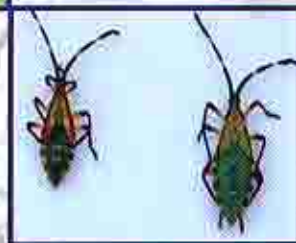


# **Insect Pests of Arid Vegetable Crops**

**(Practical Manual for Field Identification and Damage Symptoms)**



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**S.K. Sharma**  
**B.R. Choudhary**  
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**Central Institute for Arid Horticulture**  
**(Indian Council of Agricultural Research)**  
**Bikaner-334 006, Rajasthan**



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## PREFACE

Vegetables are becoming popular for nutritional and health security point of view as they are excellent sources of minerals, proteins, vitamins, antioxidants and photochemical *etc.* Presently, India is the second largest producer of vegetables next to China with a total production of 156.32 mt from an area of 8.99m ha during 2011-12. The average productivity is only 17.39t/ha which is very less in comparison to many other countries. There are many reasons for low productivity of the arid vegetables. Hot arid region are marked by abiotic limitations such as high temperature, high potential evapo-transpiration, low erratic rainfall, low soil fertility, poor quality of ground water, *etc.*, which lead to poor crop growth and yield. Apart from the climatic limitations, the biotic factors like pest and diseases are also one of the limiting factor for crop production in hot arid ecosystem.

A central problem is to identify and understand patterns in the distribution and abundance of species. In this endeavour, useful information has been generated on identification, host and damage symptoms of the pest in different vegetables at various research institutions and SAUs of the country. Earnest efforts have therefore, been made to compile information on identification, host and damage symptoms of pest in a systematic manner, grouped in different chapters and presented in the form of a bulletin entitled **Insect Pests of Arid Vegetable Crops (Practical Manual for Field Identification and Damage Symptoms)**. Correct identification of the insect, nature of damage and host preference is the prerequisites for effective pest control. This publication contains excellent colored photographs depicting salient identification characteristics of insect, symptoms of damage on plants under natural condition so as to update the knowledge of extension agencies and farmers with to the pests in the field.

The authors are grateful to Dr. S. Ayyappan, D. G., ICAR and Secretary, DARE and Dr. N. K. Krishna Kumar, D. D. G. (Hort.), ICAR, New Delhi for their constant inspiration, encouragement and valuable suggestion to bring out this publication. We are highly thankful to Dr. S. K. Sharma, Director, CIAH, Bikaner, who encouraged and provided valuable suggestions and ideas to improve the authenticity and quality of this bulletin.

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

Place: Bikaner  
Date: 11.03.2013

  
Shравan M Haldhar



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## INTRODUCTION

In India, nearly 3, 17,090 sq km area falls under arid region, of which 70, 300 sq km has been classified as cold arid and remaining is hot arid region. About 61% of total hot arid area lies in Rajasthan. Arid vegetables are becoming popular for nutritional and health security point of view as they are excellent sources of minerals, proteins, vitamins, antioxidants and photochemical. Presently India is the second largest producer of vegetables next to China with a total production of 156.32mt from an area of 8.99m ha during 2011-12. The average productivity is only 17.39 t/ha which is very less in comparison to many other countries. The vegetable crops like watermelon/*mateera* (*Citrullus lanatus*), *kachri* (*Cucumis callosus*), snap melon/*phoot/ kakadi* (*Cucumis melo* var. *momordica*), long melon/*Kakri* (*Cucumis melo* var. *utilissimus*), round melon/*tinda* (*Praecitrullus fistulosus*), cluster bean (*Cyamopsis tetragonoloba*), bottle gourd (*Lagenaria siceraria*), ridge gourd (*Luffa acutangula*), etc. have great potential in arid pockets area of country because they are well adapted to existing adverse climatic conditions and possess unprecedented ability to withstand against stresses like moisture stress, high soil pH and load of pests and diseases. Snap melon is good source of carbohydrate (3.0%), protein (0.3%), fat (0.1%) and vitamin A (265 IU) and minerals (0.4%). It is much liked by the people suffering from sugar related disorders. *Kachri* contains carbohydrate (7.45%), protein (0.28%), fat (1.28%), fibre (1.21%), vitamin C (29.8 mg) and iron (0.18 mg). It is one of the important components of the delicious vegetable popularly known as *Panchkuta* in the desert districts of north-western India. The mature fruits of snap melon and *kachri* are usually cooked with various vegetable preparations, *chutney*, pickles and are also used for garnishing the vegetables or as salad. The fruits of round melon at cooking stage contain 1.4% protein, 1.4% fat, 3.4% carbohydrates 1% fibre, 0.5% minerals, 13 mg carotene and 18 mg vitamin 'C'/100 g of fresh weight. Fruits are also useful for dry cough and for improving blood circulation in the body. Watermelon locally known as *mateera* fruits contain 90-95% water, 3.5-7.4% carbohydrate, 0.18-0.25% protein, 0.10-0.20% fat, 0.25-0.35% fibre, 0.2-0.3% minerals and good source of lycopene. Rind contains citrulline, an amino acid which is involved with athletic ability and immunity. The other major nutritional components of watermelon are vitamin A (590 IU) and lycopene (4100µg/100g), an



anti-carcinogenic compound found in red flesh. It is rich in iron content among all members of cucurbitaceous crops. Watermelon seeds are rich in fat (about 45% edible oil) and protein (30-40%). The seeds are powdered and baked like bread in desert parts of India. The unripe fruits are also cooked as a vegetable in some parts of India. Besides the nutritional and medicinal value, it has significant role in quenching thirst of desert masses and keeps them cool during hot summers.

