Major Insects of Groundnut

Compiled by

Faujdar Singh and D. L. Oswalt

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Contents

Introduction

Insects are animals belonging to the class insecta of phylum Arthropoda. An insect has at least some of the following characteristics (Oudejans 1982):

- Insects are tracheal arthropods. Exoskeleton is made of chitin.
- The body is divided into a head, thorax, and abdomen (Fig. 1).
- The head has a pair of antennae (feelers), mouth parts, and one pair of eyes. The antennae are borne on the forehead, and used for feeling and smelling.
- The thorax is trisegmented into prothorax, mesothorax, and metathorax. Each of the three thorax segments bears one pair of jointed (articulated) legs for a total of six legs. Each leg is composed of five parts.
- An adult insect usually has two pairs of wings. One pair on each mesothorax and metathorax (flies only have one pair; many adult insects have none).
- The abdomen is divided into many segments. The posterior abdomen is often extended into an ovipositor with which the female lays eggs.

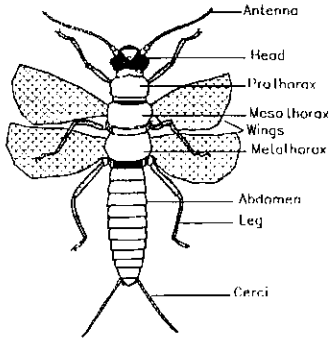

Figure 1. Parts of an insect body.

Life Cycles of Insects

Insects have two kinds of life cycles.

1. **Simple (Hemimetabola).** In this case, the pupal stage is absent (Fig. 2). Nymphs (immature stage) usually look similar to the adult. As nymphs get older the wing 'buds' grow and wings attain full size in the adult. The different stages are egg, nymph, and adult.

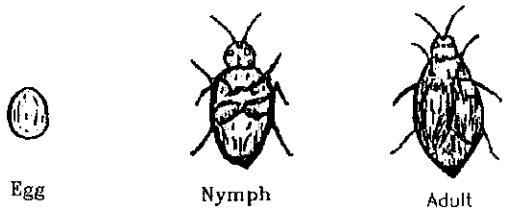

Figure 2. Stages of a simple life cycle of an insect.

2. **Complex (Holometabola).** In this type of life cycle, a pupal stage is present (Fig. 3). The larvae and adults are different in appearance. The change in form occurs in the pupal stage. The different stages are egg, larva, pupa, and adult.

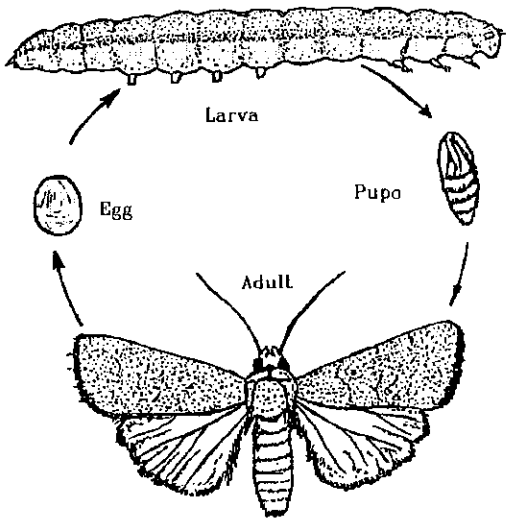

Figure 3. Stages of a complex life cycle of an insect.

Classification of Insects

Class insecta is divided in to 29 orders (Richards and Davies 1977). Those of high economic importance in groundnut production are Homoptera, Hemiptera, Isoptera, Dermaptera, Coleoptera, Lepidoptera, Thysanoptera, Hymenoptera, and Diptera.

1. **Homoptera.** They have two pairs of membranous wings with sucking mouth parts. Examples are aphids, jassids, and *Hilda*.

2. **Hemiptera** (bugs). The front pair of wings are partly thickened, although the tip is always membranous. A beak arises from front of the head to suck plant sap, and the mesothorax has a triangular scutellum.

3. **Isoptera** (termites). Termites, commonly known as white ants, have slender white bodies and large, light brown heads. They live either inside the plant or in the soil. There are different castes; worker, soldier, king, and queen. They are social insects with very short cerci.

4. **Dermaptera** (earwigs). Earwigs are brown to black and have nippers or pincers (up to 2 mm) at the end of abdomen. Mostly they are found in the soil close to the root and pod zone.

5. **Coleoptera** (beetles and weevils). Adults have their front wings modified into hard wing covers (elytra). This protects the membranous flying (hind) wings that are folded under the elytra. Larvae have many forms, but always have three pairs of legs. Some common beetles are:

   a) **Scarabaeoids.** Adults (cockchafers) and larvae (white grub) have many local names. They are soil inhabitants, larvae feed on roots, adults on foliage.

   b) **Weevils.** Adults have the front part of their head elongated and have characteristic antennae. The head is often buried in a fold of the thorax. The larvae usually live in the soil and feed on roots. The legs are often hard to see.

   c) **Lady bird beetle.** Both adults and larvae are predators of insect pests, particularly aphids.

   d) **Wireworm.** The adults (click beetle) can jump by flexing their body. Larvae cause damage to pods. They are up to 2 mm in length.

   e) **Blister beetle.** These beetles are large and have a very obvious black band with yellow, orange, or red spots. They are up to 30 mm in length. Adults prefer to feed on red and yellow flowers.

6. **Lepidoptera** (butterflies and moths). They possess a long coiled proboscis. Their wings are covered with scales. The larvae (caterpillars) are harmful as they are defoliators, borers, and miners. Their caterpillars can be distinguished because they have additional legs on their abdominal segments (prolegs).

7. **Thysanoptera** (thrips). They are very small insects (about 1 mm long). They live in flowers and young foliage, especially between the folded leaflets. Adults have fringed wings. The larvae appear similar to the adult, but have no wings.

