INTEGRATED PEST MANAGEMENT IN VEGETABLE CROPS

Prepared by

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Foreword

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior implemented the new revised course curriculum of PG program, which takes care contemporary needs and prepare the students as contributors of sustainable agriculture.

The faculty is committed to impart quality teaching to the students to keep pace with the present world of competition.

Therefore, looking to the need of students the bulletin entitled "Insect pest management in vegetable crops" prepared by Dr. S. B. Singh Assistant Professor and Dr S. N. Upadhyay, Professor, College of Agriculture, Indore, deserves due appreciations.

The bulletin containing the recent advances of management of vegetable insects through bio practices and new molecules of insecticides in detail which will be helpful to increase the knowledge in relation to vegetable insect pests and their management.

I personally believe that this bulletin will be useful to the students, entomologists and extension personnel.

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(A. M. Rajput)
Vegetables being the rich source of mineral, vitamins, antioxidants and photochemicals are increasingly becoming important for nutritional and health security of rural and urban people of our country. India is the second large producer of vegetables in the world after China but its productivity is quite low. The reasons for low productivity are many. However, among these the insect pest infestation is one of the major constraints in realizing potential yield of vegetables.

The demand for clean and ecologically sound environment envisages careful planning for manage the obnoxious pests. Sole reliance on insecticides and disregards for deleterious side effects can no longer be accepted. Experience has shown that shift is urgently required in view of rationalizing the insecticide uses through the integration of several management practices to minimize over reliance on insecticides and also to meet out international standard for export. In this endeavour, useful information has been generated on bio-ecology and management of the pest indifferent vegetables. Earnest efforts have been made to compile available information on bio-ecological and management aspects of vegetable pests in a systematic manner, grouped in different chapters and presented in the form of a compendium entitled "Insect pest management in vegetable crops". This publication contains excellent coloured photographs depicting salient identification characteristics of insect, symptoms of damage on plants etc. Efforts have also been made to cover the information on host range, nature of damage, description of biology and control measures of individual insect pests.

The authors are grateful to Dr A. K. Singh, Vice Chancellor, RVSKVV, Gwalior, Dr B. S. Baghel, Dean, Faculty of Agriculture, Dr R. L. Rajput, Direction Instruction and Dr A. M. Rajput, Dean, College of Agriculture, Indore for their constant inspiration, encouragement and valuable suggestion to bring out this publication.

It is hoped that publication will be useful for research workers, teachers, students, planners and extension workers.

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Authors

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Integrated Pest Management (IPM) is a component of the agro-ecosystem management technology for sustainable crop production. It is a knowledge-intensive system and background information regarding the pest, abiotic and biotic factors, agro-ecosystem and management tactics required for execution of IPM programmes.

**TOMATO**

**Fruit Borer** (*Helicoverpa armigera* Hubner)

The adult is stout and medium-sized moth and has a dark circular spot in the centre on the forewing. They lay small, single, and whitish round eggs on the trifoliate leaves beneath the topmost flower cluster.

Borer damaged fruits

Eggs hatch in about 3-4 days and the first instars larvae initially feed on the leaves and migrate to the developing green fruit later. The larvae bore into the fruits with the posterior end outside the hole. Full-grown caterpillars show characteristic whitish and dark brown longitudinal stripes.

**Management**

**Under Open Conditions:** Effective management can be done by adopting marigold as a trap crop. Giving sprays of Ha NPV @ 250 LE/ha at 28, 35, and 42 days after transplanting. Mechanical collection and destruction of bored fruit at periodic intervals (3-4 times) brings down the borer incidence to less than 2 per cent.

**Under Protected Conditions:** Spray Ha NPV at 250 LE/ha + 1% jaggery along with sticker (0.5 ml/litre) during evenings when the larvae are young. For grown-up larvae spray Indoxacarb 14.5 SC @ 0.5 ml/l or Thiodicarb 75 WP @ 1g/l.
Serpentine Leaf Miner (*Liromyza trifolii* Burgess)

The tiny, metallic fly punctures the leaf lamina and feeds on the oozing sap. It lays eggs on the outer margin of leaves. Within 2-3 days, whitish maggots hatch out of these eggs and start mining the leaves and pupate in 6-10 days. Pupation takes place in the soil and occasionally on the leaf surface itself. Typical serpentine shaped tunnels are formed in the leaf lamina indicating the path of feeding by the maggots.

**Leaf miner damage on tomato leaves**

![Image of tomato leaves with leaf miner damage]

**Management:**

Often the incidence starts from nursery itself. Hence, remove infected leaves at the time of planting or within a week of transplanting.

Apply neem cake to furrows (open)/beds (polyhouse) @ 250 kg/ha at planting and repeat after 25 days.

Spray neem seed powder extract 4% or neem soap 1% at 15-20 DAPS.

In open conditions, if the incidence is high, remove infected leaves and spray Triazophos 40 EC (1ml) mixed with 7.5 g neem/l.

Under protected conditions avoid frequent spraying of synthetic pesticides. At the most, one spray of Deltamethrin 2.8 EC @ 1ml/l or Cypermethrin 25 EC @ 0.5 ml/l or Triazophos 40 EC @ 2ml/l may be given, if required.

**Whiteflies (*Bemisia tabacii*)**

Whitefly is a well-known vector, which transmits tomato leaf curl virus. It has piercing and sucking mouthpart and both nymphs and adults feed on lower surface of the leaves causing deformation of young leaves. Whiteflies also excrete honeydew, causing sooty mould. Under protected conditions whiteflies become more persistent, which require extensive management practices as mentioned below.
Damage by Whiteflies

Management

Use virus resistant hybrids.

Raise nurseries in seedling trays under nylon nets or polyhouses.

Spray Imidacloprid 200 SL (0.3ml/l) or Thiamethoxam 25 WP (0.3 g/l) in nursery at 15 days after sowing.

Remove the leaf curl infested plants as soon as disease symptoms are expressed. This helps in reducing source of inoculums of the disease.

Drench the base of the seedlings with Imidacloprid 200 SL (0.03ml/l) or Thiamethoxam 25 WP (0.3 g/l) before transplanting.

If pro treys are used for raising nursery, drench the pro treys with the chemicals one day before transplanting.

After transplanting give need-based sprays of Imidacloprid 20 SL (0.3ml/l) or Thiamethoxam 25 WP (0.3 g/l) at 15 days after planting and do not repeat after fruiting stage as this may leave harmful residues in fruits.

Install yellow sticky traps coated with adhesive or sticky glue at crop canopy level for monitoring adult whitefly population.

If the traps indicate the whitefly activity, spray Dimethoate 30EC @ 2ml/l or neem seed kernel extract 4% (NSKE) or pongamia or neem oil (8-10 ml/l) or neem soap (10g/l).