There are many reasons for low productivity of the arid vegetables. Hot arid regions are marked by abiotic limitations such as high temperature, high potential evapo-transpiration, low erratic rainfall, low soil fertility, poor quality of ground water, etc., which lead to poor crop growth and yield. Apart from the climatic limitations, the biotic factors like pest and diseases are also one of the limiting factors for crop production in hot arid ecosystems. Vegetables are more prone to insect pests and diseases mainly due to their tenderness and softness as compared to other crops and virtual absence of resistance characters because of intensive hybrid cultivation. The insect pests inflict crop losses to the tune of 40 per cent in vegetable production. The main pests of vegetable crops are red pumpkin beetle, *Aulacophora foveicollis* (Lucas); fruit fly, *Bactrocera cucurbitae* (Coquillett); leaf miner, *Liriomyza trifolii*; pod borer, *Helicoverpa armigera* (Hubner), white flies, *Bemisia tabaci*; thrips, *Frankliniella occidentalis*; shoot and fruit borer, *Leucinodes orbonalis* (Guenee); Hadda beetle, *Epilachna vigintioctopunctata* (Fabricius); aphids, *Aphis gossypii* (Glover) and ash weevil, *Mylocherus subfasciatus*. The cucurbit fruit fly (*B. cucurbitae* Coquillett) has been the most prominent pest over the last several decades in India. Depending on the environmental conditions and susceptibility of the crop species, the extent of losses varies between 30 to 100%. The field experiments on assessment of losses caused by cucurbit fruit fly in different cucurbits have been reported 28.7 - 59.2, 24.7 - 40.0, 27.3 - 49.3, 19.4 - 22.1, and 0 - 26.2% yield losses in pumpkin, bitter melon, bottle melon, cucumber, and sponge melon, respectively. Considering previously reported, it is apparent that >50% of the cucurbits are either partially or totally damaged by fruit flies and are unsuitable for human consumption.





**Table: 1 Yield losses due to insect-pests in vegetables**

Crop	Pests	Yield loss (%)	State
Bittergourd	Fruitfly ( <i>Bactrocera cucurbitae</i> )	60-80	Uttar Pradesh
Cucumber	Fruitfly ( <i>Bactrocera cucurbitae</i> )	20-39	Assam
Le gourd	Fruitfly ( <i>Bactrocera cucurbitae</i> )	63	Gujrat
Muskmelon	Fruitfly ( <i>Bactrocera cucurbitae</i> )	76-100	Rajasthan
Sponge gourd	Fruitfly ( <i>Bactrocera cucurbitae</i> )	50	Andhra Pradesh
Snake gourd	Fruitfly ( <i>Bactrocera cucurbitae</i> )	63	Assam
Brinjal	Fruit and shoot borer ( <i>Leucinodes arbonalis</i> )	63	Haryana
Brinjal	Mite ( <i>Polyphagotarsonemus latus</i> )	54-66	Karnataka
Chillies	Thrips ( <i>Scirtothrips dorsalis</i> )	>90	Karnataka
Tomato	Fruit borer ( <i>Helicoverpa armigera</i> )	22.39-37.79	Karnataka
Okra	Fruit borer ( <i>H. armigera</i> )	22.1	Himachal Pradesh
Okra	White flies ( <i>Bemisia tabaci</i> )	54.04	Rajasthan



## INSECT-PESTS OF VEGETABLE CROPS IN HOT ARID REGION

### 2.1 Pests of cucurbits

#### 2.1.1 Melon fruit fly (*Bactrocera cucurbitae*)

- It is commonly called melon fruit fly. It is widely distributed and has been recorded from East Africa, some parts of USA, northern Australia, Taiwan, Okinawa in Japan, South China, South-east Asia and the Indian sub-continent.

#### Host range

- It is highly polyphagous pest having a wide range of host plants but its preferred hosts are musk melon, snap melon, bitter gourd and snake gourd.

#### Nature of damage

- The female flies puncture the soft and tender fruits with their stout and hard ovipositor and lay eggs below the epidermis.
- On hatching the maggots feed inside on the pulp of fruits and the infested fruits can be identified by the presence of brown resinous juice which oozes out of the punctures made by the flies for oviposition.



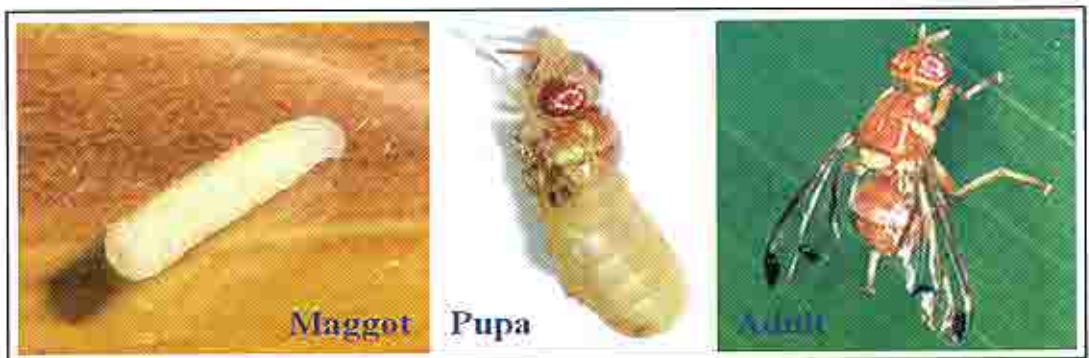
Damage symptoms of fruit fly on round melon, kachari, bottle gourd and watermelon



- These punctures also serve as an entry for various bacteria and fungi; as a result, the infested fruits start rotting, get distorted and malformed in shape and fall off from the plants pre-maturely.

