

Low cost insect pest management strategies for oilseed crops

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Oilseeds constitute second largest agricultural commodity after cereals in India occupying more than 13% of cropped area. Groundnut (*Arachis hypogaea*), soybean (*Glycine max*), rapeseed-mustard (*Brassica* spp.), sunflower (*Helianthus annuus*), castor (*Ricinus communis*), sesame (*Sesamum indicum*), safflower (*Carthamus tinctoris*), linseed (*Linum usitatissimum*) and niger (*Guizotia abyssinica*) are the major oilseed crops. Besides, abiotic factors, oilseed crops are prone to yield depredation to a host of insect-pests, consequently high yield losses in these crops are suffered by the resource poor farmers. Hence, there is an urgent need to circumvent the pest damage following pest management strategies to get more productivity in these energy rich crops. Although the consumption of pesticides in oilseed crops in India is very meager i.e. less than 4%, still these are to be used as the fire fighting tools only at appropriate time when the pests reach the economic threshold level. In case of most of the insect-pests, relying upon cultural practices and empirical approaches give the excellent management. The major insect pests of oilseed crops and their management are presented in this chapter.

1. MAJOR INSECT PESTS OF CASTOR AND THEIR MANAGEMENT

More than two dozen of insect-pests are found associated with this crop of which castor semilooper, tobacco caterpillar and capsule borer are the major ones, which may cause yield losses, if remained un-attended.

Insect pests of castor and their management

Insect pests and Nature of damage	Management
<p>Semilooper (<i>Achaea janata</i>)</p> <p>Larvae damages crop by defoliation. The neonate larvae nibble the outer tissue of leaf. During second and third instars, larvae damage the leaves by making holes while older larvae are voracious feeders which can totally defoliate the plants during outbreaks, leaving only veins, petiole and stem.</p>	<ul style="list-style-type: none">• Hand picking and destruction of older larvae during early stages of crop growth to keep defoliation at low level.• Spray profenofos (1ml/l) or malathion (2 ml/l) or flubendiamide (0.2ml/l) or chlorantraniliprole (0.3ml/l), if more than 25% defoliation is observed. Avoid chemical spray when 1-2 larval parasitoids (<i>Microplitis</i> sp.) are observed per plant.

<p>Tobacco caterpillar (<i>Spodoptera litura</i>)</p> <p>Larvae damages crop by defoliation. Newly hatched larvae feed gregariously and skeletonise the leaves giving mesh like appearance which can be easily located from a distance. After few days of feeding, young larvae disperse to other leaves of the plant and other plants and defoliate them. During heavy infestations, larvae also feed on capsules. Sometimes the larvae bore into the stems causing withering of branches and partial or total death of the plant.</p>	<ul style="list-style-type: none"> • Collect and destroy egg masses and gregarious stages of the larvae along with damaged leaves. • Install sex pheromone trap @ 10 traps/ha for early deduction of the pest. • Spray profenofos (1ml/l) or flubendiamide (0.2ml/l) or chlorantraniliprole (0.3 ml/l) or thiodicarb (1g/l) or quinalphos (2ml/l) or chlorpyrifos (2 ml/l), if defoliation is above 25%.
<p>Capsule borer (<i>Conogethes punctiferalis</i>)</p> <p>Larvae bore the capsules and characteristic webbing of capsules along with excreta is seen. Infestation starts from flowering stage. When inflorescence is attacked at the time of emergence, it withers and dries away and the terminal shoot also gets killed. Though, the borer can bore into the tender shoots, it has preference for capsules.</p>	<ul style="list-style-type: none"> • Good agronomic management with no or less use of insecticides on the crop usually keeps the borer at low level. • Spray profenofos (2ml/l) or indoxacarb (1ml/l) or spinosad (0.4ml/l) or dust the spikes with quinalphos 1.5% (20 kg/ha), if at least 10% capsules are damaged.
<p>Leafhopper (<i>Empoasca flavescens</i>)</p> <p>Nymphs and adults suck sap from plants. Hopper burn symptoms are noticed if infestation is severe. The initial symptom of yellow patches on the margins of leaves is followed by leaf curling. The yellow colour then changes to brown and the leaf becomes dry and brittle on the margins. Heavy pest infestations resulting in stunted growth and poor formation of capsules.</p>	<ul style="list-style-type: none"> • Growing triple bloom cultivars like GCH-4, GCH-7, DCH-519 which usually do not express damage symptoms. • Spray dimethoate (1.7 ml/l) or malathion (1.5 ml/l) or thiamethoxam (0.4g/l) or acetamiprid (0.2g/l). Repeat spray if required after a fortnight.
<p>Thrips (<i>Retithrips syriacus</i>)</p> <p>Nymphs and adults suck sap resulting in characteristic wrinkling of plants and withering of developing spikes. Thrips damage is clearly seen on the tender most and not fully opened leaf.</p>	<ul style="list-style-type: none"> • Varieties resistant to leaf hopper are also usually tolerant to thrips damage. • Spray dimethoate (1.7 ml/l) or thiamethoxam (0.4g/l) or acetamiprid (0.2g/l), if damage symptoms appear.