Rogue out the virus affected plants as soon as the symptoms are observed.

**Tobacco Caterpillar (Spodoptera lituara)**

This is a minor pest under open conditions and assumes severe form under protected cultivation particularly in ill managed playhouses. Eggs are laid in clusters on foliage. Young larvae feed gregariously on leaves. Mature larvae, migrate and cause extensive damage to leaves and fruits. They hide in soil and crop debris during the day time.

**Tobacco Caterpillar damage on leave**
Management

Collection and destruction of egg masses and gregarious larvae.

Spray Spodoptera NPV 250 LE/ha + 1% jaggery along with sticker (0.5 ml/litre) during evenings.

Use poison baiting. Mix 10 kg of rice bran or wheat bran with 2 kg jaggery by adding a little water in the morning.

In the evening add 250 gm of Methomyl or Thiodicarb formulation and sprinkle over the bed. Caterpillars get attracted to fermenting jaggery, feed and get killed.

Red Spider Mites (Tetranychus urticae)

Red spider mites thrive under high temperature, dry weather and are more serious under protected conditions. They are generally found on the lower surface of older leaves. However, when the infestation is very high they attack all parts of the plant and are observed in colonies covered by white-silky webs. Adults and nymphs lacerate the leaves causing yellowing and discoloration.

Damage by Red Spider Mites (Tetranychus urticae)

Management

Remove and destroy the affected leaves.

Under open conditions, spray Dicofol 18.5 EC @ 2.5 ml or wettable sulphur 80 WP @ 3g/l. Spray lower leaves and lower leaf surface thoroughly as mites are generally observed there.
As an alternative to the chemical acaricides spray neem oil/neem soap/ pongamia soap 1%.

Under polyhouse conditions spray need-based application of acaricides like Abamectin 1.9 EC @ 0.5 ml/l or Dicofol 18.5 EC @ 2.5 ml/l or Fenazaquin 10 EC @ 1 ml/l in rotation with plant products like pongamia oil or neem oil (8-10 ml/l) or neem soap (10 g/l).

When incidence is severe, remove and destroy all severely infected leaves followed by a spray of mixture of an acaricide with botanicals mentioned above.

**Root-knot Nematodes (Meloidogyne incognita, M. javanica)**

Root-knot nematodes cause root galls on the feeder roots and sometimes affect the entire root system showing heavy galling. This affects the uptake of nutrition and water and the plants show wilting during warmer part of the day. This causes stunted plants with yellow foliage resulting in yield reduction.

Damage by Root-knot Nematodes

Management

Use nematode resistant variety/hybrid if available.

Follow crop rotation with marigold, wherever possible.

Seed treatment with bio-pesticides- *Pseudomonas fluorescens* @ 10g/kg seed.

Nursery bed treatment with *T. harzianum* @ 50 g/ sq. m.

For the management of nematodes in the main field apply 2 tons of farmyard manure enriched with *T. harzianum* and *Paecilomyces lilacinus* lilacinus per acre before planting, along with 100-200 kg of neem or pongamia cake.

Apply Carbofuran 3G @ 1 kg ai/ha at transplanting.

Under polyhouses the following pest management practices depicted as a flow chart may be followed.

**The IPM package in tomato under polyhouse**

Raise seedlings in pro treys in polyhouse 15 DAS (Days after seed sowing)

Spray the plants with Imidacloprid or Thiamethoxam.

**One day before transplanting** drench the base of seedlings with Imidacloprid or Thiometoxam

**At transplanting**

Apply neem cake 250 kg/ha. 15 DAP (days after planting)
Spray the seedlings with Imidacloprid or Thiomethoxam 25 DAP (days after planting)

Apply neem cake 250 kg/ha

**Post flowering and fruiting stage**

Monitor for pest like fruit borer, tobacco caterpillar, leaf miner, whitefly and red spider mite.

Erect yellow sticky traps to monitor whitefly.

Spray NPV according to the pest.

Remove leaves severely infected with leaf miner/red spider mite

Spray neem seed powder/neem soap for leaf miner.

Spray synthetic acaricide/botanical in rotation to control red spider mite,

spray systemic insecticide/botanical to control whitefly.

**BRINJAL**

**Shoot and Fruit Borer (Leucinodes orbonalis Guen)**

This pest has developed resistance against all groups of insecticides and management is very difficult. Adult moths lay tiny white eggs singly on flower buds and other plant parts. Eggs hatch into small light brown larvae. Caterpillars feed inside the tender shoots before flowering and cause wilting of the affected shoots. Later, the larvae bore into flowers; bud and the grown up larvae migrate and bore fruit contaminating them with excreta. When the incidence is high, unopened flower buds swell and harbour the borer. Just before pupation, the grown up larvae come out of the fruits and flower buds to pupate in silky cocoons on plant parts or debris.

**Damage by Shoot and Fruit Borer**

![Image of affected plant]

**Management**

Use nylon net barrier for raising nurseries to eliminate pest incidence coming from nursery to main field. Cut and destroy wilted insect damaged shoot tips during pre-flowering and flowering period at weekly intervals. Regularly destruction of larvae in swollen damaged flower buds and fruits after each harvest is compulsory. Grow all round barrier crops like maize. Practice clean cultivation.
**Pheromone Trap:** Use of water traps loaded with pheromone @ 30 /Acre can reduce the pest incidence to minimum level.

**Botanical and Bioagents:** Apply neem or pongamia cake @ 250-500 kg/ha to ridges at flowering and repeat 2 more times at 30-45 days interval.

Spray NSPE 4% or neem oil 2% at 10 days interval. 

Mix Cypermethrin 25 EC (0.75 ml/l) with neem soap @ 7.5g/ l and spray.

Spray *Bacillus thuringiensis* formulation (1%) at weekly interval followed by release of *Trichogramma chilonis* @ 2,50,000 /ha (50,000 / release -5 times at weekly intervals, starting from flowering).

**Leafhopper (**Amrasca biguttula biguttula Ishida)**

Both adults and nymphs suck the sap from leaves. The eggs are inserted into the midrib or veins. On hatching the nymphs move along the veins and nymphs suck the leaf sap. On the older leaves, the damage is seen as yellowish-green mosaic patches followed by brown necrosis and curling along the leaf margin.

Damage by Leafhopper

![Leafhopper Damage]

**Management**

Soil application of neem cake 250 kg/ha followed by sprays of NSPE 4% or neem soap 1% at 10 days interval.

Spray of systemic insecticides like Dimethoate 30 EC @ 2ml/l or Imidacloprid 200 SL @ 0.3ml/l or Acephate 75 SP (1 g/l) at pre-flowering stage.