8. **Hymenoptera** (wasps, bees, and ants). Ants are distinguished from termites by the shape of antennae. The first abdominal segment is fused with the metathorax. The second abdominal segment forms a narrow waist (pedicel). Hind wings are connected to the forewings by hooklets. They have two pairs of membranous wings. Parasitic *Hymenoptera* that belong to this group have a wide range of forms.

9. **Diptera** (flies). Adult flies have one pair of well-developed wings. The hind wings are modified into button-shaped structures called haltered, used for balancing the body while flying. Larvae (maggots) vary in size and have no legs.

10. **Neuroptera** (lace wings). The adults are brown or green. Their wings are large in comparison to the body. Wings are transparent and provide a good roof to the body. Cerci are absent, antennae are well developed. The larvae are brownish with large mandibles. The eggs are laid on silken stalks.

Insects of Groundnut

The major insects of groundnut can be grouped (Wightman 1986) as soil inhabiting insects, foliage feeding insects, those that transmit virus diseases, and insects that damage flowers and growing parts (Table 1).

The management of each group of insect pests, including procedures for survey, layout of experiments, and use of pesticides are discussed in Management Procedures (MP 1–12).

Table 1. Major insect pests of groundnut.

Common name	Scientific name
A. Soil-inhabiting insects	
1. Termites	*Odontotermes velonensis* (Washmann)
	Odontotermes obesus (Rambur)
	Microtermes thoracalis (Srostidet)
2. White grubs	*Lachnosterna consanguinea* (Blanch)
	Lachnosterna serrata Fabricicus
3. False wireworms[1]	*Gonocephalum* sp.
4. Earwigs[1]	*Anisolabis annulipes* (Luc)
5. Subterranian ants[1]	*Dorylus orientalis* Westwood
6. *Hilda*[1]	*Hilda patruelis* Stal
B. Foliage feeding insects	
1. Leaf miner	*Aproaerema modicella* Deventer
2. Red hairy caterpillar	*Amsacta albistriga* Walker
	A. moorei Butler
3. Bihar hairy caterpillar	*Spilosoma obliqua* Walker
4. Tabacco caterpillar (armyworm)	*Spodoptera litura*
5. Bollworm	*Helicoverpa armigera* (Hubner)
C. Foliage feeder and vectors	
1. Aphid	*Aphis craccivora* Koch
2. Thrips	*Thrips palmi* Karni
	Scirtothrips dorsalis Hood
	Caliothrips indicus Bagnal
	Frankliniella schultzei (Trybom)
3. Jassid	*Empoasca kerri* Pruthi
D. Insects damaging flowers	
1. Blister beetle	*Mylabris pustulata* Thunberg

1. Minor pests.

MP 1. Termite

Termite (Fig. 4) damage to groundnut is common in light soil when rainfall is moderate. The *Microtermes* and *Odontotermes* species seriously attack groundnut. *Microtermes* are widespread in Sudan, Saudi Arabia, and Yemen. *Odonotermes obesus* Ram. is common in India (Amin 1988).

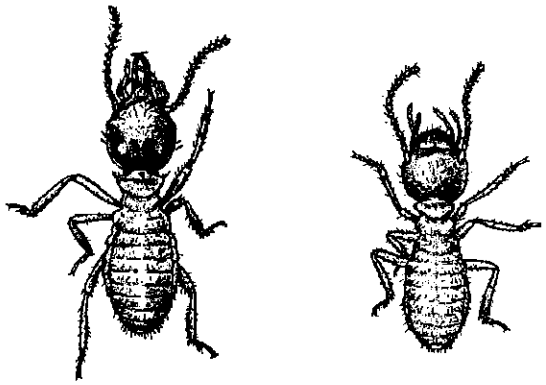

Figure 4. Adult termites: soldier (left) and worker (right). (Source: Feakin 1973.)

Symptoms

Termites damage groundnut in three ways (Amin 1983). They

1. tunnel into roots or stems (affected plants die);
2. pierce pods and feed on seeds;
3. scarify pods leading to roughness on the pod surface that makes them fragile and they shatter or crack during harvest. These pods are more prone to fungal invasions.

Microtermes kill plants directly by destroying the root system. *Odontotermes* feed on soft corky portion of the pods causing scarification and bore in to the pod.

The distribution of termites in a field is nonrandom, therefore, samples must be taken at several places in a plot or the entire area should be treated as a sampling unit.

The observations on termite damage are recorded in four ways:

1. Plants killed (%).
2. Pods bored (%).
3. Pods scarified (%).
4. The injury rating of a scarified pod is made on a 1 to 9 scale, where 1 is no scarification and 9 is total scarification of a pod.

Control Measures

- Seed dressing with insecticides such as aldrin @ 3 g kg^{-1} of seed protect the seed from termite attack (but it is not used due to long residual effect and the lipophilic nature of the chemical).

- An application of carbofuran 1 kg a.i. ha^{-1} provides effective control of termites. The feasibility of the chemical control in the semi-arid tropics (SAT) is questionable.

- Drenching the infested soil with aldrin effectively controls termites and checks their further spread in the plot (Ghewande et al. 1987).

- Harvesting at optimal maturity, deep plowing during the off-season, and using mulches of neem cake can reduce scarification of pods (Ranga Rao and Wightman 1991).

MP 2. White Grub

White grubs [*Lachnosterna* (=*Holotrichia*) *consanguinea* Blanch.] (Fig. 5) are major pests in sandy-loam or light-red soils (Amin 1988). Feakin (1973) described four species of white grubs that are destructive to groundnut.