<p>White fly (<i>Bemisia tabaci</i>) Nymphs and adults suck the sap causing yellowing and drying of the affected leaves. The insect secretes honey dew and it promotes growth of black sooty mould which interferes with photosynthesis.</p>	<ul style="list-style-type: none"> • Single and double bloom varieties are relatively resistant to whitefly than triple bloom castor cultivars. • Spray dimethoate (1.7 ml/l) or thiamethoxam (0.4g/l) or acetamiprid (0.2g/l) during peak activity of the pest.
<p>Hairy caterpillar (<i>Euproctis</i> sp.) Larvae damages crop by defoliation. Hatched larvae feed gregariously and skeletonise leaves. Mature caterpillars disperse to other leaves / plants and defoliate and often capsules get damaged.</p>	<ul style="list-style-type: none"> • Collect and destroy egg masses and gregarious stages of the larvae along with damaged leaves. • Spray dichlorvos (0.7 ml/l) or profenofos (2ml/l) or quinalphos (2 ml/l), if defoliation is exceeding 25%.
<p>Bihar hairy caterpillar (<i>Spilarctia obliqua</i>) Larvae feed voraciously on the foliage in early stage and defoliate the plant. Larvae also damages flowers and pods.</p>	<ul style="list-style-type: none"> • Collect and destroy infested plant parts along with larvae. • Spray dichlorvos (0.7 ml/l) or profenofos (2ml/l) or quinalphos (2 ml/l)), if defoliation is exceeding 25%.
<p>Red hairy caterpillar (<i>Amsacta albistriga</i>) Larvae cause damage by defoliation. Often the larvae feed or destroy the germinating seedling causing death of the plants. Major damage is caused by migrating caterpillars. More destruction to young crop.</p>	<ul style="list-style-type: none"> • Setting of light traps on community basis with the first monsoon rains to attract the moths and kill them, sowing cucumber along with castor to attract the migrating caterpillar and facilitate mechanical killing of the larvae by jerking them off into kerosinized water. • Placing the twigs of <i>Ipomoea</i>, <i>Jatropha</i> or <i>Calotropis</i> to attract the migrating caterpillars and kill them mechanically, opening deep furrows around field area and dusting quinalphos 1.5%. • Spray of dichlorvos (0.7 ml/l) or profenofos (2ml/l) or quinalphos (2 ml/l), if defoliation is exceeding 25%.
<p>Serpentine leafminer (<i>Liriomyza trifolii</i>) Maggots enter in between the epidermal layers and feed by making characteristic</p>	<ul style="list-style-type: none"> • Neem seed kernel extract (5%) and other neem based formulations were found to be effective in reducing the pest population.

serpentine mines. The damage starts with cotyledonary leaves and moves upward as the plant grows.	<ul style="list-style-type: none"> • Satisfactory control of the leaf miner could not be achieved with the commonly used insecticides like acephate.
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2. MAJOR INSECT PESTS OF SUNFLOWER AND THEIR MANAGEMENT

The crop is damaged by tobacco caterpillar, which may denude the foliage during certain years. Sometimes green semilooper and capitulum borer also cause damage to this crop.

Insect pests of sunflower and their management

Insect pests and Nature of damage	Management
<p>Green semilooper (<i>Thysanoplusia orichalcea</i>)</p> <p>Larvae damages crop by defoliation. Early instars feed on chlorophyll, tender leaves with transparent leaf spots, later feed from leaf margin and defoliate leaving midribs in case of severe incidence.</p>	<ul style="list-style-type: none"> • Spray neem seed kernel extract (NSKE) 5% or dichlorvos (0.7 ml/l) or profenofos (1 ml/l).
<p>Tobacco caterpillar (<i>Spodoptera litura</i>)</p> <p>Larvae damages crop by defoliation. Newly hatched larvae feed gregariously and skeletonise leaves giving mesh like appearance which can be easily located from a distance. After few days of feeding, the young larvae disperse to other leaves of the plant and other plants and defoliate them. During heavy infestations, larvae also feed on the head by boring into the thalamus of the head.</p>	<ul style="list-style-type: none"> • Collect and destroy egg masses and gregarious stages of the larvae along with damaged leaves. • Install sex pheromone trap @ 10 traps/ha for early deduction of the pest. • Spray profenofos (1 ml/l) or dichlorvos (0.7 ml/l) or chlorantraniliprole (0.3 ml/l) or quinalphos (2ml/l).
<p>Bihar hairy caterpillar (<i>Spilarctia obliqua</i>)</p> <p>Larvae feed voraciously on the foliage in early stage and defoliate the plant. After few days of feeding, the young larvae disperse to other leaves of the plant and other plants and defoliate them. During heavy infestations,</p>	<ul style="list-style-type: none"> • Collect and destroy egg masses and gregarious stages of the larvae along with damaged leaves. • Spray neem seed kernel extract (NSKE) 5% or dichlorvos (0.7 ml/l) or profenofos (1ml/l) or quinalphos (2ml/l).