**Ash Weevil (**Myllocerus subfasciatus Guerin)**

Ash weevil is an endemic pest feed on the foliage and cause saw teeth like damage along the leaf margin. The adults lay eggs in and around base of the plants in soil and the hatching grubs feed on roots. Affected plants wilt and dry up. Wilting is first noticed in patches in a plot. One can notice very few roots in such wilting plants when uprooted. Both the roots and plant base show scraped damage. Grubs pupate in the soil encrustation.
Damage by Ash Weevil

Management

Soil application of neem cake at the time of transplanting (@ 250 kg/ha) and repeat the neem cake application for 1 or 2 times at 30 and 60 DAP.

Epilachna Beetle (Epilachna vigintioctopunctata, Fab.)

Both the grubs and the adult beetles scrape the leaves in semi-circular or half moon shaped fashion. Females lay torpedo shaped, 15-50 yellowish eggs on the ventral surface of leaves. Heavy infestation result in leaf skeletonization. Pupation takes place on the plant itself.

Epilachna Beetle damage on brinjal

Management

Collect and destroy adult beetles.

Spray any contact insecticide like Carbaryl 50 WP @ 3g/l or 40 EC @ 1.5 ml/l if required.

Red Spider Mites (Tetranychus urticae Koch)

Tiny mites feed mainly on the lower surface of the leaves by scrapping the epidermis causing yellowing of leaves followed by foliage drying. Practices detailed under tomato can be adopted for its control.

Red spider mites damage on brinjal
Management

Spray of Dicofo 18.5 EC @ 2.5 ml or any other acaricide like wettable sulphur 75 WP @ 3 g/l.

As an alternative to the chemical acaricides, spray of neem soap/pongamia soap 1% on the under surface of the leaves.

Root-knot Nematodes (Meloidogyne incognita, M. javanica) : The root-knot nematodes cause root galls on the feeder roots which sometimes affect the entire root system showing heavy galling. This affects the uptake of nutrition and water and the plant show wilting during warmer part of the day. Later, stunting of plants with yellow foliage and reduction in yield is very common.

Root-knot infected plant

Management

Seed treatment with bio-pesticide- *Pseudomonas fluorescens* @ 10 g/kg seed.

Nursery bed treatment with *T. harzianum* @ 50 g/ sq.m.

Apply 2 tons of farmyard manure enriched with *T.harzianum* and *Paecilomyces lilacinus* per acre before planting, along with 100-200 kg of neem or pongamia cake.

Apply Carbofuran 1G @ 1kg ai/ha at transplanting.

CHILLI AND CAPSICUM

Thrips (*Scirtothrips dorsalis*)

Thrips are minute insects with fringed wings, serious during dry periods of high temperature. Both adult and nymphs suck the sap from young developing leaves. Affected leaves curl upwards along the margin and get crinkled and reduced in size. They also feed on floral parts
and fruits. Fruit damage result in rough brown patches affecting their quality and drastically reducing the market value.

Leaf damage due to thrips in capsicum

Management

Apply neem cake @ 250 kg/ha to plant beds while planting and repeat after 30 days.

Spray Acephate 75 SP@ 1.0g/l or Fipronil 5 SC @ 1ml/l or ethofenprox 10 EC @ 1ml/l in rotation. Spray Acephate 75 SP (0.5 gm) + pongamia oil (2ml) +1 ml sticker in one litre water after emulsifying (shaking thoroughly in a bottle).

White or Yellow Mites (*Polyphagotarsonemus latus*)

These are very minute mites and cannot be seen by naked eyes. Damage is more in hot and humid conditions. Adults and nymphs scrape terminal leaves and auxiliary shoots. As a result, leaves become narrow, twisted with elongated petiole. The damage is characterized by downward curling of leaves and stunted growth of plants and dropping of flowers.

Yellow mite damage on capsicum fruit discoloration

Management

Apply wettable sulphur 80 WP @ 3g/l or any acaricide (directing the spray on the ventral surface of leaves).

Spray pongamia oil (2ml/l) mixed with acaricides.

Spray neem seed powder extract 4% at 10 days interval when the pest incidence is low.
As and when the pest incidence increases, spray with synthetic acaricides like Dicofol 18.5 EC @ 2.5ml/l and repeat the spray after 10 days, if required.

Under protected conditions spary acaricides like Abamectin 1.9 EC @ 0.5ml/l or Dicofol 18.5 EC @ 2.5 ml/l or Fenazaquin 10 EC@ 1ml/l in rotation with plant products like pongamia oil or neem oil (8-10 ml/l) or neem soap (10g/l) when the leaves start curling down with all the precautions.

**Aphids (Aphis gossypi and Myzus persicae)**

These are small green insects and suck the sap from tender leaves and flower buds. Excretion of honeydew by aphids promotes sooty mould growth, thereby reducing photosynthesis and fruit quality. Aphids also act as vectors for transmitting mosaic virus disease.

Damage by Aphids

Management

Spray Acephate 75 SP @ 1g/l or Dimethoate 30 EC @ 2 ml/l in rotation when required.

Remove all the virus affected plants and destroy.

**Root-knot Nematodes (Meloidogyne incognita)**

Root-knot nematodes cause root galls on the feeder roots which sometimes affect the entire root system showing heavy galling. This affects the uptake of nutrition and water and the plants also show wilting during warmer part of the day. Later, stunting of plants with yellow foliage and reduction in yield is very common.

Management

Management practices given under tomato and brinjal are also effective on chillies.

**IPM package in capsicum under polyhouse**

Raise seedlings in pro treys in polyhouse

At transplanting Apply neem cake 250 kg/ha. at15 DAP

Spray Acephate for thrips at 30 DAP

Apply neem cake 250 kg/ha Post flowering and fruiting stage monitor for pest like fruit borer, tobacco caterpillar, thrips and yellow mite.
Spray NPV according to the pest. Spray Acephate / Fipronil / Ethofenprox / Acephate + pongamia oil in rotation for thrips control.

In post flowering and fruiting stage Spray synthetic acaricide / botanical in rotation to control yellow mite.

**OKRA**

**Leafhoppers (Amrasca biguttula biguttula)**

Hoppers lay pear shaped, elongated and yellowish white eggs in the veins on the under surface of leaves. Both the adults and nymphs suck the cell sap. Nymphs move diagonally when disturbed. There are 10 to 12 overlapping generations in a year. Plants loose their vitality and affected leaves turn yellow and curl upwards. When the infestation is high during summer, leaves turn brick red and show large necrotic spots, which is often confused with fungal infection.

**Management**

Apply neem cake @ 250 Kg/ha to soil immediately after germination and repeat after 30 days.

In the initial stages of crop before flowering spray systemic insecticide like Acephate 75 SP (1ml/l) or Imidacloprid (0.3 ml/l).

Once the fruit harvest starts avoid systemic insecticides.