### Description

- Fly is reddish brown with lemon yellow markings on thorax with spotted wings.
- Costal band with large apical spot, almost covering apical part of cells r2+3 and r4+5.



- Cross veins R-M and DM-Cu thickly infuscated and 3 frontal setae.
- Scutellum is yellow in color.
- Adults hibernate during winter and they become active in hot weather.

### 2.1.2 Hadda beetle (*Epilachna vigintioctopunctata*)

- This species originated in the far east of Russia and has been expanding its range in the second half of the 20<sup>th</sup> century and is now found over most of Russia, north-east China, northern Korea, Australia and Japan. It is found in different parts of South East Asia.



### Host range

- The insect is considered to be one of the important pests of brinjal, sometimes becoming serious on cucurbits like water melon, musk melon, ridge gourd *etc.*

### Nature of damage

- The grubs and adults scrape the leaves in a characteristic manner and feed.
- They feed on the epidermal layers of leaves which get skeletonized and gradually dry away.
- They affect the crop in all the stages.



### Description

- Beetle is small round to slightly oblong in shape measuring about 5 mm in length and 3.5 mm in width.
- The underside of the beetle is flat while the upper side is convex.
- It is light brick red or pinkish in colour bearing 12-28 small black dots on the pronotum and elytra.
- These black dots are symmetrically placed in a crescent manner.



- Adult lives for one month to more than two months.
- The yellow elliptical eggs are laid generally on the undersurface of leaves in batches of hundreds, glued to the leaf surface in a vertical position.
- The freshly hatched grub is yellowish and turns to cream yellow white, when full grown.



- The grub is broad in front and narrows posteriorly and is covered with spiny structures all over.

### 2.1.3 Melon aphid (*Aphis gossypii*)

- It has a worldwide distribution. However on cotton, often it causes appreciable damage during severe drought conditions.

#### Host range

- It is a polyphagous pest. It infests the cotton, cucurbits, brinjal, chillies, amaranthus etc.

#### Nature of damage

- It infest the tender shoots and the under surface of leaves in very large numbers and suck the sap.



- Severe infestation results in curling of leaves, stunted growth and gradual drying and death of young plants.



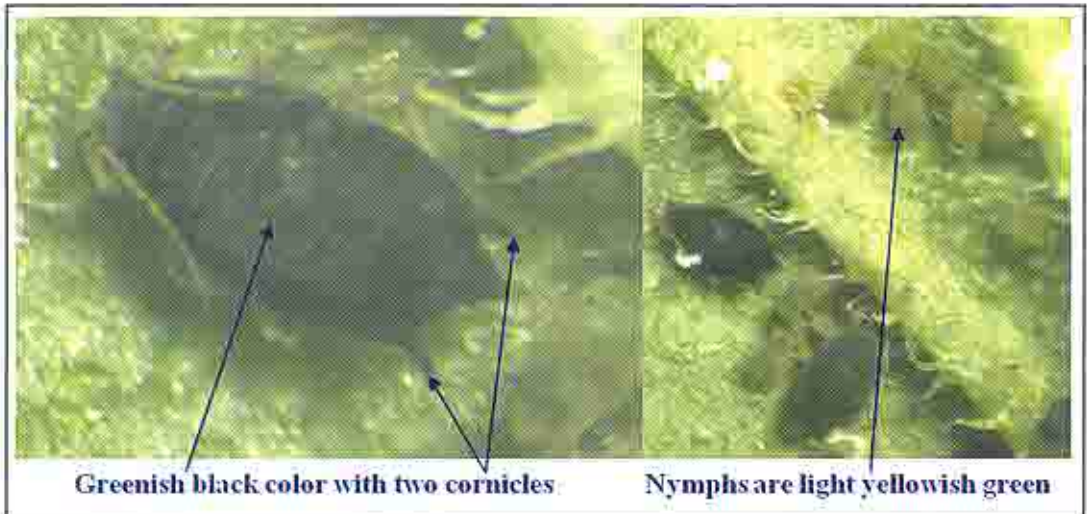
**Curling of leaves and stunted growth**

**Aphids damage to under surface of leaves**

- Black sooty mould develops on the honey dew of the aphids which falls on the lower leaves affecting photosynthetic activity.
- The economic threshold level (ETL) is 10% affected plants counted randomly.

### Description

- Adult is small, soft, yellowish, green or greenish black in colour.
- They are characterized by the presence of two tubes like structures called cornicles, on the abdomen.
- They are wingless normally but winged forms are often found mostly in the beginning and towards the end of season.
- Nymphs are light yellowish green or brownish or greenish black in colour.
- Wings are thin, transparent and are held like a roof over the body.
- They reproduce both sexually and parthenogenetically.



- Parthenogenetic females give rise to female's ovo - viviparously.

#### 2.1.4 Leaf eating caterpillar (*Diaphania indica*)

- This moth occurs in many tropical and subtropical regions, though it is native to southern Asia; it is occasionally a significant pest of cucurbits and some other plants.