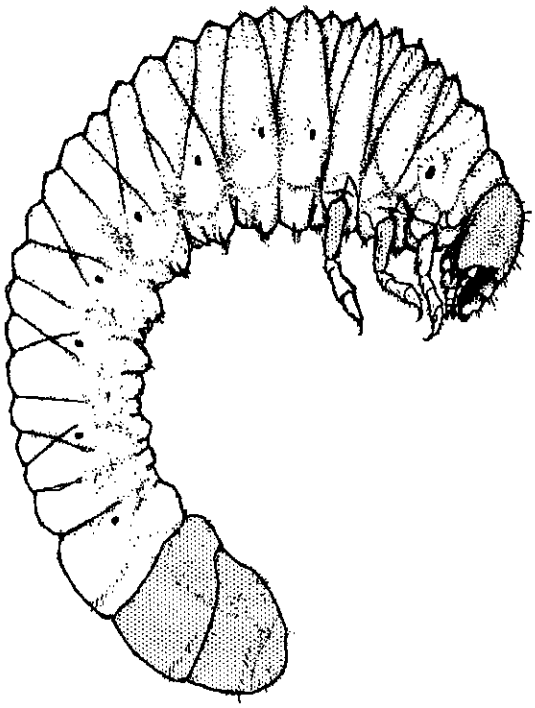

Figure 5. A typical white grub.
(Source: Feakin 1973)

Damage

The young grubs feed on small roots and organic matter. The older grubs (third instar) can eat the entire tap root. The affected plants wither and die. The damage in a field occurs in patches.

Control Measures

- Expose diapausing stages by deep summer plowing.
- Monitor the population using light traps.
- Apply carbofuran @ 1 kg a.i. ha^{-1} at sowing.
- Drench the infested area of soil with carbofuran to prevent further spread.
- Early sowing, preferably in 2nd week of June.
- The neem tree (*Azadirachta indica*) is the main host of the adult beetles. Therefore, it is necessary to spray all these trees that are close to the groundnut crop. Spraying with 200 g of carbaryl 50 WP (Sevin®) or 50 mL Folithion® in 100 L water will kill the adult beetles and check the spread of grubs during the crop season (Ghewande et al. 1987).
- Treat the seed with chlorpyriphos @ 12.5 mL kg^{-1} seed.

MP 3. Thrips

Thrips (Fig. 6) are small insects that inhabit the terminal buds and flowers of groundnut. They transmit tomato spotted wilt virus in groundnut and several other crops: green gram, black gram, cowpea, soybean, and tomato.

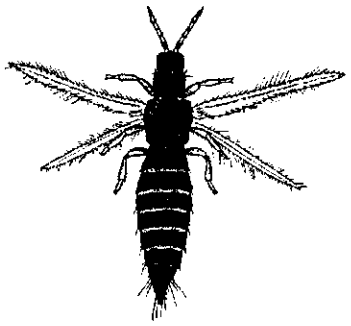

Figure 6. An adult thrip (*Frankliniella* sp.) (Source: Feakin 1973.)

Symptoms

Four genera of thrips commonly infest groundnut (Amin 1988).

1. ***Scirtothrips dorsalis* Hood.** Adults and nymphs feed on young leaves causing the dull yellowish-green patches on the upper leaf surface and dark-brown necrotic patches on the lower leaf surface. Yield losses of 17% pods and 30% haulm have been recorded.

2. ***Frankliniella schultzei* Trybom.** The feeding of this species results in white scars on the upper surface of young foliage. The insects mostly inhabit the young leaves and flowers. The nymphs prefer the leaf buds and adults prefer flowers.

3. ***Thrips palmi* Karni.** They cause foliage damage similar to *Frankliniella*. Recent studies indicated that this is the most effective vector for bud necrosis virus (BNV).

4. ***Caliothrips indicus* Bagnall.** The feeding of this species results in spots or 'stippling' on the upper surface of the old leaves. The lower leaves of the plants are preferred for feeding. The injury results in white spots and patches intermingled with black excreta on the leaf surface.

Assessment of thrips damage. Thrips damage can be recorded in the following ways:

1. By counting the number of leaflets damaged on five plant samples. Five thrips on each terminal leaflet, up to 20 days after emergence, indicates a severe infestation.

2. Recording the severity of foliage damage on a 1 to 9 scale:

1	= no damage	
3	= low level of damage	<30%
5	= moderate damage	<50%
7	= severe damage	<70%
9	= heavy damage	>90%

Control Measures

1. Sprays are recommended when 5 thrips plant^{-1} are observed when the crop is up to 30 days old. Apply dimethoate 250-300 g a.i. ha^{-1} or monocrotophos 150-200 g a.i. ha^{-1} (G.V. Ranga Rao, ICRISAT, personal communication 1992).

2. Grow resistant genotypes Robut 33-1, ICGS 11, and ICGS 44.

MP 4. Jassid

The jassid (*Empoasca kerri* Pruthi) inhabits young foliage. This insect (Fig. 7) prefers the first three terminal leaves. Their feeding induces yellowing of foliage that begins at the tip, known as hopper burn.

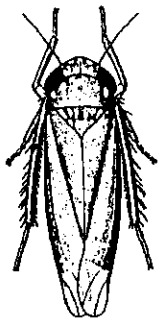

Figure 7. An adult jassid.

Damage

Adults and nymphs suck sap from the leaves and petioles. The leaves turn yellow. A heavy infestation on young plants causes stunting and leaf tips turn yellow with a typical 'V-shape' marking. The affected crop shows severe yellowing. On close examination of infected plants, nymphs can be seen on the under side of the leaves.

Jassid injury is assessed by sampling five 1-m rows, selected diagonally and on a minimum of 30 terminal shoots ha^{-1} (Amin 1983). Five to ten jassids $plant^{-1}$ at 30 days after emergence can damage the crop seriously.

Observations recorded on jassid damage are:

1. Percentage yellowing of foliage.
2. Number of jassid nymphs on 30 of the first three terminal leaves.

Control Measures

1. Spraying with monocrotophos 150-200 mL a.i. ha^{-1} or dimethoate 200-250 mL a.i. ha^{-1}.
2. Use of jassid tolerant and agronomically suitable genotypes; NCAC 343 and NCAC 2232.
3. Intercrop groundnut with pearl millet to reduce the jassid infestation on groundnut (Amin 1988).

MP 5. Aphid

The aphid (*Aphis craccivora* Koch) is a brownish-gray polyphagous insect (Fig. 8). They are the vectors of groundnut rosette virus (GRV), peanut mottle virus (PMV), and peanut stripe virus (PSV) in Asia and Africa. Aphids can cause yield losses of up to 40% (Khan and Hussain 1965). They cause serious damage in a drought situation when the crop is young.

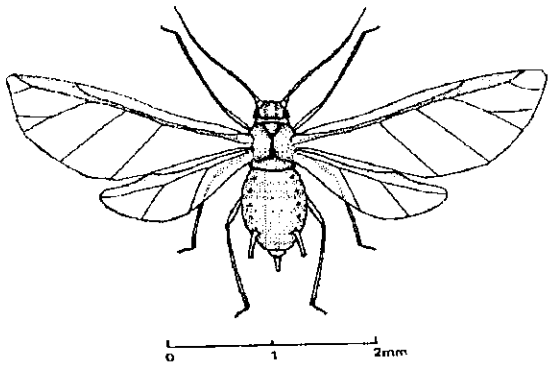

Figure 8. A winged adult aphid, *Aphis craccivora* Koch (Source: Feakin 1973.)

Symptoms

Aphids infest crops at all stages of growth when conditions are favorable. Aphids are sporadic pests of groundnut. They build-up large populations during low-rainfall years in the rainy (*kharif*) season. Their feeding cause the leaves to curl and growth to be stunted. Both adults and nymphs feed mostly on growing tips and young foliage by sucking sap (Amin 1988).

Aphids remain hidden in the crop canopy. Therefore, to count aphids the crop canopy needs to be opened. The nonrandom distribution of aphids requires sampling of large areas. Five subplots (each 1 m^2) arranged diagonally are adequate for sampling (Amin 1983).

The following observations are recorded for damage caused by aphids:

1. The number of plants infested with aphids.
2. The size of individual aphid colonies are recorded as aphids $plant^{-1}$: small (11-25), medium (26-100), and large (>100) .

Control Measures

1. Spray is recommended when there are 7-10 aphids plant^{-1} at 20-30 days after emergence (DAE).
2. Spray of dimethoate 200-250 mL a.i. ha^{-1} or monocrotophos 150-200 mL a.i ha^{-1} provides good control.
3. Destroy the volunteer groundnut plants and weed hosts.
4. The genotype ICG 5240 (EC 36892) is reported to be resistant to aphids (Padgham et al. 1990).

MP 6. Leaf Miner

Groundnut leaf miner (*Aproaerema modicella* Deventer) is a serious pest. It attacks both rainy and postrainy season crops. It is widely distributed in Asia. It attacks soybean.

Symptoms

Leaf miner larvae, mine the leaves and feed inside the leaflet. Initially short blister-like mines are seen on the upper surface of the leaflets. The larvae come out of the mine after 5-6 days. They draw nearby leaves together to feed and pupate in the webbed leaves. The leaf-mine areas dry under severe infestation. The entire foliage may dry and give a burnt appearance.

Observations

The observations on leaf miner are recorded as percentage of dried foliage. The leaf miners are randomly distributed in the field. Five-row plots of 1 m length are selected diagonally for a sampling unit (Amin 1983). Threshold levels at various crop stages are: 5 miners plant^{-1} at 30 days after emergence (DAE), 10 miners plant^{-1} at 45 DAE, and 15 miners plant^{-1} at 50 DAE (Ranga Rao and Wightman 1991).

Control Measures

1. Growing a groundnut-cereal crop rotation could considerably reduce the incidence of leaf miner.
2. Spraying is recommended when 5 larvae are found plant^{-1} at the seedling stage (30 DAE), 10 larvae plant^{-1} at the flowering stage (50 DAE), and 15 larvae plant^{-1} at the pod-filling stage (70 DAE).
3. Spraying with dimethoate at 200-250 mL a.i. ha^{-1}, provides an effective control.
4. Resistant genotypes, ICG (FDRS) 10 and NCAC 17090, give better yields under a heavy incidence of leaf miner.

MP 7. Tobacco Caterpillar

The tobacco caterpillar [*Spodoptera litura* (F).] is polyphagous and occasionally causes severe damage to groundnut (Fig. 9). The larvae are nocturnal in habit. During the day they hide in the leaf litter near the base of the stem. This insect has a wide range of hosts like tobacco, castor, chilies, cotton, cabbage, and cauliflower (G.V. Ranga Rao, ICRISAT, personal communication 1992).

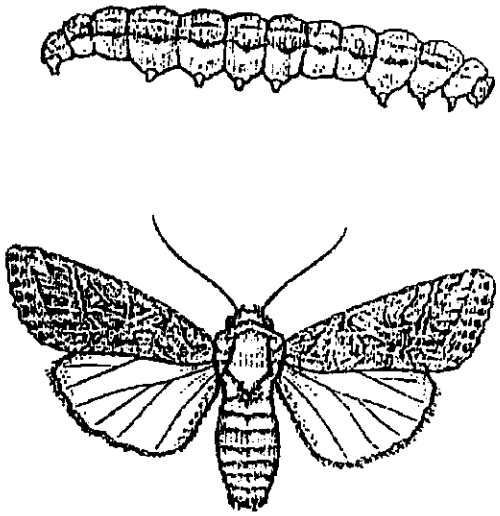

Figure 9. Larva and adult of *Spodoptera litura* (F). (Source: Feakin 1973)

Damage

These insects feed on the foliage and growing tips. Severe infestation causes total defoliation, leaving only bare stems. Beside the foliar damage, the late-instar larvae can damage the developing pods particularly in light soils.

Observations

The percentage defoliation is recorded as an index of severity of damage. An additional observation is recorded on the number of larvae per 1-m row, selected diagonally at 5 places in a plot.

Control Measures

1. Groundnut plants are susceptible to defoliation when they are young (<50 DAE). They can withstand substantial defoliation without any crop loss after 50 DAE. Therefore, apply insecticide when the groundnut plants are young and there are three egg masses 1.5 m^{-1} row or seven larvae on a 1.5-m row.

2. Dusting of carbaryl or parathion @ 25.3 kg ha^{-1} (850 g a.i.) controls the larvae. For caterpillars, spray 200 mL dichlorvos 100 EC dissolved in 400 L of water ha^{-1} (Ghewande et al. 1987), or spray with monocrotophos at 200–300 mL a.i. ha^{-1}.

3. Deep summer plowing helps to destroy pupae.

4. Insect populations can be monitored and controlled by using pheromone traps.

MP 8. Hairy Caterpillar

Hairy caterpillar is a common pest of groundnut in southern India (*Amsacta albistriga* Walk) and in northern India (*A. moorei*). These pests are economically important, but highly sporadic on groundnut. They are considered rainy-season pests.

Symptoms

This insect feeds on the foliage and growing tips, causing defoliation. Continuous feeding of young larvae from the under-surface of the leaves results in dried scraped patches. Mature larvae disperse and feed individually by devouring leaves, flowers, and growing points. Under severe infestation, only bare stems of plants remain, resulting in a heavy loss of yield (Nagarajan et al. 1957).

Observations

As an index of severity, the percentage defoliation is recorded. Number of larvae (1.5-m row)$^{-1}$ repeated at five locations $plot^{-1}$ could also be recorded.

Control Measures

1. Dust carbaryl or parathion (10%) @ 25 to 30 kg ha^{-1} or spray monocrotophos @ 200–300 mL a.i. ha^{-1}. This should be done when three egg masses or seven larvae are seen in a 1.5 m^2 area of the crop.

2. Destroy the moths, as they emerge from the soil after hibernation (Nagarajan et al. 1957). Communities should collect and destroy egg masses. Summer plowing may help to expose pupae to predators and unfavorable weather.

3. Sowing a barrier crop, such as barnyard millet (*Echinochloa frumentacea* Link), hinders the invading caterpillars (Aiyadurai and Ratnaswamy 1961).

4. Set up a bonfire light trap to attract and destroy the moths after the first monsoon rain.

5. Dig trenches around the field and dust these with an insecticide (parathion) to kill migrating larvae.

MP 9: Insect Pest Surveys in Groundnut

Surveys are required to assess the level of insect infestation in groundnut.

Method of survey. To survey small insects (for example, thrips and jassids) the affected plants are counted. For other insects the number of insects plant^{-1} or number of larvae m^{-2} is counted. A small area is surveyed by taking 10-15 samples from 10 plants, however, for a large area (2 ha or more) 30 samples are to be considered. A diagonal pass through the field during a survey should be made leaving 2-3 m as border on all sides (Fig. 10).

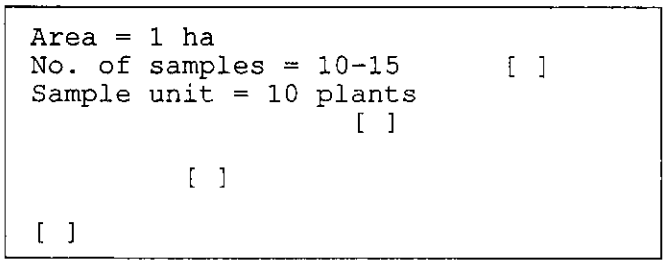

Figure 10. Illustration for sampling insect fauna.

The survey timing and the sampling units for groundnut insect pests in India are given in Table 2 and Table 3.

The percentage infestation for each insect should be considered to determine the threshold level for recommending a spray.

$$\text{Infestation (\%)} = \frac{\text{Number of infested plants} \times 100}{\text{Number of sampled plants}}$$

Example: Out of 45 sampled plants, if 10 plants are infested, the

$$\text{Infestation (\%)} = \frac{10 \times 100}{45} = 22.2\%$$

Table 2. Survey timings for groundnut insect pests in India.

Pest	Rainy season	Postrainy season
Jassids	September	February
Aphids	July-August	-
Thrips	September	January-February
Tobacco caterpillar	September	March-April
Hairy caterpillar	August	-
Gram caterpillar	August	March
Leaf miner	September	March-April
White grubs	September	-
Termites	September-October	March-April
Ants	September-October	March-April

(Source: G.V. Ranga Rao, ICRISAT, personal communication 1992)

Table 3. The optimal sample size for monitoring groundnut insect pests.

Pest	Observation(s)	Sampling unit field^{-1} (<0.5 ha)
Leaf miner	No. of larvae, dried foliage (%)	1-m row (10 plants)
Tobacco caterpillar	Defoliation (%)	2-m row (20 plants)
Aphids	Aphids plant^{-1}, load low (<25), medium (26-50), heavy (>51)	1 m^2 or 25 plants
Jassids	Foliage yellowing (%) Nymphs and adults present in the top three opened leaves	1-m row (10 plants)
Thrips	Leaf damaged (%) Thrips terminal^{-1} leaf	1-m row (10 terminals)
Termites	Plants killed (%), Pod scarification (%)	2 m^2 or 50 plants
White grub	Plants killed (%)	2 m^2 or 50 plants
Pod borers	Pod damage (%)	2 m^2 or 50 plants

(Source: G.V. Ranga Rao, ICRISAT, personal communication 1992)

MP 10. Conducting Entomology Experiments

A general procedure and some precautions to conduct entomology experiments are described by Amin (1983) as follows:

1. Entomological experiments should be carried out at least for 3 years and at 3-5 locations to confirm the findings. Select the testing spot where insect intensity is regular to minimize chances of escapes.

2. Insect behavior is affected by the pattern of green crop and noncovered soil area. Therefore, plant density should be uniform in all the plots. A 1-m guard row of the same genotype may be sown on all sides of an experimental plot. This will help reduce the coefficient of variation. This will also reduce the effect of soil treatment in one plot on an adjacent plot (Varma and Pant 1979).

3. A minimum of three and an optimum of four to five replications should be planned for the entomological experiment.

4. Fungal diseases, such as leaf spot and rust, interfere with observations on insect injury. An entomological trial needs to be protected from diseases.

5. A 1 to 9 scale is useful for evaluation of insect damage consideration:

Score	Description
1	Highly resistant
2-3	Resistant
4-5	Moderately resistant
6-7	Susceptible
8-9	Highly susceptible

Screening for Host-Plant Resistance

A general field-screening system at ICRISAT Center is as follows (G.V. Ranga Rao, ICRISAT, personal communication 1992):

Stage 1. Preliminary Screening

The material is grown in a nonreplicated trial, one row of 4-m length. For comparison the susceptible cultivar is sown every fifth plot. The observations are recorded as damage level (%), number of insects plant^{-1}, and yield. The highly susceptible lines are discarded.

Stage 2. Selection

The genotypes retained from preliminary screening are sown in one 4-m row in a randomized block or lattice design with a minimum of three replications including susceptible checks. The genotypes with low pest damage (%), and number plant^{-1} are retained for further testing.

Stage 3. Advance field and laboratory testing

The materials selected from the second stage are grown in large plots (> 4 rows of 4-m length) in a completely randomized-block design with checks. To confirm resistance, rigorous field and laboratory tests are conducted. The resistant lines are identified for multilocational tests.

MP 11. Procedure for Pesticide Application

The pesticides are generally available in different forms and may require dilution before use. To prepare the desired dilution requires:

- Active ingredient (a.i.) of the insecticide selected
- Area to be covered
- Rate of spray application (L ha^{-1} or m^{-2})
- Rate to be applied (a.i. ha^{-1} or a.i. m^{-2})

1. Active ingredient (a.i.) of pesticide and commercial formulation required

The active ingredients are indicated on the pesticide package. This helps to calculate the required pesticide for a given area.

Commercial formulation required

$$(\text{kg ha}^{-1}) = \frac{\text{Area to be covered} \times \text{Rate of active ingredient} \times 100}{\text{a.i.(\%) in commercial formulation}}$$

Example:

Recommended rate = 0.7 kg a.i. ha^{-1}
a.i. in commercial formulation = 35%
Area to be covered = 0.4 ha

Solution:

$$\text{Amount of commercial formulation required} = \frac{0.4 \text{ ha} \times 0.7 \text{ kg ha}^{-1} \times 100}{35} = 0.8 \text{ kg}$$

If the recommendation is in terms of commercial formulation, then

Amount of commercial formulation required (kg) = Recommended rate formulated x Area to be covered

Example:
Recommended rate of formulation = 2.0 L of 35 EC ha^{-1}
Area to be covered = 0.4 ha

Solution:

Amount of commercial formulation required = 2.0 L ha^{-1} x 0.4 ha = 0.8 L

2. Amount of spray solution for area to be covered

This will depend on the type of spray machine. High volume, medium volume, low volume, and ultra-low-volume sprayers will require 250-750, 100-250, 10-100, and 1-10 L of solutions ha^{-1}.

Once the sprayer and type of application is decided, calculate the amount of spray solution required as follows:

Spray solution required for a given area = Spray solution ha^{-1} x Area to be covered

Example:
Spray solution required = 500 L ha^{-1}
Area to be covered = 0.4 ha

Solution:

Amount of spray solution required for 0.4 ha = 500 L ha^{-1} x 0.4 ha = 200 L

3. Precautions in handling pesticides

The following precautions should be strictly followed (Pawar 1987).

1. Keep pesticides and spraying equipment beyond the reach of children, pets, and irresponsible persons.
2. Use hand gloves while preparing the spray solution.
3. Do not drink, eat, chew, or smoke during pesticide mixing, application, or cleaning and storing of equipment.
4. Use protective clothing, including goggles and a face mask, during pesticide application.
5. Avoid application of pesticide against the wind to check the drift falling on the operator.
6. Wash clothes after pesticide application with soap or detergent.
7. Avoid walking through the crop freshly treated with pesticide.

8. Destroy and dispose all pesticide containers by burying them in the ground at a safe place.

9. Transfer pesticide into fully labelled containers.

10. In case of an accident, wash off the affected area and rush to the doctor.

MP 12. Storage Pests of Groundnut

The major pests attacking groundnut in stores are groundnut borer or groundnut weevil [*Caryedon serratus* (Olivier)], almond moth (*Ephestia cautella*), rice moth (*Corcyra cephalonica*), Indian meal moth (*Plodia interpunctella*), and red flour beetle [*Tribolium castaneum* (Herbst)]. The groundnut is also attacked by the khapra beetle (*Trogoderma granarium* Everts) and *Elasmolomus sordidus (Fabricius)* in Africa and Asia (Dick 1987).

The groundnut borer (Fig. 11) is the most important pest in Asia as well as Africa. This pest attacks the seed of nonshelled nuts penetrating through the nondamaged shell. Infestation of harvested groundnut can occur while crop is drying in the field or when it is stored near the infested stocks or crop residues. Adult females lay their eggs on the outside of the pods or the seeds. When the first instar larva hatches it burrows directly through the pod wall to reach the seed. Each larva feeds solely on a single seed. When mature, larva may completely or partially emerge from the pod (Dick 1987).

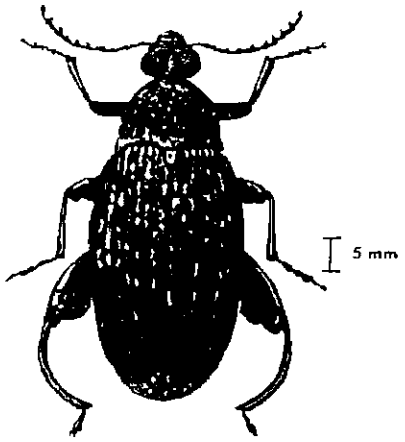

Figure 11. The groundnut borer.

Damage

A single larva of a groundnut borer will make a large excavation in the cotyledon. Externally no sign of damage is visible, unless one carefully looks for eggs. Pupation takes place in the pod. The adults emerge from the pod through an 'escape' window on the pod made

by the late-larval stage. The life cycle takes about 40 days. Larvae often migrate to the bottom of a stack or heap before pupating in distinctive ovoid cocoons. The damage caused by the subsequent generation is heavy in this part of the stock.

Control

a) As most of postharvest groundnut pests are unable to penetrate the intact pods except for the *Caryedon* it is better to store groundnut in their pods as long as possible to avoid storage-pest damage.

b) Maintain a low pod-moisture content. At high moisture conditions, insect populations develop fast.

c) Fumigation with one 3-g tablet of aluminum phosphide per gunny bag (40 kg) and covering with a polyethylene sheet for 5 days can control the storage pests without affecting seed viability. However, this will not be effective for *Caryedon*.

d) When groundnut seeds are stored, care should be taken to avoid breakage. The broken seed should not be stored for long periods. The direct application of insecticides to shelled groundnut can result a high level of toxic residues. Therefore, it is not recommended.

e) Dusting with attapulgite-based clay dust (ABCD) can help minimize most of the storage insects in groundnut.

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Evaluation

Select the most appropriate answer and check the correct answer at the end of the booklet.

1. An organism with a head, thorax, and an abdomen with six legs is
   a) a pest. b) an insect.
   c) a fungus. d) a nematode.

2. The simple life cycle of an insect has an egg,
   a) larva, pupa, and adult. b) pupa, and adult.
   c) nymph, and adult. d) larva, and adult.

3. The complex life cycle of an insect has an egg,
   a) larva, pupa, and adult. b) pupa, and adult.
   c) nymph, and adult. d) larva, and adult.

4. Termites belong to the order
   a) Dermaptera. b) Coleoptera.
   c) Isoptera. d) Lepidoptera.

5. Thrips belong to the order
   a) Thysanoptera. b) Hymenoptera.
   c) Diptera. d) Hemiptera.

6. The groundnut leaf miner belongs to the order
   a) Isoptera. b) Dermaptera.
   c) Coleoptera. d) Lepidoptera.

7. Soil inhabiting insects of groundnut are
   a) leaf miner, *Helicoverpa*, and red hairy caterpillar.
   b) aphids, thrips, and jassids.
   c) blister beetles.
   d) termites, white grubs, wireworms, and ear wigs.

8. Boring into the pod and its scarification are the major symptoms of the damage caused by
   a) white grub. b) termites.
   c) false wireworm. d) white tringe beetle.

9. When affected plant leaflets show a burnt appearance and are webbed, these are symptoms caused by
   a) red hairy caterpillar. b) false army worm.
   c) *Helicoverpa*. d) leaf miner.

10. The vector of the groundnut rosette virus is
    a) thrips. b) *Polymixa graminis*.
    c) *Bemisia tabacci*. d) aphids.

11. The death of plants by tunnelling of roots or stems, scarification and penetration into pods, and feeding on seeds are the symptoms of damage caused by
    a) white grubs.
    b) false wireworms.
    c) white fringed beetles.
    d) termites.

12. Application of carbofuran at the rate of 1 kg a.i. ha^{-1} provides an effective control to
    a) *Spodoptora litura*.
    b) jassids.
    c) aphids.
    d) termites and white grubs.

13. An organism either of animal or of plant origin that is harmful to crop is called
    a) an insect.
    b) a disease.
    c) a pest.
    d) a nematode.

14. The scientific name of white grub is
    a) *Odontotermies obesus*.
    b) *Empoasca cerri*.
    c) *Aphis craccivora*.
    d) *Lachnosterna consanguinea* (Blanch).

15. For surveying the incidence of leaf miner in a hectare of land the sample unit should be
    a) a 10-m row.
    b) 30 terminal shoots.
    c) 50 terminal shoots.
    d) 5 rows $plot^{-1}$ of 1-m length.

16. Spray control for leaf miners at the seedling stage (30 DAE) is recommended when the insect incidence is
    a) 5 larvae $plant^{-1}$.
    b) 5 insects $plant^{-1}$.
    c) 10 mines $plant^{-1}$.
    d) 2 mines $plant^{-1}$.

17. For evaluating insect damage (1 to 9 scale) scores of 1 and 2 indicate
    a) resistant and moderately resistant.
    b) moderate damage and severe damage.
    c) highly resistant.
    d) shoot damaged ones.

18. The host of white grub adult is
    a) *Margifera indica*.
    b) *Cicer arietinum*.
    c) *Cajanus cajan*.
    d) *Azadirachta indica*.

19. Feeding by adults and nymphs on young leaves causes brownish green patches on upperleaf surfaces and necrotic patches on lower leaf surfaces. These are damage symptoms caused by
    a) *Scirtothrips dorsalis*.
    b) *Frankliniella schultzei*.
    c) *Caliothrips indicus*.
    d) *Lachnosterna consanguinea*.

20. There are four species of thrips. Feeding by adults and nymphs by one species causes white scars on the upper leaf surface. This species is
    a) *Frankliniella schultzei*.
    b) *Caliothrips indicus*.
    c) *Scirtothrips dorsalis*.
    d) *Thrips palmi*.

21. An insect inhabits young foliage and induces yellowing of the foliage. Yellowing that starts at the tips and gradually spreads to other portions of the leaves is caused by
    a) *Aphis craccivora.* b) *Aproaerema modicella.*
    c) *Scirtothrips dorsalis.* d) *Empoasca kerri.*

22. Insects that draw groundnut leaves together, feed and pupate in the webbed leaves, and come out of the mine after 5-6 days are the
    a) *Aphis craccivora.* b) *Aproaerema modicella.*
    c) *Empoasca kerri.* d) *Scirtothrips dorsalis.*

23. Spraying of endosulfan @ 1 kg a.i. ha^{-1} provides effective control for
    a) aphids and tobacco caterpillars. b) leaf miners.
    c) thrips. d) all the above.

24. Foliage feeding insects that cause defoliations are
    a) aphids, thrips, and jassids.
    b) blister beatles and aphids.
    c) leaf miner, *Helicoverpa, Spodoptera*, and red hairy caterpillars.
    d) termites, white grub, and wireworms.

25. The main insect vectors of groundnut diseases are
    a) leaf miner, *Helicoverpa*, and red hairy caterpillar.
    b) blister beetles and whitefly.
    c) aphids, thrips, and jassids.
    d) termites, white grub, and false wireworms.

26. The insect that damages the primary root, causing swollen root ends and death of plants is the
    a) false wireworm. b) white fringe beetle.
    c) white grub. d) termite.

27. Severe leaflet damages, resulting in defoliation, are the symptoms of _____ damage.
    a) red hairy caterpillar, *Spodoptera*, and *Helicoverpa*
    b) aphid and termite
    c) jassid and aphid
    d) none of the above

28. The vector of tomato spotted wilt virus in groundnut is the
    a) *Polymixa graminis.* b) *Bemisia tabacci.*
    c) *Frankliniella schultzei.* d) *Thrips palmi.*

29. Application of dimethoate at 1.12 kg a.i. ha^{-1} or monocrotophos at 120-250 mL a.i. ha^{-1} provides effective control to
    a) white grub and termites.
    b) false wireworm and *Spodoptera*.
    c) aphid, thrips, and jassids.
    d) leaf miner and blister beetles.

30. Adult aphids and nymphs mostly suck the sap from
   a) old leaves and branches.
   b) stems and lower leaves.
   c) growing tips and young foliage.
   d) roots and stem.

31. Aphids remain hidden
   a) in the soil.
   b) on the soil surface.
   c) in the crop canopy.
   d) near the base of plant.

32. Plant leaf damage with a fine mottling, white-yellow, and tinged-red edges are the symptoms of damage caused by
   a) jassids.
   b) thrips.
   c) aphids.
   d) blister beetles.

33. The initial leaf yellowing that later turns brown at the tips is caused by
   a) aphids.
   b) thrips.
   c) jassids.
   d) leaf miner.

34. To control *Spodoptera litura* before the flowering stage, spraying is recommended when there
   a) is 1 larva m^{-1} of row.
   b) are 2 larvae m^{-1} of row.
   c) are 10 larvae m^{-1} of row.
   d) are 5 larvae m^{-1} of row.

35. Spraying to control thrips and jassids is recommended when there are
   a) 7 larvae m^{-1}.
   b) 6 insects $plant^{-1}$.
   c) 2 larvae $plant^{-1}$.
   d) 1 larva $plant^{-1}$.

36. Stippling on the upper surface of the old leaves is observed when damage is caused by
   a) *Scirtothrips dorsalis*.
   b) *Frnkeliniella schultzei*.
   c) *Caliothrips indicus*.
   d) none of the above.

37. Feeding on young leaves resulting in curled leaves and stunted growth is due to the damage caused by
   a) leaf miners.
   b) jassids.
   c) aphids.
   d) spodoptera.

38. Spraying of carbaryl 50 WP 0.2% provides effective control of
   a) leaf miners.
   b) jassids.
   c) thrips.
   d) false wireworms.

39. To control *Spodoptera litura* at the 1 eggmass m^{-1} stage, the use of _____ is recommended.
   a) endosulphan 100 mL a.i. ha^{-1}
   b) dimethoate 200 g a.i. ha^{-1}
   c) monocrotophos 300 g a.i. ha^{-1}
   d) thimet® (phorate) 2.5 kg a.i. ha^{-1}

40. Spraying groundnut near the maturity stage to control leaf miner is recommended when there are
   a) 2 mines $plant^{-1}$.
   b) 5 mines $plant^{-1}$.
   c) 10 mines $plant^{-1}$.
   d) 20-25 mines $plant^{-1}$.

Correct responses to the questions.

1. b); 2. c); 3. a); 4. c); 5. a); 6. d); 7. d); 8. b); 9. d);

10. d); 11. d); 12. d); 13. c); 14. d); 15. d); 16. a); 17. c);

18. d); 19. a); 20. a); 21. d); 22. b); 23. d); 24. c); 25. c);

26. c); 27. a); 28. d); 29. c); 30. c); 31. c); 32. b); 33. c);

34. d); 35. b); 36. c); 37. c); 38. a); 39. c); 40. d).