Spray neem or pongamia soaps @ 0.5% or pulverized neem seed powder extract (NSPE) 4% at the lower surface of the leaves.

**Shoot and fruit borer (Earias vittella and E. insulana)**

Spotted bollworms are active throughout the year reaching peaks during March-May and August-October. Female lays green coloured eggs with longitudinal ridges on buds, flowers and fruits. Like brinjal shoot and fruit borer, the infestation is seen on shoots before and after flowering, feed exclusively on fruits. Infested shoots wither and wilt.

Fruit borer damage on okra
Management
Collect and destroy the affected fruits and stems.

Apply neem cake @ 250 kg/ha after germination and repeat two more times at 30 days interval and spray neem soap 1% or NSPE 4%. Spray at 10 days interval.

During rainy season, spray effective contact insecticides like Indoxacarb 14.5 SC @ 0.75 ml/l.

A waiting period of minimum one week to be maintained.

Avoid staggered planting.

Aphids (Aphis gossypii)
This is a polyphagous pest, feeding in colonies and completely covers the shoot tips, buds and lower surface of leaves. Both nymphs and adults suck the sap. They also excrete honeydew on which sooty mould develops.

Damage by Aphids

Management
Clip and destroy infested shoots

Thoroughly spray neem or pongamia soap (1%) or pulverized neem seed powder extract (NSPE) 4%.

During pre-flowering period spray systemic insecticides like Dimethoate 30 EC (2ml/l) or Acephate 75 SP or Acetamiprid.

Petiole Maggot (Melanagromyza hibisci Spencer)
This is a dipteran fly and attacks the crop throughout the growth period. Generally drying of leaves is noticed. If petioles of such leaves are opened, yellow maggot and pupae can be noticed. Pest attacks immediately after germination and may cause mortality, or cracking of main stem.
Management

Apply neem cake @ 250 kg/ha immediately after germination and repeat after 30 days followed by sprays of NSPE 4% or neem soap 1% at 10 days interval after flowering.

Whitefly (*Bemesia tabaci*)

It is a polyphagous vector transmitting yellow vein mosaic disease (YVM). It lays eggs on the lower surface of leaves. Both the adult and the nymph feed by sucking leaf sap. They excrete honeydew, which results in sooty mould. At present many varieties and hybrids resistant to YVM are available in market and hence, disease management is very easy.

Damage by Whitefly

Management

Grow YVM resistant varieties/hybrids.

Apply neem cake @ 250 kg/ha at germination and again at 30 DAP followed by sprays of pulverized neem seed powder extract 4% or neem oil 1%.

Spray Imidacloprid 200 SL @ 0.3ml/l or Thiomethoxam 0.3 gm/l (should not be sprayed after flowering stage)

Mites (*Tetranychus cinnobarinus, Oligonychus coffeae*)

The infestation of mites is mostly observed during the warm and dry periods of the season. Nymphs and adults lacerate the leaves resulting in whitish grey patches and affected leaves become mottled, turn brown and fall.

Management

Spray Dicofol 18.5 EC @ 2.5 ml or any other acaricide like wettable sulphur 50 WP @ 3g/l.

As an alternative to synthetic acaricides, spray neem soap/pongamia soap 1%.

Thoroughly spray on the under surface of the leaves for good control.

Root-knot Nematodes (*Meloidogyne incognita, M. javanica*)

The root-knot nematodes typically cause root galls on the feeder roots, affecting the uptake of nutrition and water. The above ground symptoms are, stunting of the plant with yellow foliage often mistaken for nutrient deficiency symptoms. The reduction in size of fruits is often accompanied by fresh flower drop.
Management

Seed treatment with bio-pesticide *Pseudomonas fluorescens* @ 10g/kg seed.

Apply 2 tons of farmyard manure enriched with *Pochonia chlamydosporia* and *Paecilomyces lilacinus* per acre before sowing, along with 100-200 kg of neem or pongamia cake.

In case of severe incidence, apply Carbofuran 1.5 kg ai/ha.

CRUCIFEROUS VEGETABLES (Cabbage, Cauliflower, etc.)

Diamond Back Moths (DBM) (*Plutella xylostella* L.)

Diamond back moths are small greyish brown insects bearing whitish triangular spots on posterior margins of the forewings and while resting the wings come together and form a diamond pattern. This is a major pest of cruciferous crops, particularly cabbage and cauliflower during January-June and also during dry periods in monsoon. Eggs are yellowish white, and are laid singly on tender leaves. A single female may lay about 40-60 eggs. Incubation period is 3-6 days. The first instar larvae mine the epidermal surface of the leaves. Second instars onwards the larvae feed externally by making holes in the leaves. Pupation occurs inside silken cocoon on the plants, which last for 4-6 days. The complete life cycle from egg to egg takes place in about 20-25 days.

Damage on cabbage by Diamond Back Moths

Eggs

Pupa

Adult
Management

Sow Indian mustard as a trap crop.

Spray neem seed powder extract @ 4% or neem soap 1% or pongamia soap 1% thoroughly coverage to the crop canopy.

Install light traps (3-4 with 60 or 100 Watt bulbs / acre) to control adults.

For one acre plot use 3-4 light traps (60 or 100 Watt bulbs) by hanging above a bucket half filled with water.

Alternatively, hang the bulb above a gunny bag (slating below) smeared with grease or oil. Illuminate the bulbs for full night. Adults of DBM will get attracted to light and get trapped in the water/oil.

Use the light traps for 3-4 days for effective control of DBM adults.

As this pest has developed resistance against many insecticides, use of effective insecticide currently available in market is essential.

The adults migrating from neighbouring plots are to be controlled by using light traps spraying an affective insecticide.

Leaf Webbers (Crocidolomia binotalis Zeller)

The moths lays eggs in clusters of 40-100 on leaf surface, which hatch in 5-7 days. Young larvae feed gregariously and later web the leaves together and feed within. This results in rotting of cabbage head and cauliflower curds. The larval period lasts for 25-20 days while pupation occurs in soil, which varies from 15-40 days.

Leaf webber damage on cabbage

Management

Collect and destroy egg masses and gregarious larvae.

Spray any contact insecticide on the foliage when the larvae are observed.

Spray neem seed kernel extract 4% or pulverized neem seed powder extract (NSPE) 4%.
**Stem Borer (Hellula undalis Zeller)**

The adult moths lays eggs singly on leaves, the hatched larvae mine the leaves along side veins. The grown up larvae bore into stems preventing head initiation, which results in multiple shoots and multiple head formation.

**Management**

Spray the seedlings with an effective contact insecticide before planting followed by one more spray at 10 DAP, particularly for summer and kharif crop (March-July). Spray pulverized Neem Seed Powder Extract (NSPE) 4%.