##### Host range

- It is serious pest of cucurbits like cucumber, muskmelon, round gourd and ridge gourd.

##### Nature of damage

- Initially after hatching, caterpillars feed on the leaves by binding them together.
- Some time the flowers and fruits are also infested.
- The vines are cut from one side and the terminal parts become yellowish and dry up.

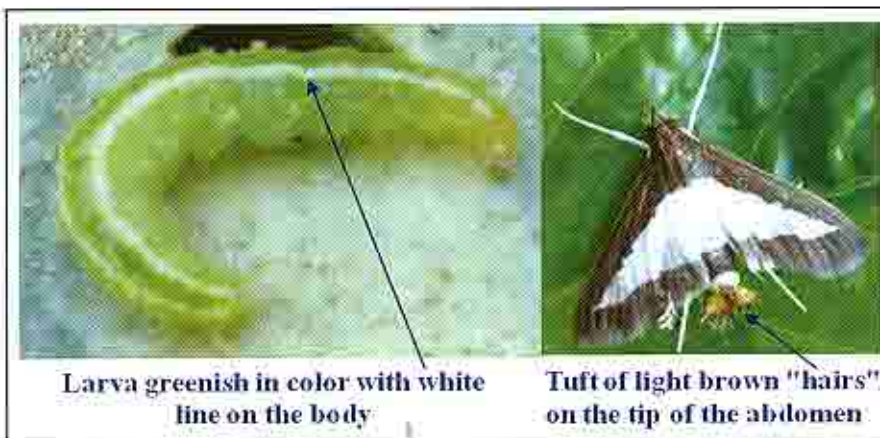


- The bored fruits become unfit for consumption.



### Description

- The wingspan is about 30 mm.
- Adults have translucent whitish wings with broad dark brown borders.
- The body is whitish below and brown on top of head and thorax as well as the end of the abdomen.







- There is a tuft of light brown "hairs" on the tip of the abdomen, vestigial in the male but well-developed in the female.

### 2.1.5 Red pumpkin beetle (*Aulacophora foveicollis*)

- This pest is found in almost all states of India though it is more abundant in northern states.

#### Host range

- They infest bittergourd, snakegourd, melons, pumpkin etc.

#### Nature of damage

- The beetles bite irregular holes on leaves and also feed on flowers.
- Beetles injure the foliage, flowers and cotyledons by biting holes into them.



- Early sown cucurbits are severely damaged necessitating resowing.
- Beetle damage results in V type of holes on leaves.



- They prefer young seedlings and tender leaves and the damage at this stage may kill the seedlings.
- The roots as well as the stem and fruits that come in contact with the soil are damaged by the grubs.

### Description

- Adult has reddish brown elytra.
- Brownish elongate eggs are laid in the soil.
- Grubs are creamy white with darker oval shield at back.
- Grub period is 13-25 days. Pupation takes place in an earthen cocoon.
- There are 5 to 8 generations in a year.

#### 2.1.6 Whitefly (*Bemisia tabaci*)

- It is known to infest about 50 different species of plants but it becomes quite a serious pest of cotton in certain regions of the country. The infestation by this pest adversely affects the physiology of the plant at all its stages of growth.

### Host range

- It is distributed in all cotton growing regions of the world. It also infests water melon, cucumber, chillies, brinjal, tomato, potato, tobacco *etc.*

### Nature of damage

- The nymphs are found in large numbers on the under surface of leaves and drain of sap due to sucking.
- Severe infestation results in premature defoliation, development of sooty mould on honey dew excreted, and shedding of buds and bolls and bad boll opening.



- The ETL is 5- 10 nymphs or adults per leaf.

### Description

- Adult is minute insect measuring about 0.5 mm in length.
- It having white or greyish wings, a yellowish body and red medially constricted eyes.





- The eggs are light yellow in the beginning but turn brown later on.
- The nymphs remain stationary once they settle down.
- There are about a dozen overlapping generations in a year.

### 2.1.7 Two-spotted spider mites (*Tetranychus urticae*)

- It's commonly called red spider mite. It has a worldwide distribution and is highly polyphagous having a very wide range of host plants.

#### Host range

- It is a polyphagous pest like cucubits, brinjal, tomato *etc.*

#### Nature of damage

- Colonies of mites comprising of eggs, nymphs and adults are found feeding on ventral surface of leaves under protective cover of fine silken webs.
- Initially, mite feeding causes yellowing or bronzing of leaves.
- As a result of their feeding innumerable yellow spots appear on the dorsal surface of leaves and the affected leaves gradually start curling and finally get wrinkled and crumpled.
- This in turn affects the growth and fruit formation capacity of the plants.

#### Description

- Eggs are globular in shape, about 0.1 mm in diameter and whitish in colour.
- Nymphs are greenish-red in colour and about 3 mm in length.
- Nymphs and adults have 4 pairs of legs.



- There are only two nymphal stages protonymphal and deutonymphal.
- Adults are ovate in shape, reddish-brown in colour and 0.4 mm (male) - 0.5 mm (female) in length with four pairs of legs.
- Longevity of adult males and females is 4 - 9 and 9 - 18 days respectively.

### 2.1.8 Serpentine leaf miner (*Liriomyza trifolii*)

- Serpentine leaf miner is polyphagous pest, native of Florida and believed to be accidentally introduced into India. It is widely distributed in Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Rajasthan.

#### Host range

- It is a serious pest on cucumber, tomato, cotton, ridge gourd, brinjal, potato.

#### Nature of damage

- The maggot punctures the epidermal layers and scraps the chlorophyll content between the layers.
- In severe cases the photosynthetic activity reduced and leads to death of the plant.



### Description

- Adults are small, measuring less than 2 mm in length, with a wing length of 1.25 to 1.9 mm.
- The head is yellow with red eyes.





- The thorax and abdomen are mostly gray and black although the ventral surface and legs are yellow.
- The wings are transparent.
- The female deposits the eggs on the lower surface of the leaf, but they are inserted just below the epidermis.
- The puparium is initially golden brown in color, but turns darker brown with time.

### 2.1.9 Surface grasshopper (*Chrotogonus trachypterus*)

- Surface grasshoppers are widely distributed in the Orient and Africa. In India, *C. trachypterus* is more common in the north, whereas *C. oxypterus* occurs in the southern regions. The surface grasshopper is a pest of pastures almost throughout the year. It is distributed throughout the plains in India including Orissa, South Arcot, Madura, Coimbatore, Bellary, Madhya Pradesh and Rajasthan.

#### Host range

- Cucurbits, oats, rice, maize, pearl millet, finger millet, *Cyperus rotundus*, *Echinochloa colona*, *Cynodon dactylon*.

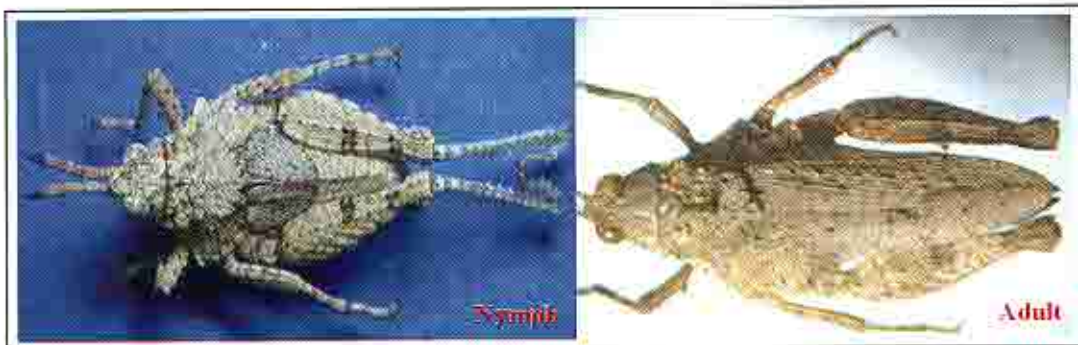
#### Nature of damage

- The nymphs and adults feed on leaves by cutting germinating plants of cucurbits, cotton, wheat, and others, particularly in areas adjoining wastelands.
- Often, such damaged fields had to be re-sown.
- The surface grasshoppers are reportedly polyphagous and they feed on a number of cultivated crops.



### Description

- Antennae shorter than body; tympanum present on either side of the first abdominal segment.
- Fastigial furrow present; apical areolae generally present; lower basal lobe of hind femur longer than upper lobe.



- Anterior margin of pronotum forming wide collar, covering posterior and lower part of mouth.





- Tegmina reaching upto apex of abdominal segment.
- Egg pods were hard, elongated and cylindrical with a slight bend at the middle.

## 2.2 Pests of brinjal

### 2.2.1 Brinjal fruit and shoot borer (*Leucinodes orbonalis*)

- Found throughout the tropics in Asia and Africa. It is one of the serious pests of brinjal throughout the country. It is minor pest in the America.

#### Host range

- It is main pest of brinjal but also infests potato, *Solanum nigria*, *S. xanthocarpum*, bittergourd etc.

#### Nature of damage

- Transplanted seedlings are attacked.
- Drooping of tender shoots and wilting in vegetative stage.
- During fruiting stage caterpillars enter into fruits make holes and feed inside.





- Initially, the entry hole is so small that it is not visible.
- Later, fruits bear large circular holes plugged with excreta.

### Description

- Moths are medium in size with white wings having large brown patches and red markings.
- Wing span measures about  $\frac{3}{4}$  of an inch.
- The head and thorax are blackish brown.
- The female moth lays about 80-120 eggs singly on tender shoots and developing fruits of brinjal.
- The full grown caterpillar generally pupates outside the bore holes on the stem, fruit stalks *etc.* in a dark buff coloured cocoon in dirty brown silk.

### 2.2.2 Brinjal jassids (*Amrasca devastans*)

- Distributed all over India; but particularly serious in Sind, Punjab and Tamil Nadu.

### Host range

- It is a polyphagous pest attacking okra, brinjal, beans, castor, cucurbits, hollyhock, potato, sunflower and other malvaceous plants.

### Nature of damage

- The nymphs and adults remain on the under surface of the leaves and suck the cell sap and while feeding inject their toxic saliva.
- As a result the plant become stunted, the leaves crinkle, turn yellowish and become cup shaped.



- Brownish or reddish colour may develop along the edges of the leaves. This is called the 'hopper burn'.

### Description

- It is a small insect, varying from less than 1 mm to about 3 mm.
- Its adult stage is subjected to seasonal changes in colour.
- It is reddish in winter and greenish yellow in summer.





- The adult is a wedge shaped insect about 3.5 mm in length.
- There is a black spot on each forewing and two small black spots on the vertex.
- Both nymphs and adults move diagonally, when disturbed.
- The eggs are usually inserted full length into the spongy parenchymatous tissue between the vascular bundles and the epidermis.
- There are 8-10 overlapping generations.

### 2.2.3 Blister beetle (*Mylabris pustulata*)

- These beetles are brightly colored insects that secrete a compound containing cantharidin when disturbed. Cantharidin, a terpenoid, produces blisters on human skin upon contact and hence these beetles are called "blister" beetles.

#### Host range

- This beetle is highly polyphagous and it feeds on the flowers of several plants in the family's Convolvulaceae, Cucurbitaceae, Leguminosae, Malvaceae etc.

#### Nature of damage

- The adult is the destructive stage. As the insects feed on the plants' reproductive parts, they can cause significant yield losses.

#### Description

- The adult is about 2.0-2.5 cm in length.





- It bears red or reddish orange and black alternating bands on the forewing (elytra).



- Each female lays about 100-2000 eggs depending on the quality of the food they ingest.
- The eggs are usually laid in the soil.
- Upon hatching, the grub feeds on soil-dwelling insects, including pests, and do not cause any damage to the crop.
- The grubs have several instars, with two or more different forms of larva.
- The mobile first instar grub is known as triungulin because it has three-clawed legs.

## 2.3 Pests of Tomato

### 2.3.1 Tomato pod borer (*Helicoverpa armigera*)

- It is widely distributed in the tropics, subtropics and warmer temperate regions of the world extending as far North as Japan and Germany



### Host range

- Gram pod borer is a major pest of tomato. It is highly polyphagous attacking a number of host plants.
- It attacks a number of weeds and important plants like cucurbits, cotton, pigeonpea, chickpea, field beans, roses *etc.*

### Nature of damage

- The young larvae feed on tender foliage; advanced stage larvae attack the fruits.
- They bore circular holes and thrust only a part of their body inside the fruit and eat the inner contents.



- If the fruit is bigger in size, it is only partly damaged by the caterpillar but later it is invariably invaded by fungi and bacteria and spoiled completely.
- The larvae move from one fruit to another and a single caterpillar may eat and destroy 2 - 8 fruits.

### Description

- Moth is stout, medium sized with brownish/greyish forewings.



- A dark cross band near outer margin and dark spots near costal margins of fore wing.
- The spherical, yellowish eggs are laid singly on tender parts and buds of plants.



- Caterpillars are of varying colour, initially brown and later turn greenish with darker broken lines along the side of the body.
- The full grown caterpillar pupates in the soil in an earthen cell.

### 2.3.2 Tobacco caterpillar (*Spodoptera litura*)

- It is found throughout the tropical and sub tropical parts of the world; wide spread in India.

#### Host range

- It is cosmopolitan, highly polyphagous and besides tobacco, it feeds on cotton, castor, groundnut, tomato, cabbage and various other cruciferous crops.

#### Nature of damage

- Early instar larvae (gregarious phase) scrape on green matter that give a mesh like appearance to damaged leaves which can be spotted easily from a distance.



- Older larvae cause total defoliation.

### Description

- Moth is medium sized and stout bodied with forewings pale grey to dark brown in colour having wavy white crisscross markings.
- Hind wings are whitish with brown patches along the margin of wing.
- Moths are active at night.
- The eggs are covered over by brown hairs.







- Caterpillar measures 35-40 mm in length, when full grown. It is velvety, black with yellowish – green dorsal stripes and lateral white bands with incomplete ring like dark band on anterior and posterior end of the body.
- Pupation takes place inside the soil.
- There are eight generations in a year.

### 2.3.3 White tailed mealy bug (*Ferrisia virgata*)

- It is pan - tropical in distribution and is found all over the Indian subcontinent and South-East Asia.

#### Host range

- It is polyphagous and has a very wide range of host plants including tomato, beans, cashew, cassava, coffee, cocoa, citrus, cotton.

#### Nature of damage

- The crawlers become active and wander about, moving swiftly till they find a succulent spot where they puncture the epidermis, inject their toxic saliva and start sucking the cell sap.
- The mechanical injury thus caused also serves as an entry for various disease producing organisms (bacteria and fungi).
- From 2<sup>nd</sup> instar onwards the nymphs secrete honeydew on which black sooty mould develop, which in turn hinders the photosynthetic activity of the plant resulting in stunted growth.

#### Description

- Adult females are apterous, long, slender, slightly oval (3.5 – 4.5 x 1.5 – 2.0 mm) covered with dusty white waxy secretion and having a pair of conspicuous long glossy wax tassels at the caudal end.



- Eggs are laid in clusters in cottony ovisac which remains concealed under the female.



- Freshly hatched crawlers are yellowish in colour and become pale white in 2 - 3 days.
- Reproduction is sexual as well as parthenogenetic.
- Longevity of males is 1 - 3 days while the females live for 5 - 7 weeks.
- It is found throughout the year, though it is less active during winter.

## 2.4 Pests of Khejri

### 2.4.1 Coreid bug (*Homoeocerus variabilis*)

- It is newly recorded pest on Khejri, *Prosopis cineraria* that are found in arid and semi-arid region of India.

#### Host range

- Khejri, *Prosopis cineraria* and other forest plants

#### Nature of Damage

- The sucking type mouth part is found in coreid bug.



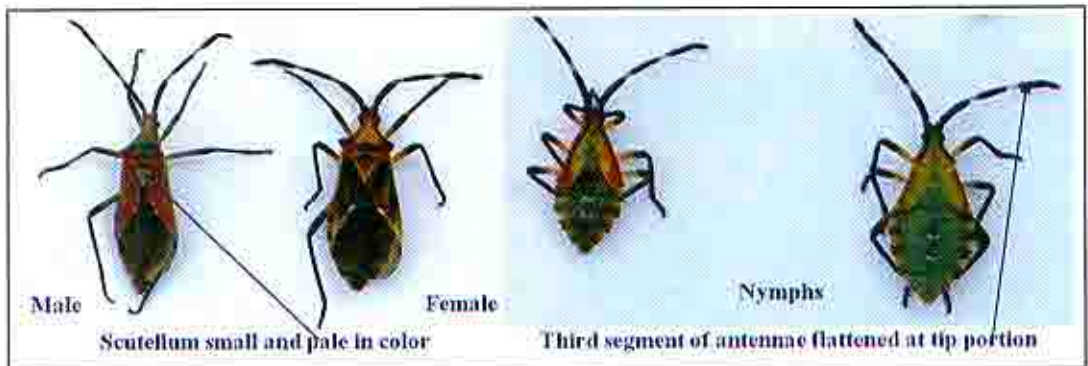
- It damages the new flowering/ leaves/ stem of the khejri plant.
- Due to attack of this pest, the growth of khejri plant was suppressed and dry of the new branches/ leaves.



- In winter season, the coreid bug was found on stem/ branches of plant in gregarious stage.

### Description

- The body is ochraceous with a broad basal fascia to the pronotum between the lateral angles.





- The scutellum is small and pale in color. Antennae four segmented, the basal part of second and third segment is pale yellow, and third segment of antennae is flattened at tip portion.
- The fourth segment of antennae is shorter in all segments.
- The mean body length of male and female is vary and were recorded 12.22 mm and 15.49 mm, respectively.

#### 2.4.2 Gall forming insects

- Four distinct types of galls were identified on *P. cineraria* in western Rajasthan.

#### Host range

- *Prosopis cineraria*, *Acacia nilotica*, *Albizia lebbek*, *Artocarpus integrifolia*, *Shorea robusta*, *Butea monosperma*, *Dalbergia sissoo*, *Eucalyptus* spp., *Ficus glomerata*, *Morus alba*, *Pongamia pinnata*.

#### Nature of damage

- Galls reduce vegetative growth and seed formation in *P. cineraria*. The genesis of these growths is a result of a nutritional dependence of the causal organisms on plant tissues.

#### Description

##### A. Galls on branches

- Galls were solid, hard, woody brown structures, caused by a chalcid, *Pediobopsis* sp.





- Galls measured 11.2-45.2 mm in length and 11-42 mm in breadth.
- Each gall has an oval larval chamber in the centre which opened externally through a small pore in the periphery through which the adults ultimately escaped.
- These galls were formed throughout the growing season.

#### **B. Galls on rachis of leaflets**

- Galls were globose, indehiscent and hard and measured 3.4-10.2 mm in length and 2.0-3.4 mm in breadth.
- Galls were prevalent throughout the growing season.



- The causal insect was found to be a cecidomyid, *Contarinia prosopidis*.
- The larval development took place in the gall cavity where they sucked sap from the tissues.

#### **C. Galls on leaflets**

- Galls were of variable size and developed on leaflets mostly during the rainy season.



- The causal organism was found to be *Eriophyes prosopidis*, a mite.



- The mites bred parthenogenetically, giving rise to large number of galls on the leaflets.

## 2.5 Pest of beans

### 2.5.1 Bean aphid (*Aphis craccivora*)

- Aphid is a serious pest, causing damage to most bean growing areas in the world. Leguminaceous crops are the major host of this pest.

#### Host range

- It is a polyphagous pest including beans and other pulses, citrus *etc.*
- It acts as a vector of Rosette disease in groundnut and broad bean virus in pea.

#### Nature of damage

- Both nymphs and adults suck sap from tender leaves and shoots.
- The first signs of attack are small bleached areas on the leaves of infected plants.



- The leaves then turn yellow and become crumpled.



- The effects of infestation are worst on seedlings and young plants.
- Early damage to the growing point of the plant distorts the head.
- Even when young plants are infected only lightly, the leaves of the plants when they are mature continue to show signs of the original attack.
- Honeydew can make the leaves sticky where several fungi species grow on the honeydew producing black marks on the leaf surfaces.

### Description

- The wingless aphids are up to about 2.5 mm long, grayish-green in color, with a dark head and black stripes on the body.
- The aphid is covered with a grayish-white colored waxy powder, which is also secreted onto the surface of host plants.
- The winged aphids are slightly longer than the wingless ones and have a dark colour head and body.



- The veins on the wings appear brown in colour.
- The aphids have small siphons (looking like small antennae) at the back of their body.
- Warm, dry weather favors a rapid build-up of aphid colonies.

### 2.5.2 Leaf minor (*Chromatomyia horticola*)

- It is found throughout the world including India, China, Indonesia, Iraq, Israel, Japan, Korea, Kuwait, Malaysia, Mongolia, Nepal, Philippines, Sri Lanka, Taiwan, Thailand, Vietnam etc.

#### Host range

- Leguminous crops, cucurbits, crucifers, tomato, lettuce etc.

#### Nature of damage

- Larvae mine into the leaves and leave a trail of faecal matter inside the mines.
- Pupation takes place inside the mines with the pupa apically protruding through the mine.

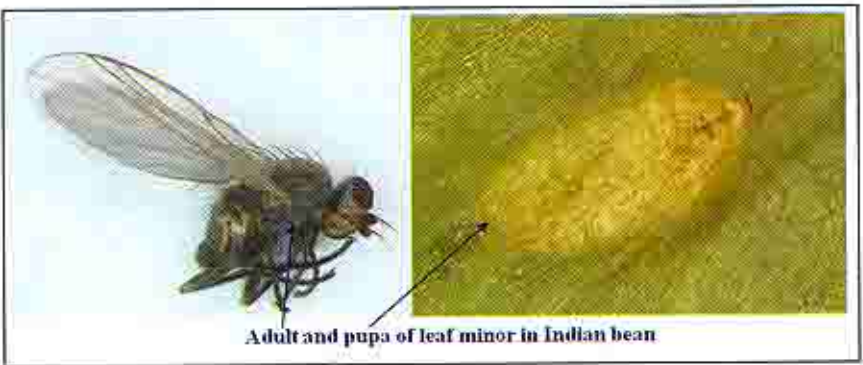




- Upper-surface, less often lower-surface corridor. Frass in isolated grains. Pupation within the mine, in a usually lower-surface, pupal chamber
- Rot and decay of seedlings is a secondary effect.
- Mining causes stem wilt in seedlings.

**Description**

- Adult flies are greyish with black dorsal setae.





- They make prominent whitish tunnels in the leaves.
- The mesonotum is greyish black and yellowish frons.
- The insect complete one generation in about 13-14 days and pass through several generations during the period of its activity.

### 2.5.3 Pod borer (*Maruca vitrata*)

- This pest is found throughout South India on pulses and beans. It is also webs the dhaincha leaves.

#### Host range

- The pod borer is a major pest in the bean growing regions of India.
- Larvae cause damage on most crops of the legume family such as long bean, french bean, faba bean, sword bean, soybean and green bean.

#### Nature of damage

- The caterpillar with short hairs on black warts webs together the flowers and feeds on them.





- After the green bean plant flowers, the larva penetrates into the flower through their edges.
- The larva can spin a thread to connect flowers together, and then enter to damage.
- It can roll leaves to make a nest-like and then feed on the mesophyll layer of the leaves and leaf veins.
- It also bores into pods at one end and eats up the ripening seeds.
- Mass excreta can be seen at the entrance of larval burrow.
- Older insects can eat branches and stems.

### Description

- Male adult pod borer is 11.2 mm long and wing span of 24 mm.
- Moth is dark brown forewings with white club shaped cross band along anterior margin and white hindwings with dark brown border.
- The abdomen has nine nodes and is longer in males than females.



- At the distal end of the abdomen are three black hair groups.



- The larvae are tube shaped, with slender heads.
- Their color changes from greenish to brown depending on the food available.

#### 2.5.4 Pod borer (*Etiella zinckenella*)

- It is found throughout the world including India, Middle belt of Russia, the North Caucasus, South Siberia, Baltic States, Byelorussia, Ukraine, Moldavia, Transcaucasia, Kazakhstan, Western Europe, North Africa, Asia Minor, the Middle East, China, Korea, Japan, South-East Asia.

#### Host range

- Major host plants recorded from India include pigeonpea, cowpea, lablab, soybean, peas, chickpea, *Crotalaria juncea*, *C. micans*, *C. saltiana*, *Lathyrus sativus*, *Phaseolus lunatus*, *P. vulgaris*, *Vigna mungo*, and *V. unguiculata*.

#### Nature of damage

- The larvae feed on floral parts, newly formed pods and seeds in developing pods.
- Faecal pellets inside damaged pods and small round holes on pods plugged with excreta can be noticed.

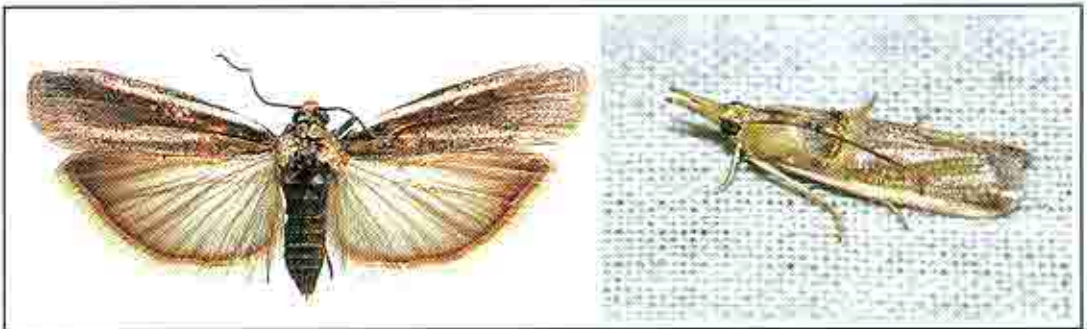




- Shedding of blossom and young pods; mature pods marked with a brown spot (rotten patch) due to the build-up of faeces inside the pod.
- Split pods containing greenish larva having five black spots on the prothorax and a lot of white frass and silk.

### Description

- Body length 8-11 mm, wingspan 19-27 mm.
- Wings longer than abdomen, folding as roof.
- Forewing is yellow or brown-grayish with characteristic light stripe along fore edge, with orange spot on basal third, and with dark fringe.



- Hindwings are light gray, with dark venation and dark double line near fringe; the fringe is long and light in color.
- Top of abdomen with a tuft of golden-yellow hairs.
- