnut rosette assistor virus (GRAV), on which the other two components depend for transmission by the aphid *A. craccivora*. Neither GRV nor GRAV alone cause obvious symptoms in groundnut. There are three forms of symptoms, chlorotic, green and mosaic rosette. Chlorotic rosette disease occurs throughout Africa south of the Sahara. Green rosette disease is found in West Africa and Uganda, and has recently been found in Angola, Malawi and Swaziland. Mosaic rosette is reported only from East Africa. With any of these diseases, early infection causes severe or total loss of yield. Late infection can cause reduction in the number and size of pods. Plants that are infected early are severely stunted with much shortened internodes, and appear as small dark green bushes.

Scientists have developed high-yielding groundnut varieties with resistance to rosette suitable for medium and high rainfall areas. Several of these varieties have performed well in many countries ( eg, ICGV –SM 90704, ICGV 12991).

## Thrips

***Scirtothrips dorsalis*** Hood.

***Thrips palmi*** Karny.

***Frankliniella schultzei*** (Trybom)

***Caliothrips indicus*** (Bagnall)

(Thysanoptera: Thripidae)

Thrips (Fig. 67) are small insects that live in the flowers and folded leaflets of groundnut. They are only about 2 mm long, pale cream in color and are usually hidden from view, and are therefore not very conspicuous. The most important ones on groundnut are *S. dorsalis*, *T. palmi*, and *F. schultzei*. It is virtually impossible to distinguish between species with the naked eye under field conditions, although their damage symptoms vary slightly.



Figure 67. *T. palmi* adult (scanning electron micrograph, x70).

The eggs are embedded in young groundnut tissues. The nymphs pass through four instars (two nymphal, and the 'prepupal' and 'pupal' instars) before becoming adults. Under optimal conditions, the immature stages last about 15 days. Adults live for 20 days and lay 40 - 50 eggs inside the leaf tissue.

Nymphs and adults suck sap from the surface of the leaflets with their rasping and sucking mouthparts. This initially results in white patches on the upper and necrotic patches on the lower surface of the leaves (Fig. 68). Distortions of the young leaflets and patchy areas of necrotic tissue get punctured and split as the leaflets grow. Injury is normally seen in seedlings.



Figure 68. Groundnut foliage damaged by thrips.

In severe infestations, particularly in the winter crop (November-sown in southern India), leaf distortion causes stunted plants (if more than 5 thrips terminal<sup>-1</sup> were noticed below 20 DAE of the crop). The effect of thrip damage on yield under low populations is not precisely known. However, farmers often apply insecticides to control thrips. This often results in outbreaks of more serious pests. Among different genera *T. palmi* transmits peanut bud necrosis and stem necrosis viruses, which can cause widespread yield loss.

The feeding activity of *C. indicus* is occasionally seen as a pale mottling on the lower leaves; however this species is of no economic significance.



Figure 69. Symptoms of bud necrosis disease.

Bud Necrosis in groundnut is caused by peanut bud necrosis Virus (PBNV), which is transmitted by thrips (*T. palmi*). Initial symptoms appear on young leaflets as faint chlorotic spots (Fig. 69) that may develop into chlorotic or necrotic rings. Later, these chlorotic spots and necrotic rings spread on all the leaflets of plants. Early infection results in plant mortality, but the late infection leads to weathered crop growth and poor seed set.

Groundnut stem necrosis disease (PSND) is caused by Tobacco Streak Virus (TSV) and is transmitted by thrips, through infected pollen from parthenium, sunflower and marigold deposited on the groundnut leaves or through the viruliferous thrips. First symptoms appear on young leaves as necrotic lesions and vertical necrosis. The necrosis later spreads to the petiole and stem. Necrotic lesions on the stem later spread upwards killing the bud (Fig. 70).

### **Management of bud and stem necrosis diseases**

Studies on various factors contributing to the multiplication and spread of vectors have provided ways and means of managing disease. Several cultural practices such as



Figure 70. Symptoms of stem necrosis disease.

adjustments to sowing dates, sowing at the recommended rate, maintaining optimum plant population, intercropping with fast-growing cereal crops such as maize and pearl millet, can reduce the incidence of PBNB. These practices have been shown to reduce infestation by *T. palmi*.

Considerable progress has been made in the identification of sources of field resistance to PBNB. Although many high-yielding PBNV resistant varieties have been developed, they are medium-maturing types. There are several varieties with resistance to thrips (Robut 33-1, Kadiri 3, ICGS 44, ICGV 86031 and ICGV 86388), which should be grown in endemic areas to reduce the risk of thrip damage and bud necrosis disease.