**Aphids (Brevicoryne brassicae Linn, Myzus persicae Sulzer)**

Aphids suck the sap, devitalize the plants affecting the quality of head or curds and become severe when contract insecticides are sprayed regularly. Direct feeding on young growth leads to wilting of plants. Early attack may lead to stunted growth. Symptoms of viruses transmitted by B. brassicae include mosaic, chlorotic and necrotic lesion on leaves. M. persicae is the most important aphid virus vector.
Management

Spray any systemic insecticide like Dimethoate 30 EC @ 2ml/l when the aphids are observed.

Spray pulverized neem seed powder extract Ê È (NSPE) 4%. Follow mustard trap crop IPM as mustard will Ê È attract all aphids after flowering and main crop will be spared of the pest incidence.

LEGUMINOUS VEGETABLES

Pod Borers

A complex of pod borers viz., Lampides boeticus L., Maruca testulalis Geyer, Adisura atkinsoni (Lethierry), L. boeticus, Helicoverpa armigera affects the leguminous crops by feeding floral parts and pods resulting in reducing their marketable quality.

Lycaenid Borer (Lampides boeticus L.)

This is a butterfly pest and commonly known as pea blue. The eggs are laid singly in flowers and flowers buds. In peas, the larvae bore into young pods. The entry hole gets blocked after sometime. However, in lablab, the larvae bore into flower buds. The pest can be monitored by the presence of the bored holes. When the larvae attains fourth instars, they migrate and cause extensive damage to flower buds and pods. Hence, control measures need attention in the early stages of pest incidence.

Damage by Lycaenid Borer

Management in peas,

Spray at flowering as soon as eggs are noticed with Cypermethrin 25 EC@ 2.5 ml/l or Indoxacarb 14.5 SC @ 0.5 ml/l.

In lablab, spray at flower bud stage, when on an average about 1 flower bud is damaged per inflorescence.

Spotted Pod Borer (Maruca testulalis Geyer)

The pyralid moth lays eggs on small flower buds as soon as flowering starts. Flower buds can be examined for holes caused by young larvae. Control measures are to be followed at flower bud stage itself to prevent the larvae from developing and feeding on pods.
Damage by Spotted Pod Borer

Management

Apply neem cake 250 kg/ha at flowering and first spray at flower bud formation with pulverized neem seed powder extract (PNSPE) 4% or neem soap 1%. Repeat after one week.

Spray Cypermethrin 25 EC @ 0.5ml/l or Chlorpyriphos 20 EC @ 2.5 ml/l or Indoxacarb 14.5 SC @ 0.5 ml/l.

Field Bean Pod Borer (*Adisura atkinsoni*, Lethierry)

This is the major pod borer in field bean and the larva resembles *H. armigera*. The eggs are laid on tender pods. The young larvae bore into these pods and develop inside and come out after attaining fourth instar, which is a migratory stage. Hence, control measures at tender pod stage and again at flat pod stage of the crop are essential.

Management

Apply neem cake 250 kg/ha at flowering and repeat after 20 days.

Spray pulverized neem seed powder extract (NSPE) 4% of neem soap 1% at tender pod formation. Repeat sprays at 10 days intervals.

Spray Cypermethrin 25 EC @ 0.5 ml/l or Chlorpyriphos 20 EC @ 2.5 ml/l or Indoxacarb 14.5 SC @ 0.5 ml/l at peak egg laying period at tender pod stage and repeat after 15 days.

Gram Pod Borer (*Helicoverpa armigera* Hubner)

This polyphagous pest attacks peas occasionally along with *L. boeticus*. The habit of egg laying and larval feeding are the same as pea blue butterfly.

Management

As soon as eggs are noticed give the first spray at flowering with Indoxacarb 14.5 SC @ 0.5 ml/l or Novaluron 10 EC @ 0.75 ml/l.
Aphids (*Aphis craccivora* Koch & *Acrythosiphon pisum* Harris)

Both nymphs and adults suck the sap from young plant parts like shoot tips and inflorescence. *A. craccivora* is greenish black and *A. pisum* is greenish in colour. *A. pisum* generally occurs on peas.

**Management**

Clip infected shoots and spray neem soap or pongamia soap @ 1%. Spray Acephate 75 WP @ 0.75 ml/l or Dimethoate 30 EC 2ml/l.

Bean Fly (*Ophiomyia phaseoli* Tryon)

This species is serious in French beans and peas but can also be noticed on dolichos beans. This pest is serious during dry periods of Kharif (June-August) and after January-February when temperature increases above 30°C and can cause more than 70% mortality of the plants. The adults are small flies and lay eggs in the unifoliate leaves that come immediately after germination. It punctures the leaf, lays eggs under the leaf epidermis which turn into white spots, often confused with disease. These dried ovipositional cavities are observed within 2-3 days of germination of seeds. The larvae mine the leaf lamina, veins, midrib, and petiole and enter the stem resulting in mortality. The incidence is high during prolonged dry spells between rains, particularly in June-July months. When the incidence is early and high, plants invariably die. This mortality is noticed only after 25-30 days, when the plants are about to flower.

**Management**

Apply neem cake 250 kg/ha immediately after germination. Do not delay, particularly during *kharif* period.

Monitor the plants for adult activities, puncture marks and petiole mining soon after germination. As soon as a few adults are noticed hovering over the crop, spray Acephate 75 WP @ 0.75 g/l or PNSPE 4% or neem soap 1% or neem formulation with 10000 ppm Azadirachtin 2 ml/l.

The botanicals get washed away by rain and become ineffective if it rains within 1-2 days of spray. Give second spray after 12-20 days of sowing if 5 leaves show petiole mining symptoms per 10 leaves.

Bean Fly (*O. centrocematis*)

This species is specific to peas and lays eggs in the base of the stem resulting in drying of the leaves, from the base. Hence, the first symptom is drying of the first primitive leaf at the base, which occurs after about 20 days of sowing.
Management

Apply neem cake 250 kg per hectare to the ridges immediately after germination followed by sprays of pulverized neem seed powder extract 4% or neem soap 1% or neem formulation with more than 10000 ppm Azadirachtin 2-3 ml/l at 20 and 30 DAP.

Spray Acephate 0.75 ml/l or Dimethoate 30 EC @ 2ml per litre at 20 and 30 DAP.

Leafhoppers (*Empoasca kerri Pruthi*)

The greenish yellow nymphs and adults suck the sap. During September-October after onset of north-east monsoon, the pest becomes very serious causing withering of the foliage and plants.

Management

It can easily be controlled by any systemic insecticide or neem soap sprays as given under okra and brinjal.

**CUCURBITACEOUS VEGETABLES**

**Red Pumpkin Beetle (*Aulacophora foveicollis* Lucas)**

The adults are small, elongated yellow and defoliate the leaves immediately after germination. The larvae feed on roots and plant parts.