the larvae also feed on the head.	
<p>Capitulum borer/Head borer (<i>Helicoverpa armigera</i>) Larvae cause damage to receptacle, ovaries, developing seeds and the resulting loss in seed. During pre-anthesis stage they feed scraping the bracts first and later feed through ray-florets which cover disc florets and finally find access to immature ovaries.</p>	<ul style="list-style-type: none"> • Spray profenofos (1ml/l) or spinosad (0.4ml/l).
<p>Leafhopper (<i>Amrasca biguttula biguttula</i>) Nymphs and adults suck sap from plants. Hopper burn symptoms are noticed if jassid infestation is severe. The initial symptom of yellow patches on the margins of leaves, then changes to brown and becomes dry and brittle on the margins. Heavy pest infestations resulting in the loss of vitality and poor seed development.</p>	<ul style="list-style-type: none"> • Seed treatment with imidacloprid 70 WS @ 5g/kg of seed. • Spray imidacloprid (0.2 ml/l) or dimethoate (1 ml/l).
<p>Thrips (<i>Frankliniella scultze</i>, <i>Thrips palmi</i> and <i>Scirtothrips dorsalis</i>) Both nymphs and adults suck sap. Several species of thrips are reported to be associated with sunflower necrosis disease(SND)</p>	<ul style="list-style-type: none"> • Seed treatment with imidacloprid 70 WS @ 5g/kg of seed. • Spray imidacloprid (0.2 ml/l) dimethoate (1 ml/l).

3. MAJOR INSECT PESTS OF SAFFLOWER AND THEIR MANAGEMENT

Safflower crop is damaged by a number of insect pests of which safflower aphid is the key pest causing 40 to 50% yield loss, if these pests are not properly managed.

Insect pests of safflower and their management

Insect pests and Nature of damage	Management
<p>Safflower aphid (<i>Uroleucon compositae</i>) Nymphs and adults suck sap. Yellowing of leaves followed by drying.</p>	<ul style="list-style-type: none"> • Use resistant / moderately resistant varieties like A1, Bhima. • Avoid late sowing in November. • Spray border rows up to 2m as soon as pest appears with NSKE 5% or insecticides like

	<p>dimethoate (1.5ml/l).</p> <ul style="list-style-type: none"> • Spray dimethoate (1.5ml/l) or dust quinalphos 1.5%, if aphid spread to entire field.
<p>Safflower caterpillar (<i>Perigea capensis</i>)</p> <p>Larvae damages crop by defoliation. Larvae also feed on capsules.</p>	<ul style="list-style-type: none"> • Spray indoxacarb (0.3ml/l) or quinalphos (2ml/l).
<p>Gujhia weevil (<i>Tanymecus indicus</i>)</p> <p>It is a soil borne pest. Only adult stage causes damage. Eats away the tender stem resulting into resowing of crop many times. Feeds on foliage till maturity of crop.</p>	<ul style="list-style-type: none"> • Soil application of phorate (10kg/ha) at sowing followed by foliar sprays of chlorpyrifos (2ml/l) reduce the damage.
<p>Capitulum borer/Head borer (<i>Helicoverpa armigera</i>)</p> <p>Larvae cause damage to receptacle, ovaries, developing seeds and the resulting loss in seed.</p>	<ul style="list-style-type: none"> • Spray profenofos (1 ml/l).
<p>Leaf defoliator (<i>Spodoptera exigua</i>)</p> <p>Larvae damages crop by defoliation. Hatched larvae feed gregariously and skeletonise leaves. Mature caterpillars disperse to other leaves / plants and defoliate.</p>	<ul style="list-style-type: none"> • Collect and destroy plant parts/plants having gregarious stage of caterpillars. • Spray profenofos (1ml/l) or chlorantraniliprole (0.3 ml/l) or quinalphos (2ml/l) or dust quinalphos 1.5% (25 kg/ha), when their population is likely to reach 10/m row length.

4. MAJOR INSECT PESTS OF SESAME AND THEIR MANAGEMENT

Sesame, an important indigenous oil crop, is grown as rainfed *kharif*, semi-rabi and also as summer crop. The crop is damaged by a number of insect-pests and diseases. *Til* leaf roller and gall fly are the major pests causing up to 100% yield loss.

Insect pests of sesame and their management

Insect pests and Nature of damage	Management
<p>Leaf roller and capsule borer or leaf webber (<i>Antigastra catalaunalis</i>)</p>	<ul style="list-style-type: none"> • Crop rotation is very effective in reducing pest population. • Early sown (first week of July) <i>kharif</i> crop is