Management of PSND involves removal of weeds, particularly parthenium, that emerge with the early rains and maintaining optimum plant populations. Seed treatment with Imidacloprid (Gaucho 70 ws) indicate low thrips damage and subsequently low PSDN incidence.

## Jassids or leaf hoppers

***Empoasca kerri*** Pruthi

***Empoasca fabae*** Harris

***Empoasca dolichi***, Paoli

***Empoasca facialis***, Jacobi

***Bachlucha*** spp.

(Homoptera: Cicadellidae)

The commonest jassid that attacks groundnuts in Asia is *E. kerri* (Fig. 71), although *Bachlucha* spp. can be abundant in western India, especially in Gujarat. *E. dolichi* and *E. facialis* are the common jassid species on groundnut in Africa, while *E. fabae* is wide spread in the Americas.

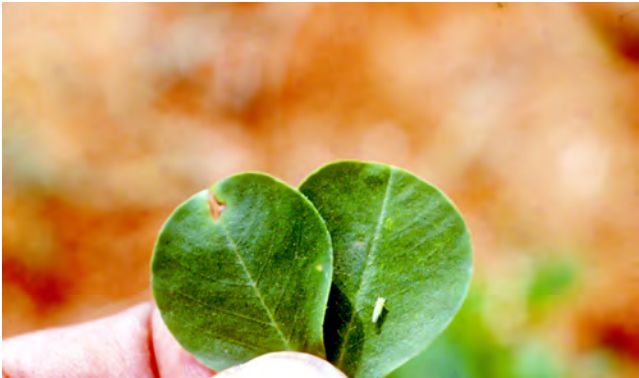


Figure 71. *E. kerri* adult.

Jassid eggs are embedded in the leaf tissue close to the midrib, or in the petiole. Under normal conditions, the eggs hatch in about a week, and nymphs develop into adults in 10 days. About 40 nymphs can be expected from a single female. High density jassid populations are seen during August and September, and February and March at ICRISAT - Patancheru. High and well distributed rainfall and low temperatures encourage jassid reproduction.

Both adults and nymphs suck sap from young leaves, mostly from the lower surface. The first symptom of attack is a whitening of the veins. Chlorotic (yellow) patches then appear, especially at the tips of leaflets, probably caused by a reaction between the jassids' salivary secretion and plant sap. Under severe infestation, the leaf tips become necrotic in a typical V shape, giving the crop a scorched appearance known as 'hopper burn' (Fig. 72).



Figure 72. Severe *E. kerri* infestation.



## Spider Mites

***Tetranychus urticae*** Koch  
(Acarina: Tetranychidae)

Spider mites are well distributed throughout Asia and eastern Africa and are polyphagous in nature. The adult mites are 0.5 mm in size and are oval in shape. Yellow eggs are laid on the under surface of the leaflets and the nymphs hatch out in a couple of days. These nymphs feed on the under surface of the leaflets under a protective webbing. One generation can be completed in a fortnight under ideal conditions.

In groundnut, spider mites feed on the underside of the uppermost leaves and are hard to find because of their tiny size. When spider mites reach high numbers, webbing can be seen around infested leaves. Spider mites can be very serious pests during extended dry periods.

Problems with spider mites usually worsen when certain fungicides and insecticides are used (Fig. 73). Rainfall and more humid conditions are likely to lower mite numbers.



Figure 73. Spider mite damage in groundnut.

## Management of sap sucking Insects

**Aphids, Thrips and Jassids:** Effective chemical control measures are available to control these sucking pests.

However, indiscriminate use of chemicals should be avoided and they should be applied based on economic threshold levels. Seed treatment with Imidacloprid @ 2 mL kg<sup>-1</sup> seed provides protection for almost a month against sucking pests. Rains or sprinkler irrigation also help to wash down aphids. However, if dry conditions prevail, their severity may increase.

If more than five thrips terminal leaf<sup>-1</sup> (folded) are observed before 20 days after seedling emergence (DAE), Imidacloprid @ 20 mL a.i. ha<sup>-1</sup> or Dimethoate @ 200–250 mL a.i. ha<sup>-1</sup> should be sprayed. Thereafter, it is not necessary to control thrips.

If more than 10% of the foliage show 'hopper burn' ('V' shaped yellowing at the leaf tip) before 30 DAE, Imidacloprid @ 20 mL a.i. ha<sup>-1</sup> or Dimethoate @ 100–200 mL a.i. ha<sup>-1</sup> should be sprayed. There is no need to control this insect pest thereafter.

Studies on groundnut aphid and mites at ICRISAT-Patancheru, indicated that rainfall or overhead sprinkler irrigation could substantially decreased (up to 80%) mite populations. Though sprinkler irrigation is not within the reach of most groundnut farmers in developing countries, application of only water sprays (through sprayers) can provide equally effective control against leaf miners and sucking pests such as aphids and mites.

If the above options are not satisfactory then chemical sprays are advised. Mix 2-3 ml of Sticker (Sandovit, if not available, 2-3 g of surf powder / detergent liter<sup>-1</sup> of spray fluid) with the chemical sprays. Among chemicals Wettable Sulfur 2-3 gms or Kelthane 2 ml, or Karathane 2-3 gms, Pegasis @ 1 gms liter<sup>-1</sup> or Vertemic @ 0.5 ml liter<sup>-1</sup> or thiovit @ 2 gms liter<sup>-1</sup> of water as foliar spray can provide effective control. Use 200-250 liters of spray fluid to cover one ha of groundnut using motorized low volume sprayers.

## Insects of Post-harvest importance (storage Pests)

More than 100 insect species are known to live and feed on stored groundnuts, some of which are of economic importance. The most commonly reported stored pests of groundnut in Asia and Africa are discussed in this chapter. Storing groundnut in the pod protects the seed against most post-harvest pests. The only exception is the groundnut bruchid *Caryedon serratus* (Olivier). The other insects that are commonly found feeding on shelled groundnuts include the rice moth (*Corcyra cephalonica* Stainton), red flour beetle (*Tribolium castaneum*) and pod sucking bug *Elasmolomus sordidus* (Fabricius). Insect infestation in groundnut is well known for causing direct loss, but indirect loss in terms of quality of the produce also impacts its trade and use. The heat and moisture generated by a large insect population in storage also increases the risk of mold growth, which indirectly spoils the quality through mycotoxin contamination, rendering the stock unfit for human and animal consumption.

### Groundnut bruchid

***Caryedon serratus*** Olivier  
(Coleoptera: Bruchidae)

*C. serratus* is widely distributed in groundnut growing areas of the world except in USA.

The adult is a brown beetle, about 4-7 mm long and 5 mm wide with prominent large hind legs (Fig. 74). A single gravid female lays 20-30 creamy white eggs (1 mm long), which are glued to the surface of groundnut shell or kernels (Fig. 75). The incubation period varies from 4 to 6 days. The newly hatched larva burrows straight through the eggshell and pod wall, and starts eating the kernel. No damage

can be seen at this stage unless one searches carefully. The first sign of attack is the appearance of 'windows' (approximately 3 mm in diameter) made on the pod wall by the grub to allow the adult to leave the pod. Each larva feeds solely within a single kernel. Larval development is completed in 40 to 45 days, and the pupal stage lasts for about 15 days (Fig. 76). Sometimes, the grown-up larvae leave the produce and pupate at the bottom of the sacks. By this stage, the groundnut seeds are badly damaged and are unfit for human consumption, seed use or oil expulsion.



Figure 74. *C. serratus* adult.



Figure 75. *C. serratus* eggs.

Under optimum conditions (30-33°C and 70-90% relative humidity), the life cycle of *C. serratus* is completed in about 60 days. A systematic search of groundnut storage godowns and farmers stocks is needed to establish the extent and severity of infestation.



Figure 76. *C. serratus* larvae; damaged seeds and pods.

## Red flour beetle

***Tribolium castaneum*** Herbst  
(Coleoptera: Tenebrionidae)

The red flour beetle is of Indo-Australian origin, widely distributed in temperate areas, and can survive the winter in protected places (godowns). In the United States, it is found primarily in the southern states. Thus, it is known to be cosmopolitan in distribution and infests all crop products, which is particularly severe in the tropics.

Red flour beetles attack stored groundnuts and other grain products such as flour, cereals and meal. The adults are 3-4 mm long and brown in color (Fig. 77). The adults live for several months and are strong fliers. The female lays eggs in cracks of the testa or on the damaged portions of the kernel to enable the young grub to feed on the kernel directly. A female lays up to 450 individual eggs, distributed among the pods or seed. Eggs hatch in 3-4 days. The grubs are cylindrical in shape with prominent projections on the last abdominal segment. The pupal period lasts for 7-10 days, and the adults can live up to 18 months. The mean



Figure 77. *T. castaneum* adult.

developmental period requires about a month under optimal conditions (30°C and 90% RH). Pupation takes place inside the damaged kernel without a cocoon. The grubs feed on the kernel making them unfit for use as seed and human consumption. The damage results in powdery appearance of the produce (Fig. 78). The infestation can be recognized by the presence of creamy white grubs and active adults.



Figure 78. Damage caused by *T. castaneum*.

## Rice moth

*Corcyra cephalonica* (Stainton)

(Lepidoptera: Galleriidae)

Rice moth is cosmopolitan in distribution and known to infest all crop products, which is particularly severe in unhygienic storage situations.

The rice moth has a wingspan of 12-15 mm, with grayish brown forewings (Fig 79). The female lays up to 150 eggs within a few days of emergence. The adults live for 1-2



Figure 79. *C. cephalonica* adult.

weeks and drop their eggs in the produce. The creamy white larvae (Fig. 80) start feeding on the seed immediately after hatching. At maturity, they construct white silken cocoons for pupation. The larvae are capable of damaging sound kernels, and can feed both on the surface and within the seed. They spin a tough silken fiber, webbing the kernel and frass. This type of damage can easily be distinguished from the fine dust that results from beetle damage. Pupation



takes place in the galleries developed by the larvae or in the crevices in storage structures. Development from egg to adult requires 30-35 days under optimum (30°C and 90% RH) storage conditions.



Figure 80. Larva of *C. cephalonica*.

## Pod-sucking bug

*Elasmolomus (Aphanus) sordidus* (Fab.)  
(Hemiptera: Lygaeidae)

Pod-sucking bugs are widespread in Africa, Asia, Brazil, Mexico and Hawaii. Besides groundnut, they also attack sesame and cotton.

On groundnut, the initial infestation starts when the harvested plants are dried in the field. The adult is dark brown, approximately 10 mm long and 2 mm wide (Fig. 81). Each female lays about 100 eggs in its lifespan of about 30-40 days. In the field, the females lay their eggs in the soil or on groundnut haulms, but under storage conditions, eggs are laid loosely among the groundnuts or on sacks. The first instar nymphs have a bright red abdomen; later instars become progressively darker. All stages of the pest feed on seeds, perforating the pod with their rostrum. This causes seed shrivelling (Fig. 82) and increases the free fatty acid content of the oil, producing a rancid flavor. The infested pods are discolored and show oily spots on the outside. In case of severe infestation, the produce is unfit for seed as well as human consumption.



Figure 81. *E. sordidus* adult.



Figure 82. *E. sordidus* damaged kernel.

## Management of storage pests

It is very important to harvest groundnut at optimum maturity to reduce the post-harvest losses and to maintain the quality of the produce under long-term storage conditions. The easiest and most practical method to look for pod maturity is internal pericarp color. Darkening of the internal surface of the pericarp is directly related to seed maturity (Fig. 83). When 75–80% pods show internal pericarp darkening, it means the crop is at optimum



Figure 83. Pods showing optimum maturity.

maturity. At harvesting, groundnut pods generally contain about 35% moisture, which must be reduced to below 7% to provide optimal conditions in storage. In the postrainy season, when higher temperatures (40-45 °C) prevail at the time of harvesting, the pods must be stripped immediately and dried under shade. For protection against storage pests, except for the groundnut bruchid, groundnuts should be stored unshelled.

In the developing world, the high cost of chemical pesticides, and non-availability of effective formulations and efficient storage structures necessitate the need for low cost effective post-harvest insect management practices. While making the decisions on chemical control, one should be aware of the economic threshold to justify the investment, level of contamination and the operational hazards. This will further be determined based on the purpose of the product such as for oil extraction, food or seed.

## **Prevention of infestation**

**Commercial storage:** Good warehouse management and hygiene are key to prevention of insect infestation in stored products. Before shifting groundnut to the store, it should be thoroughly cleaned and free from all crop residues. If old gunny bags are used, they should be checked for any infestation before filling with new produce. If necessary, the bags should be disinfested either by soaking in dichlorvos solution (0.05%) or by fumigation with celphos. The filled sacks must be placed on wooden platforms away from walls to protect them from moisture from the ground and to provide proper ventilation around the stacks (Fig. 84). Also, there must be some space between stacks to facilitate spraying.



*Figure 84. Groundnut bags placed on wooden platforms for long-term storage.*

**Pod storage:** Insect pests that attack groundnuts after harvest prefer kernels as they are unable to infest intact pods. Keeping the produce as pods for as long as possible is an effective strategy in limiting the damage, except against *C. serratus*. However, storage in the form of pods is bulky and requires more space. Usually the infestation in any stock starts from the outer layers of the stock, hence application of chemical protectants on the surface can provide effective control. On the other hand, dust formulations such as malathion (5%), fenvalerate (5%) can be applied to the surface of the bags or mixed directly with pods where pods are meant for seed purpose.

**Kernel storage:** Groundnut is sometimes stored as kernel to economize the space in storage, to save transportation costs and for export purposes. Groundnuts meant for confectionary use are often shelled soon after the harvest so that the damaged and shriveled kernel can be discarded. The direct application of insecticide to the kernel is discouraged because of possible residues in the kernel if not used for seed. However, kernel in sacks can be protected by the application of either liquid formulations

or dusts on the outside as recommended in pod storage. Dusting with an inert substance such as attapulgite-based clay dust (ABCD) can also help to minimize storage insect problems.

## **Management of established infestation**

When the infestation is noticed in the stocks, the most effective method of disinfestation is by fumigation. This involves application of gaseous formulations in the deeper layers of the stocks by preparing an airtight space around the stock. Chemicals used in this process such as celphos (aluminum phosphide) @ 3 g bag<sup>-1</sup> (40 kg bag) are highly toxic to human beings. Hence this should be used under the supervision of well-trained personnel. In such cases, the entire store can be effectively sealed to prevent leakage of gas during the treatment. The stock must be covered with polythene (at least 0.13 mm thick) sheets. If more than one sheet is required to cover the stock, the sheets should be joined and sealed with tape with a good overlap. Prevent the leakage of gas from the edges by placing sand or taping around the floor. After 5 days of fumigation, the produce should be thoroughly aired with an exhaust fan, and the leftover fumigant powder should be removed. This can be easily achieved if the fumigant is placed in paper envelopes. The disadvantage of this procedure is that once the tube carrying the celphos tablets is opened, all of them should be used during that application and the remaining cannot be stored for future use. If properly carried out, this fumigation can take care of all the stages of insect pests without affecting the viability of the seed; however, it does not offer any protection from residues.

## Storage for seed purpose

Under unfavorable conditions, groundnut seed (shelled groundnut) loses viability quickly. If seeds are to be stored, they should be stored under low temperature conditions. In general, the lower the temperature, the longer is the expected storage life of the seeds. The seed quality of groundnuts with  $\leq 7\%$  moisture content can be maintained for at least one year at 1 to 5°C and 65 to 70% relative humidity.

In case of pest outbreak in storage, the bags should be covered with a polythene sheet and fumigated as explained earlier. The fumigator should use protective clothing (hand gloves, nose mask and goggles). After fumigation is over, run the exhaust fan for 6-8 hours to keep the room free from chemical fumes. Fresh air should be allowed in for some time (couple of hours) by keeping the windows and doors open before handling the produce, provided they have insect proofing. At the household level, fumigation should be done outside, away from the living quarters.

**Eco-friendly management of storage pests at farm and household level:** At farm level, groundnut is often stored as pods, and it may not be possible for the smallholder farmers to provide high quality storage conditions. The pods should be stored in polythene lined gunny bags or in some other safe storage structures (small seed bins, earthen pots or metal drums in a well-ventilated and rodent free room. Only undamaged, well-dried clean pods should be stored to avoid fungal and insect pest attack in the storage.

## Approach

- When high temperatures (40-45°C) prevail at the time of harvest, the pods must be stripped immediately and dried under shade to maintain seed viability for a long period.
- Maintenance of optimum moisture content (<7%) of seed, sanitation of seed as well as storage space, and appropriate storage methods are always critical in preventing the development and damage caused by storage pests. In rural household situations where measuring moisture content is difficult, see that the testa of the seed comes away with gentle pressure applied to the seed between thumb and forefinger after thorough drying.
- Clean the storage containers thoroughly and expose them to sunlight for a couple of days before storing groundnuts.
- In case of *C. serratus*, to prevent primary infestation from alternate hosts (*Tamarind*, *Acacia* and *Pongamia*), avoid drying groundnuts near these host trees.
- In Vietnam, well dried pods are stored in earthen pots of 20-25 kg capacity lined with dried banana leaves. The top of the container is filled with a thin layer (one cm depth) of rice and then sealed with mud. This facilitates effective storage against insect pests without affecting the viability.
- Storing groundnut kernel with dried neem leaves (about 500 g of leaves for 10 kg kernel) in any sealed container is also effective.



## Notes



## International Crops Research Institute for the Semi-Arid Tropics

**The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)** is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru near Hyderabad, Andhra Pradesh, India, with two regional hubs and five country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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