Damage by Red Pumpkin Beetle

Mechanically collect and destroy the pest if incidence is low.

If the pest incidence is very severe, spray Indoxacarb 14.5 SC @ 0.5 ml/l or Cabaryl 50 WP 4g/l or 25 EC @ 2ml/l or Chlorpyriphos 20 EC2.5ml/l.

**Serpentine Leaf Miner (*Liriomyza trifolii* Burgess)**

This is an introduced pest occurring on many cucurbit vegetables. Heavy incidence is noticed in watermelon, pumpkin, cucumber, etc. However, bitter gourd seems to be resistant. A native larval parasitoid, Hemiptarsenus vericornis is the major parasitoid on this pest.
Management

Soil application of neem cake @ 250 kg/ha immediately after germination.

Destroy cotyledon leaves with leaf mining at 7 days after germination.

Spray PNSPE @ 4% or neem soap 1% or neem formulation with 10000 ppm or more (2ml/l) after 15 days sowing and repeat after 15 days, if necessary.

If the incidence is high first remove all severely infected leaves and destroy.

Then mix neem soap 5 gm and hostothion 1 ml/l and spray.

After one week, spray neem soap 1% or PNSPE or neem formulation with 10000 ppm or more (2ml/l). Never spray the same insecticide repeatedly.

Fruit Fly (*Bactocera cucurbitae* Coquillett).

This is the major pest of cucurbits. The damage by maggots results in rotting of young and ripened fruits or drying and shriveling of fruits before maturity. Sometimes even the base of the plant gets attacked and plant start wilting. The incidence is more in wet climate.

Management

Use resistant varieties.

Soil application of neem cake @ 250 kg/ha immediately after germination and repeat at flowering followed by sprays of neem soap 1% or PNSPE 4% at 10 days interval after flowering.

Crush pumpkin 1 kg and add 100 gm jaggery and 10 ml Malathion and keep in the plot (4-6 places per acre).

Adults are attracted to the fermenting pumpkin and lay eggs and get killed. Repeat the process 2-3 times in the cropping season.

Erect cuelure (para pheromone trap) 3 per acre to attract and trap male fruit flies. Spray Carbaryl 50 WP @ 3 gm/l or Indoxacarb 0.5 ml/l.

Red Spider Mite (*Tetranychus neocaledonicus* Andre)

This pest is serious on cucurbits during warmer climate. Colonies of mites with in silk web can be observed on ventral leaf surface when incidence is high.
Management

Spray neem or pongamia soap at 1% on lower surface thoroughly.

Alternately, spray Dimethoate 30 EC @ 2ml/l or Ethion 50 EC @ 1ml/l or Wettable Sulphur 80 WP @ 3g/l.

**Thrips* (*Thrips palmi* Karny)**

Both nymphs and adults feed on the young shoot tips and floral parts and is suspected vector of Tospo virus. They are serious during summer months.

Management

Soil application of neem cake (once immediately after germination and again at flowering) followed by NSPE @ 4% and neem soap 1% alternately at 10-15 days interval.

Spray any systemic insecticides like Acephate 75 SP @ lg/l or Dimethoate 30 EC @ 2ml/l.

**Leaf Eating Caterpillar* (*Dipahania (=Margaronia) indica* Saund)**

Long shining caterpillars feed on leaves and fruits.

Apply neem cake to soil immediately after germination.

Spray any contact insecticides like Carbaryl 50 WP @ 3g/l. Neem or pongamia soap @ 0.75% also effectively manages this pest.

Soil application of neem cake (once immediately after germination and again at flowering) followed by NSPE @ 4% and neem soap 1% alternately at 10-15 days interval.
Spray Carbaryl 50 WP @ 3g/l or Indoxacarb 0.5 ml/l.

**Root-knot Nematodes (Meloidogyne incognita)**

The root-knot nematodes cause root galls from the initial stages of the crop growth. The larvae feed on the roots, which show typical galls, and later the entire root system shows heavy galling. The foliage becomes light yellowish; the plants become stunted and results in flower and fruit drop. In spite of irrigation the plants appear sick and drooping during daytime.

**Management**

Seed treatment with bio-pesticide *Pseudomonas fluorescens* @ 10g/kg seed.

Apply Carbofuran 3 G @ 1kg ai/ha at sowing and repeat after 45 days.

Apply 2 tons of FYM enriched with *Pochonia chlamydosporia* and *Paecilomyces lilacinus* per acre before sowing, along with 100-200 kg of neem or pongamia cake.

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**ONION AND GARLIC**

**Thrips (Thrips tabaci Lindeman)**

Thrips feed on a wide range of cultivated plants and weeds. Some of the principal alternate hosts include cabbage, cotton, tomato, cucumber, melons, pumpkins, strawberries and many flowering plants. Thrips are pestiferous in diverse ways. They cause direct damage to leaves and bulbs, aggravate fungal diseases and even vector virus.

Thrip damage on onion

Management

**Monitoring**: Sticky traps are commonly used for detecting thrips population. Various colours were found attracting different species of thrips in various geographical areas; widely used ones are yellow and bright blue traps.

**Cultural**: Good crop management practices can be readily manipulated to the disadvantage of thrips.

**Field sanitation techniques** such as removing alternate weed host on bunds and destruction of culls of onion and garlic are helpful to some extent in bringing down thrips population.
Avoid successive planting of onion and garlic or other preferred host. Therefore, planting in upwind direction could be helpful in escaping infestation from old planting to some extent in the initial stages.

**Planting Date** By making adjustments in transplanting dates, onions can be made tolerant to early thrips attack and satisfactory yields can be obtained with minimum chemical intervention.

**Mulching** Thrips being colour-sensitive, coloured mulches may be employed for their control. Reflective plastic silver colour and aluminium painted black mulches were effective in repelling the thrips in seed crop.

**Irrigation** Sprinkler irrigation reduces thrips population considerably compared to drip and surface irrigation. Insects would be washed off or drowned in the water accumulated in the leaf bases. Due to continuous retention of moisture in the soil, the pupae get rotten. In case of garlic, sprinklers are not that effective as in case of onion mainly due to the closer inner leaf alignment that protects the thrips from splashes of water.

**Barriers** Two rows of maize or inner row of wheat and outer row of maize surrounding the onion plots.

**Biological Control** These include lady beetles, minute pirate bugs, ground beetles, big-eyed bugs, lacewings, hover flies, predatory mites and spiders. So far limited success has been achieved in biological control of *T. tabaci* in many parts of the world.

A predator, minute pirate bug, *Orius tantillus* and anthocorid bug, found effectively feeding on thrips on garlic.

*Metarhizium ansopliae*, *Paecilomyces fumosoroseus*, *Verticillium lecani* and *Frankliniella* also killed *T. tabaci* sp. Mortality of thrips was highest with *B. bassiana* at 26 0C and 75% RH.

**Plant Resistance** Commercial varieties, N-2-4-1 and Pusa Ratnar were found resistant to *T. tabaci* in Punjab but the former was susceptible to thrips in Maharashtra. The variety B-780 is moderately resistant to thrips. In Bihar, Pusa Red and N-53 had lowest thrips population while Arka Niketan had highest infestations.

**Botanicals:** Neem was found effective when mixed with insecticides.

**Chemical:** Many insecticides like dimethoate (0.06%) and Methyl Demeton (0.05%) are recommended for thrips control.

Cypermethrin at 60 g ai/ ha offers good control of this pest.

Carbosulfan (0.05%) and Lambda cyhalothrin also effectively suppress thrips population. The secret of thrips control in onion lies in the placement of the insecticide.

It is necessary for the product to reach the base of the leaves where the majority of the thrips area is located.

Unlike other crops, onion and garlic require higher pressure and spray volume for good coverage of foliage.
Addition of a spreader or sticker (0.05-1.0%) is useful for retention and spread of spray fluid on erect leaves of onion.

Avoid repeated use of the same insecticide to minimise development of insecticide resistance.

In seed crop, control of thrips is often difficult. The umbels will provide excellent hiding site and it is difficult to reach them with insecticide. From the beginning, seed crop should be monitored regularly for thrips and should be controlled well before flowers open.

Avoid sprays after flower opening. If necessary, safer insecticide should be used late in the evening when no bees are foraging.

**Maggot (Delia antique)**

Onion maggot is more restricted to cooler coastal climates where onions are grown on organic and muck soils. Maggot is primarily a pest of onions and do not cause economic damage to garlic. This pest occurs in some parts of north India.

Damage by onion Maggot

Management

**Cultural:**

Avoid planting in soils that are high in undecomposed organic matter.

Avoid close spacing while planting. Control of *D. antique* is exceptional in areas where crop rotation was followed in the previous year.

**Host Plant Resistance:** No resistant varieties are available against maggot.

**Biological:** Ground beetle is a good predator and establishing grassy refuse strips in onion crop will enhance the beetle population and reduce the maggot population.
Chemical control

Application of Pirimiphos Methyl or Deltamethrin at 2ml/lit.

Fipronil 80WG (@25 g ai/kg) and Cyromazine (75 WP @ 50 g ai/kg), an insect growth regulator as seed treatment were recommended.

**Army Worms (Spodoptera exigua, S.litura) and Helicoverpa armigera Hubner** This pest occurs sporadically on onion grown for seed. Larvae feed inside the stem and move upward to reach the base of the umbel at early stages of flowering. Subsequently it invades the umbel and feeds on seeds. Arka Niketan was least affected.

**Pest Management**

Pheromone traps can be placed at 125 cm height and dispenser should be regularly replaced for effective trapping. NPV and Bt can also be employed for control of the pest. Insecticides like Cypermethrin, Quinolphos, Acephate, etc. can be used if infestation is more.

**Bulb Mite (Rhizoglyphus robini Claparede)** This pest infests the bulbs by penetrating the outer layer of tissue. The plants wilt and rot as opportunistic fungi and bacteria gain entry inside the bulbs. Bulb mites can reduce plant stands, stunt plant growth, and promote rot of bulbs in storage. On seeded onions, they can cut off the radical before the plants become established.

Mite infested bulb

![Mite infested bulb](image)

**Management**

Decaying cole crops, especially cauliflower, may harbour very high bulb mite populations in the field.

Avoid planting successive onion or garlic crops.

Flood irrigation or heavy rains may reduce mite levels in the soil.

In garlic, sow clean seed cloves.

Hot water treatment of seed garlic before planting may reduce mite infestation

Soil drenching with Dicofol at 2 ml/l or soil application of powdered sulfur effectively reduce the mite population considerably.

**Fumigation:** with Methyl Bromide @16 g/m3 for 3 h or 10 g/m3 for 6 h is recommended for control of mobile phases of the mite in stored garlic.
**Eriophyid Mite (Aceria tulipae Keifer)**

Garlic plants infested with mite show symptoms like stunting, twisting, curling and yellow mottling and reduce the plant stand as well as yield. Mites also attack the stored garlic bulbs. Most of the mites are located at the basal portion of cloves and make them dry and desiccated. Mite is capable of transmitting viruses such as wheat yellow streak mosaic virus in wheat, garlic mosaic virus and onion mosaic caused by Allium 1 virus.

Garlic plants infested with mite-

![Image of garlic plants infested with mite]

**Management**

Flood irrigation or heavy rains may reduce field populations.

Avoid planting successive onion or garlic crops.

Wettable Sulfur 0.3% + Dimethoate (0.03%) as pre-sowing and post-sowing treatment is recommended.
### New Insecticides

<table>
<thead>
<tr>
<th>Common name</th>
<th>Trade name(s)</th>
<th>Formulation</th>
<th>Recommended conc (%)</th>
<th>(ml or g/l)</th>
<th>Target pests</th>
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</thead>
<tbody>
<tr>
<td>Abamectin</td>
<td>Vertimec</td>
<td>1.8 EC</td>
<td>0.0009</td>
<td>0.5</td>
<td>Mites/thrips</td>
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<tr>
<td>Acetamiprid</td>
<td>Pride (for seed treatment)</td>
<td>20 SP</td>
<td>0.004</td>
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<td>Sucking pests</td>
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<tr>
<td>Beta Cyfluthrin</td>
<td>Bulldock</td>
<td>2.5 EC</td>
<td>0.0035</td>
<td>1.5</td>
<td>Bores</td>
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<td>Bt Formulations</td>
<td>Halt(WP), Dipel(8L), Biobit (WP), Delfin (WG)</td>
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<td></td>
<td>0.5 to 1.0</td>
<td>DBM</td>
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<tr>
<td>Fenpropathrin</td>
<td>Danitol, Meothrin</td>
<td>10 &amp; 30 EC</td>
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<td>1.5</td>
<td>Borers</td>
</tr>
<tr>
<td>Fipronil</td>
<td>Regent</td>
<td>5 SC</td>
<td>0.01</td>
<td>2.0</td>
<td>Borers</td>
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<tr>
<td>Imidacloprid</td>
<td>Confidor, Sensor</td>
<td>17.8 SL</td>
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<tr>
<td>Imidacloprid</td>
<td>Stalone, Atom</td>
<td>200 SL</td>
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<td>Indoxacarb</td>
<td>Avaunt</td>
<td>14.5 SC</td>
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<td>Methomyl</td>
<td>Lannnate, Dunnet, Astra</td>
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<tr>
<td>Propargite</td>
<td>Omite</td>
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<td>Spinosad</td>
<td>Tracer</td>
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<td>DBM/borers</td>
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<tr>
<td>Thiamethoxam</td>
<td>Actara</td>
<td>25 WG</td>
<td>0.0025</td>
<td>0.2</td>
<td>Seed treatment (for sucking pests)</td>
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</table>
### Annexure II

**Biopesticides, pheromones used in IPM**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Biopesticides/Pheromone</th>
<th>Trade name</th>
<th>Target pest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Azadirachtin (Neem based)</td>
<td>Neemarin, Azadirachtin, Multineem, Neemguard, Neemzol, margocide</td>
<td>Caterpillars, leafhoppers, whiteflies, aphids</td>
</tr>
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<td>2</td>
<td>Bacillus thuringiensis kurstaki (Bacteria)</td>
<td>Halt, Biolep, Delfin, Dipel, Biovit, Thuricide</td>
<td>Caterpillars</td>
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<tr>
<td>3</td>
<td>verticillium lecanii (Fungus)</td>
<td>Dispel, Boverin, Biotrol</td>
<td>Caterpillars, white grubs</td>
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<tr>
<td>4</td>
<td>Beauveria bassiana (Fungus)</td>
<td>Vertalec, Mycotal, Verticel</td>
<td>Aphids, thrips, whiteflies, scale insects</td>
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<tr>
<td>5</td>
<td>Nuclear Polyhedrosis Virus (H-NPV)</td>
<td>H-NPV</td>
<td><em>Helicoverpa armigera</em></td>
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<tr>
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<td>Nuclear Polyhedrosis Virus (S-NPV)</td>
<td>S-NPV</td>
<td><em>Spodoptera litura</em></td>
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<tr>
<td>7</td>
<td>(Z) 11 Heaxadecanal &amp; (Z) Hexadecanal (97:3) (Sex pheromone)</td>
<td>Heli lure</td>
<td><em>Helicoverpa armigera</em></td>
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<tr>
<td>8</td>
<td>(Z) Heaxadecanal -11- enal &amp; (Z)- hexzadec-11-enyl Acetate (Sex Pheromone)</td>
<td>Nomate-DBM, Checkmate DBM</td>
<td><em>Plutella xylostella</em></td>
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### Economic threshold level for some vegetable crop pest

<table>
<thead>
<tr>
<th>Crop</th>
<th>Pest</th>
<th>Economic Threshold Level (ETL)</th>
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</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>Diamondback Moth (<em>Plutella xylostella</em>)</td>
<td>10 larvae (3rd &amp; 4th instar) per plant in seedling stage</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>Aphid</td>
<td>30 aphids/plant</td>
</tr>
<tr>
<td>Chilli</td>
<td>Mites (<em>Pollyphagotarsonemus latus</em>)</td>
<td>Single mite per leaf</td>
</tr>
<tr>
<td>Chilli</td>
<td>Thrips (<em>Thrips tabaci</em>)</td>
<td>2 thrips per leaf</td>
</tr>
<tr>
<td>Brinjal</td>
<td>Whitefly (<em>B. tabaci</em>)</td>
<td>5-10 flies / leaf</td>
</tr>
<tr>
<td>Brinjal</td>
<td>Shoot and Fruit Borer (<em>Lorbonalis</em>)</td>
<td>0.5% shoot and fruit damage</td>
</tr>
<tr>
<td>Tomato</td>
<td>Fruit Borer (<em>Helicoverpa armigera</em>)</td>
<td>8 eggs in 15 plants or single larva per plant or 2% fruit infestation</td>
</tr>
<tr>
<td>Okra</td>
<td>Fruit Borer (<em>Earias vittella</em>)</td>
<td>5.3 % of fruit infestation</td>
</tr>
<tr>
<td>Okra</td>
<td>Leafhopper (<em>Amrasca biguttula biguttula</em>)</td>
<td>4-5 nymphs per plant</td>
</tr>
<tr>
<td>Pea</td>
<td>Aphids (<em>Acyrthosiphon pisum</em>)</td>
<td>3-4 aphids / stem tip</td>
</tr>
<tr>
<td>Onion</td>
<td>Thrips (<em>Thrips tabaci</em>)</td>
<td>13-14 thrips/ plant 15 days after transplanting.</td>
</tr>
</tbody>
</table>
## A. List of Pesticides / Pesticides Formulations Banned in India A. Pesticides Banned for Manufacture, Import and Use.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Name of insecticides</th>
<th>S. No</th>
<th>Name of insecticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Aldrin</td>
<td>15.</td>
<td>Pentachlorophenol</td>
</tr>
<tr>
<td>2.</td>
<td>Benzene Hexachloride</td>
<td>16.</td>
<td>Phenyl Mercury Acetate</td>
</tr>
<tr>
<td>3.</td>
<td>Calcium Cyanide</td>
<td>17.</td>
<td>Sodium Methane Arsonate</td>
</tr>
<tr>
<td>4.</td>
<td>Chlordane</td>
<td>18.</td>
<td>Tetradifon</td>
</tr>
<tr>
<td>5.</td>
<td>Copper Acetoarsenite</td>
<td>19.</td>
<td>Toxafen</td>
</tr>
<tr>
<td>6.</td>
<td>CIbromochloropropane</td>
<td>20.</td>
<td>Aldicarb</td>
</tr>
<tr>
<td>7.</td>
<td>Endrin</td>
<td>21.</td>
<td>Chlorobenzilate</td>
</tr>
<tr>
<td>8.</td>
<td>Ethyl Mercury Chloride</td>
<td>22.</td>
<td>Dieldrine</td>
</tr>
<tr>
<td>9.</td>
<td>Ethyl Parathion</td>
<td>23.</td>
<td>Maleic Hydrazide</td>
</tr>
<tr>
<td>10.</td>
<td>Heptachlor</td>
<td>24.</td>
<td>Ethylene Dibromide</td>
</tr>
<tr>
<td>11.</td>
<td>Menazone</td>
<td>25.</td>
<td>TCA (Trichloro acetic acid)</td>
</tr>
<tr>
<td>13.</td>
<td>Paraquat Dimethyl Sulphate</td>
<td>27.</td>
<td>Chlorofenvinphos</td>
</tr>
</tbody>
</table>
B. Pesticides / Pesticide Formulations banned for Use but their manufacture is allowed for Export

29. Nicotin Sulfate
30. Captafol 80% Powder

C. Pesticides formulations banned for Import, Manufacture and Use (4 Nos)

1. Methomyl 24% L
2. Methomyl 12.5% L
3. Phosphamidon 85% SL
4. Carbofuron 50% SP

D. Pesticides Withdrawn

1. Dalapon
2. Ferbam
3. Formothion
4. Nickel Chloride
5. Paradichlorobenzene (PDCB)
6. Simazine
7. Warfarin