<p>In early stage of crop, caterpillars feed on tender leaves and remain inside the leaf web. At flowering, larvae feed inside the flowers and on capsule formation, larvae bore into capsules and feed on developing seeds.</p>	<p>less infested than late sown crop.</p> <ul style="list-style-type: none"> • Removal of larvae from the leaf webs during the initial stages of plant growth and destroy them. • Inter cropping with cowpea, pigeonpea, pearl millet, mungbean, urdbean and mothbean proved to be more effective than sole crop. • Install 40-50 bird perches/ha. • Spray quinalphos (2 ml/l) or profenofos (2 ml/l) or triazophos (1 ml/l) or spinosad (0.2 ml/l) or dust carbaryl (25 kg/ha).
<p>Gall fly (<i>Asphondylia sesami</i>) Maggots feed inside the floral bud leading to formation of gall like structure which do not develop into flower/capsule. The affected buds wither and drop.</p>	<ul style="list-style-type: none"> • Clipping of the galls, picking and burning the shed buds may help as prophylactic measure. • Spray dimethoate (1.7 ml/l) or quinalphos (2 ml/l) or dichlorvos (0.7 ml/l) or imidacloprid (0.3 ml/l) at bud initiation stage.
<p>Bud fly (<i>Dasynura sesami</i>) Maggots feed inside the floral bud leading to formation of gall like structure which do not develop into flower/capsule. The affected buds wither and drop.</p>	<ul style="list-style-type: none"> • Spray dimethoate (1.7 ml/l) or quinalphos (2 ml/l) or dichlorvos (0.7 ml/l) or imidacloprid (0.25ml/l)
<p>Sesame leafhopper (<i>Orosius albicinctus</i>) Nymphs and adults suck the sap of tender parts of the plants. The jassid of leaf hopper is a serious pest of sesame and is known to transmit phyllody disease.</p>	<ul style="list-style-type: none"> • Seed treatment with imidacloprid or thiamethoxam (5g/kg of seed). • Spray dimethoate (1.7 ml/l) or oxydemeton – methyl (2 ml/l) or dichlorvos (0.7 ml/l) or imidacloprid (0.3 ml/l).
<p>Hawk moth (<i>Acherontia styx</i>) Caterpillars feed on the leaves and defoliates the plant.</p>	<ul style="list-style-type: none"> • Deep ploughing exposes the pupae for birds. • Dust phosalone 4% or malathion 5% dust (25 kg/ha).
<p>Bihar hairy caterpillar (<i>Spilarctia obliqua</i>) In the early stages, larvae are gregarious feeders and are concentrated on few plants. Mature caterpillars migrate to other plants</p>	<ul style="list-style-type: none"> • Destroy egg masses and young larvae during gregarious phase. • Spray NSKE 5% or azadirachtin 0.03% (5 ml/l) or dichlorvos (0.7 ml/l) or profenofos (1ml/l) or quinalphos (2ml/l) or chlorpyrifos (2.5ml/l) or triazophos (1.5 ml/l).

and feed voraciously leaving only the stem.	
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5. MAJOR INSECT PESTS OF RAPESEED-MUSTARD AND THEIR MANAGEMENT

These crops are damaged by an array of insect pests of which mustard aphid is the major pest. The following strategies are to be to reduce the pest incidence to sub-economic levels.

Insect pests of Rapeseed-Mustard and their management

Insect pests and Nature of damage	Management
<p>Mustard aphid (<i>Lipaphis erysimi</i>)</p> <p>Mustard aphid (both nymph and adult) feeds on different parts of the plants (inflorescence, leaf, stem, twig and pods) by sucking the cell sap. In cases of heavy infestation, the entire plant can dry up and lead to seed yield losses. The aphid secretes honeydew, which is responsible to the growth of black fungus called “Sooty Mould” which hinders the photosynthesis in the plant.</p>	<ul style="list-style-type: none"> • Grow improved and early maturing varieties of Indian mustard (<i>Brassica juncea</i>) as they are fairly tolerant to mustard aphid and have more yield potential than rapeseed (<i>Brassica campestris</i>). • Early sowing of the crop (before 15th October) can help the crop to avoid the infestation by mustard aphid. • Use the recommended fertilizer dose as excess nitrogen application induced crop growth attracts more aphids • Monitor the crop field, especially during the month of December and January, when the chances of infestation and resultant yield losses remain high. Pluck and destroy infested twigs 2-3 times at 10 days interval during this period to prevent the multiplication of aphids. • Apply chemical control when the aphid population reaches the economic threshold level (ETL). Generally, ETL is reached when 26-28 aphids per 10cm of central shoot is observed in at least 10 per cent of the plant population. • Spray dimethoate (1.7 ml/l) or oxydemeton-methyl (1.7 ml/l) or thiamethoxam (0.1 g/l) or malathion (1ml/l) or chlorpyrifos (1 ml/l). Spray in the evening hours to avoid toxicity to insect pollinators
<p>Painted bug (<i>Bagrada cruciferarum</i>)</p> <p>Adults and nymphs suck the cell sap from the leaves, shoot and pods. The infestation in the two-leaf and vegetative stage results</p>	<ul style="list-style-type: none"> • Clean cultivation by weeding, hoeing and destroying of debris in and around the field. • Apply first irrigation 3-4 weeks after sowing of the crop. • Seed treatment with imidacloprid 70 WS @ 7g/kg of seed.

<p>in whitening of leaves then wilting leading to complete drying of the tender shoot/plant. The infestation at maturity results in curling of pods and shriveling of grains.</p>	<ul style="list-style-type: none"> • Spray imidacloprid (0.2 ml/l) or dimethoate (1 ml/l) or dichlorvos (0.7 ml/l) or malathion (1ml/l). • Apply phorate granules (15 kg/ha). If the problem is endemic, apply the chemical before sowing along with the last ploughing. • Harvest the crop at appropriate time (75% pod have golden yellow colour) and thresh as early as possible to avoid the further losses.
<p>Mustard sawfly (<i>Athalia lugens proxima</i>)</p> <p>The larvae make irregular holes in the leaves. Grown up larva feed from the margin of leaf and in severe infestation the crop looks as grazed by animals.</p>	<ul style="list-style-type: none"> • Clean cultivation by weeding, hoeing and destroying of debris in and around the field. • Timely irrigation helps in killing the larvae through drowning. • Seed treatment with imidacloprid 70 WS @ 7g/kg of seed. • Spray malathion (1ml/l) or dimethoate (1.7 ml/l) or quinalphos (2 ml/l).
<p>Bihar hairy caterpillar (<i>Spilarctia obliqua</i>)</p> <p>The caterpillars remain gregarious underneath leaves in early stages and feed on chlorophyll content from the margin of leaves and make them almost transparent and gradually defoliate the entire plant. Grown up larvae migrate to other plants in the field and feed voraciously leaving only the stem.</p>	<ul style="list-style-type: none"> • At the initial stages destroy the gregarious phases of caterpillar through hand collection, which is effective and eco-friendly. Collect the infested leaves and dip them in kerosene or insecticide treated solution. • For moderate infestation, dust the crop with malathion 5% dust @ 25 kg/ ha. • At heavy infestation, spray the crop with malathion 50EC @ 2 ml/l. Dust the border of fields with quinalphos 1.5% dust to check the spread of larvae.
<p>Pea leaf miner (<i>Chromatomyia horticola</i>)</p> <p>Maggots mine the leaf and a larger number of silvery zig-zag mines appear due to the feeding on the parenchyma tissues. The heavily infested leaves become yellow and fall down affecting the yield adversely.</p>	<ul style="list-style-type: none"> • Pluck the infested leaves and bury them to kill the maggots and pupae resting inside. • Spray dimethoate (1.7 ml/l) or oxydemeton-methyl (1.7 ml/l).
<p>Diamond back moth (<i>Plutella xylostella</i>)</p> <p>Larva makes tunnel and holes in the leaves</p>	<ul style="list-style-type: none"> • Collect and destroy pest infested leaves. • In cases of severe infestation, spray the crop with malathion (2ml/l).

and feed on the mesophyll.	
<p>Termite (<i>Odontotermus obesus</i>)</p> <p>Termites attack the <i>Brassica</i> crops very severely all over the country, especially under rain-fed conditions. Infested plants initially turn yellow and finally dry due to extensive root damage.</p>	<ul style="list-style-type: none"> • Use only well decomposed farmyard manure. • Destruction of plant debris in and around the fields. • Frequent irrigation helps in reduction of termite infestation. • Application of chlorpyrifos (4 litre/ha) during last ploughing and properly mixing in soil minimizes termite infestation.

6. MAJOR INSECT PESTS OF GROUNDNUT AND THEIR MANAGEMENT

The crop is invaded by a large number of insect-pests on all the phenophases of its growth. Termites and root grubs may cause severe loss up to 100% plants mortality in rainfed areas, whereas *Spodoptera* give a severe jolt to its productivity under irrigated situations. Thrips are the vector of a number of virus diseases. The following pest management practices are suggested in groundnut crop.

Insect pests of groundnut and their management

Insect pests and Nature of damage	Management
<p>Defoliators</p> <p>Groundnut leafminer or Leaf webber (<i>Aproaerema modicella</i>)</p> <p>Young larvae mine into the leaves as soon as they hatch. The presence of small brown blotches on the leaf can be seen. The mines enlarge as the larvae grow. When they become too large and the larvae complete the different instars, emerge out and web the adjacent leaflets together and continuously feed on leaf tissue from inside the webbed leaves. A severely attacked field looks like a burnt appearance.</p>	<p>Management of defoliators</p> <ul style="list-style-type: none"> • Deep ploughing during April-May to expose the pupae to sunlight and predatory birds. • Set bonfires on community basis on the field bunds from 7-10 pm starting from the next day of the rain. • Setup the light traps to attract and kill the moths during June-August. • Growing cowpea as trap crop. • Intercrop with castor or red gram in the ratio of 1:11. • Form a deep trench around the field and dust with 5% carbaryl to avoid the migration of larva from one field to the other. • Collection and destruction of egg mass and

<p>Tobacco caterpillar (<i>Spodoptera litura</i>)</p> <p>In the early stages, larvae are gregarious feeders and damage by scrapping under the surface of the leaves leaving the vein and upper epidermis giving a fabric surface. Late instars larvae feed voraciously on the entire lamina, petioles and sometimes on the tender twigs on the terminal shoot of the plant. In certain cases they feed on the flower and bore the tender groundnut pods, which are just below the soil surface. More than 65% of the foliage damage is done during night time.</p>	<p>just emerged larva.</p> <ul style="list-style-type: none"> • Place the vegetative traps like jatropha or calotropis in and around groundnut fields to attract and kill larva. • Spray NSKE 5% or neem oil (5 ml/l) along with suitable surfactant like nirma powder (1g/l) or. • Spray NPV @ 250 LE at third instar stage. • Spray quinalphos (2ml/l) or malathion (1 ml/) or diflubenzuron (0.75 ml/l) or phosalone (1.5 ml/l) or dichlorvos (0.7 ml/l) or thiodicarb (1.5g/l).
<p>Gram pod borer (<i>Helicoverpa armigera</i>)</p> <p>Larvae are voracious feeders; they feed on flowers and foliage and defoliate the plants.</p>	
<p>Red hairy caterpillars (<i>Amsacta albistriga</i> and <i>A. moorei</i>) and Bihar hairy caterpillar (<i>Spilarctia obliqua</i>)</p> <p>Young larvae of hairy caterpillars feed gregariously on the under surface of the leaves by scrapping them. The grown up larvae are voracious feeders, defoliate the crop presenting a cattle grazed field. They feed on leaves, flowers and growing points.</p>	
<p>Sucking Pests</p> <p>Aphid (<i>Aphis craccivora</i>)</p> <p>Aphids congregate on young leaves and young leaf buds sometimes even on flowers and aerial pegs. They desap through a phloem vessels. Under heavy infestation, plant become chloratic and leaves curl.</p>	<p>Management of sucking pests</p> <ul style="list-style-type: none"> • Plating tall crops like bajra (for thrips), maize (for aphid) and cowpea (for jassids) as border to reduce the incidence of sucking pests. • Seed treatment with imidacloprid @ 2 ml/kg seeds. • Spray imidacloprid (0.3ml/l) or acetamiprid (0.3g/l) or thiamethoxam (0.3g/l) or dimethoate (1.7 ml/l).

<p>Leafhopper/Jassid (<i>Empoasca kerri</i>)</p> <p>Nymphs and adults suck sap from the leaves mainly from under surface. The initial injury to groundnuts appears on young leaves and veins become white. The terminal leaves may wilt if plants attacked are young. In older plants wilting of leaflets is rare. Prolonged exposure to jassids results in a 'V' shaped yellowing on the tips of leaflets, which may spread, and the entire leaflet may become yellow.</p>	
<p>Thrips (<i>Scirtothrips dorsalis</i>, <i>Frankliniella schultzei</i>, <i>Thrips palmi</i> and <i>Caliothrips indicus</i>)</p> <p>Thrips species occur on groundnut as a complex, starting from vegetative stage till harvest of the groundnut crop. Thrips feed by rasping the upper surface of the leaves, when they are in bud stage, the unfolded leaves thus distorted, condition known as "pouts". There is frequent discoloration which may be tinged with red or even black colour.</p>	
<p>Root and pod feeders</p> <p>White grubs (<i>Holotrichia consanguinea</i> and <i>H. serrata</i>)</p> <p>Although the damage to roots starts in the early first instar stage. The maximum damage occurs when the grubs are in the third instar. The attacked plants show varying degrees of wilting, and ultimately die. The roots show a sharp cut which can be distinguished from the damage by termite where the main root becomes hollow and is filled with soil. Patches of dead plants are seen throughout the field, which later coalesce and produce intensive</p>	<ul style="list-style-type: none"> • Field should be ploughed from the end of April to middle of May to expose the grubs and pupae to sunlight and predatory birds. • Mechanical control by large scale collection and destruction of adults at the time of their mass emergence. • Use of light traps and synthetic pheromone traps for monitoring adults. • Early sowing (pre-monsoon, irrigated) of crops should be done to allow roots to get established and evade from white grub attack.

areas of damage.	<ul style="list-style-type: none"> • Soil treatment: pre-sowing soil treatment with phorate granules (25 kg/ha).
<p>Termites (<i>Odontotermes obesus</i> and <i>Microtermes obesi</i>)</p> <p>Termites damage the groundnut plants from seedling stage to maturity. They gnaw and hollow out taproot causing wilting and premature death of plants especially in sandy and red soils.</p>	<ul style="list-style-type: none"> • Destruction of termatorium and queen termite in and around field. • Pre-sowing soil treatment with phorate granules (25 kg/ha).
<p>Storage pests</p> <p>Groundnut bruchid (<i>Caryedon serratus</i>)</p> <p>Groundnut bruchid beetle is a major storage pest particularly in warmer conditions causing damage to the stored produce. Grubs causes extensive damage to kernels. The heat and moisture generated by a large insect population in storage increases the risk of mold growth, which indirectly spoils the quality through mycotoxin contamination, rendering the stock unfit for human and animal consumption.</p>	<ul style="list-style-type: none"> • Proper drying of pods • Cleaning of gunny bags and fumigation of godowns before storage using aluminium phosphide @ 2-3 tablets (5g/ ton of pods) in airtight godowns.

7. MAJOR INSECT PESTS OF SOYBEAN AND THEIR MANAGEMENT

The crop is attacked by about a dozen major insect-pests. Yield losses due to individual insect pests range from 25 to 100%. However, with proper control practices, 30-35% additional yield can be obtained compared to no-pest control.

Insect pests of soybean and their management

Insect pests and Nature of damage	Management
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<p>Stem fly (<i>Melanagromyza sojae</i>) Yellowish maggots bore the nearest vein of the leaf and reach the stem through petiole and bore down the stem. As a result of severe damage, seedlings and plants wilt and dry.</p>	<ul style="list-style-type: none"> • Avoid pre monsoon sowing. • Use optimum seed rate and plant spacing. • Remove and destroy the damaged plant parts. • Soil application of phorate granules (15 kg/ha) at the time of sowing prevent early infestation. • Seed treatment with thiamethoxam (7g/kg seed) • Spray chlorantraniliprole (0.3 ml/l) or indoxacarb (0.6 ml/l) or thiamethoxam (0.2g/l) or triazophos (1.5 ml/l).
<p>Tobacco caterpillar (<i>Spodoptera litura</i>) Larvae damages crop by defoliation. Hatched larvae feed gregariously and skeletonise leaves. Mature caterpillars disperse to other leaves / plants and defoliate.</p>	<ul style="list-style-type: none"> • Collect and destroy plant parts/plants having gregarious stage of caterpillars. • Install sex pheromone trap @ 10 traps/ha for early deduction of the pest. • Spray dichlorvos (0.7 ml/l) or indoxacarb (0.6 ml/l) or profenofos (2ml/l) or chlorantraniliprole (0.3 ml/l) or quinalphos (2ml/l), when the population reach 10/m row length.
<p>Green semiloopers (<i>Chrysodeixis acuta</i>, <i>Gesonia gemma</i> and <i>Diachrysia orichalcea</i>) Larvae feed voraciously on leaves starting from the edges inwards and leaving behind only midribs and stalks. Damage is maximum in August-September and with excessive loss of foliage.</p>	<ul style="list-style-type: none"> • Use recommended dose of fertilizers including potash. • Spray dichlorvos (0.7 ml/l) or indoxacarb (0.6 ml/l) or profenofos (2ml/l) or chlorantraniliprole (0.3 ml/l) or quinalphos (2 ml/l), when the population exceeds 3-4 larvae/m.
<p>Girdle beetle (<i>Obereopsis bevi</i>) Grub feeds and hollows out the inside of the stem. Seedlings and young plants are wilted or dead. On older plants, all or part of the leaves are wilted and brown.</p>	<ul style="list-style-type: none"> • Remove girdle beetle infested plants / plant parts • Spray chlorantraniliprole (0.3 ml/l) or profenofos (2ml/l) or thiacloprid (1.5 ml/l) or triazophos (1.5 ml/l).
<p>Blue beetle (<i>Cneorane spp.</i>) Beetles scarify the cotyledons from either side at seedling stage. Seedlings either killed or their vigour reduced.</p>	<ul style="list-style-type: none"> • Spray quinalphos (2 ml/l) or malathion (2 ml/l) or triazophos (1.5ml/l) or indoxacarb (0.75 g/l) or dust quinalphos 1.5% (16.6 kg/ha).

<p>Leaf defoliator (<i>Spodoptera exigua</i>) Larvae damages crop by defoliation. Hatched larvae feed gregariously and skeletonise leaves. Mature caterpillars disperse to other leaves / plants and defoliate.</p>	<ul style="list-style-type: none"> • Collect and destroy plant parts/plants having gregarious stage of caterpillars. • Install sex pheromone trap @ 10 traps/ha for early deduction of the pest. • Spray profenofos (2ml/l) or chlorantraniliprole (0.3 ml/l) or dichlorvos (0.7 ml/l) or quinalphos (2ml/l) or dust quinalphos 1.5% (25 kg/ha), when their population is likely to reach 10/m row length.
<p>Bihar hairy caterpillar (<i>Spilarctia obliqua</i>) Larvae feed voraciously on the foliage in early stage and defoliate the plant. Larvae also damages flowers and pods.</p>	<ul style="list-style-type: none"> • Collect and destroy infested plant parts along with larvae. • Spray <i>Bacillus thuringiensis</i> var. <i>kurstaki</i> (1 g/l) or dichlorvos (0.7 ml/l) or chlorpyrifos (2ml/l) or quinalphos (2ml/l).
<p>Gram pod borer (<i>Helicoverpa armigera</i>) Larvae feed voraciously on the foliage in early stage and defoliate the plant. Larva damages flowers and pods.</p>	<ul style="list-style-type: none"> • Install pheromone traps at a distance of 50 m @ 10 traps/ha. • Erect bird perches @ 50/ha. • Spray indoxacarb (1 g/l) or chlorpyrifos (2 ml/l) or quinalphos (2 ml/l).
<p>White fly (<i>Bemisia tabaci</i>) Nymphs and adults suck the sap from leaves. The crop present sickly appearance with large number of leaves turned pale yellow. The plants remain stunted. Whitefly also transmits mosaic disease.</p>	<ul style="list-style-type: none"> • Seed treatment with imidacloprid or thiamethoxam (5g/kg seed) • Spray dimethoate (1.7 ml/l) at the crop age of 35-40 days and repeat after 15 days if needed.

8. MAJOR INSECT PESTS OF LINSEED AND THEIR MANAGEMENT

The crop is damaged by bud fly which is the key pest of linseed. The pest causes severe yield losses i.e. 20 to 75%. The intensity of pest incidence varies from location to location. Sometimes, the crop is also damaged by leafminer, thrips and gram pod borer.

Insect pests of linseed and their management

Insect pests and Nature of damage	Management
<p>Linseed bud fly (<i>Dasyneura lini</i>) The internal parts of flower bud are eaten</p>	<ul style="list-style-type: none"> • Deep summer ploughing of the fields exposes the bud fly maggots. • Crop rotation

by the maggot resulting in un-opening of the bud.	<ul style="list-style-type: none"> • Intercropping with chickpea (3:1) or mustard (5-6:1) reduces bud fly infestation. • Put bamboo pegs @ 40-50/ha for increasing the activity of predatory birds. • Adult bud flies are lured to light at night and thus light trap or attractant like jaggery (1 kg/75 lit. water) can be used to lure and kill adult flies • Spray NSKE 5% or imidacloprid (0.2 ml/l) or spinosad (0.3 ml/l)
<p>Gram pod borer (<i>Helicoverpa armigera</i>)</p> <p>The caterpillars bore the young capsules and feed on the seeds.</p>	<ul style="list-style-type: none"> • Sowing of linseed crop as per recommended sowing time of zone. • Spray profenofos (1ml/l) or spinosad (0.3 ml/l).
<p>Leafminer (<i>Chromatomyia horticola</i>)</p> <p>The larvae make tunnels on the leaf.</p>	<ul style="list-style-type: none"> • Spray dimethoate (1.7 ml/l) or oxydemeton-methyl (1.7 ml/l).
<p>Thrips (<i>Caliothrips indicus</i>)</p> <ul style="list-style-type: none"> • Nymphs and adults suck the sap from the tender shoots and leaves. 	<ul style="list-style-type: none"> • Spray of imidacloprid (0.2 ml/l) or spinosad (0.3 ml/l).

9. MAJOR INSECT PESTS OF NIGER AND THEIR MANAGEMENT

This minor oilseed crop is invaded by a number of pests of which niger caterpillar, hairy caterpillars and safflower aphid are the major ones.

Insect pests of niger and their management

Insect pests and Nature of damage	Management
<p>Niger caterpillar (<i>Condica conducta</i>)</p> <p>The caterpillar green with purple markings feeds on leaves and defoliates the plants.</p>	<ul style="list-style-type: none"> • Proper weeding reduces hiding places. • Spray quinalphos (2 ml/l) or dichlorvos (0.7ml/l) or profenofos (1 ml/l) or dust with phosalone 4% or carbaryl 5% (20-25 kg/ha).
<p>Cutworm (<i>Agrotis ipsilon</i>)</p> <p>The moth hides under dried twigs during day time and lays eggs on leaves. Larvae attack the crop and plants at ground level.</p>	<ul style="list-style-type: none"> • Keep grass bundles or crop refuges in cluster in field for the caterpillars to hide during evening and collect the caterpillar early in the morning and kill them by dusting the crop with Chlorpyrifos 1.5%DP (25 kg/ha) or spray quinalphos (2 ml/l).
<p>Bihar hairy caterpillar (<i>Spilarctia</i>)</p>	<ul style="list-style-type: none"> • Collection and destruction of egg masses and early instars of caterpillars.

<p><i>obliqua</i></p> <p>The caterpillars remain gregarious underneath leaves in early stages and cause serious loss in yield at third and fourth instar.</p>	<ul style="list-style-type: none"> • Spray dichlorvos (0.7 ml/l) or profenofos (1ml/l) or quinalphos (2ml/l) or chlorpyrifos (2.5ml/l) or dust carbaryl 5% (25 kg/ha).
<p>Surface grasshopper (<i>Chrotogonus</i> sp.)</p> <p>Grasshoppers cause damage to the crop to a great extent in its early stage.</p>	<ul style="list-style-type: none"> • Dusting with phosalone 4% or carbaryl 5% (25 kg/ha) can control the pest in early stage.
<p>Aphids (<i>Uroleucon carthami</i>)</p> <p>This is one of the important sucking pests of niger during later period of crop growth.</p>	<ul style="list-style-type: none"> • Spray dimethoate (1.5 ml/l) or oxydemeton-methyl (1.7 ml/l) or dust quinalphos 1.5% (20 kg/ha).
<p>Semilooper (<i>Plusia orichalcea</i>)</p> <p>Larva feeds on the leaves and defoliates the plant.</p>	<ul style="list-style-type: none"> • Spray NSKE 5% or dichlorvos (0.7 ml/l) or profenofos (1 ml/l).
<p>Niger capsule fly (<i>Dioxya sarorcula</i>)</p> <p>Maggot feeds on seed and pulp inside the capitula.</p>	<ul style="list-style-type: none"> • Install light trap one per ha. • Spray quinalphos (2 ml/l) or dichlorvos (0.7 ml/l) or dimethoate (1.7 ml/l) or imidacloprid (0.3 ml/l).

CONCLUSION

Integrated Pest Management (IPM) is the optimization of pest management in an economically and ecologically sound manner. This is accomplished by the use of multiple tactics in a compatible manner to maintain pest damage below the economic injury level while providing protection against hazards to the animals, plants and the environment. Cultural practices, resistant varieties, bio-control agents and use of pesticides are the integral parts of the IPM. No doubt, IPM has been accepted in principle as the most attractive option for the protection of agricultural crops from the ravages of insect pests and diseases, yet its implementation at the farmers' level has been rather limited. Still, the usage of pesticides remains as key tactics of interventions and their injudicious use represents the greatest threat to IPM. Hence, there is an urgent need to circumvent the pest damage following IPM strategies to get more productivity in these energy rich crops.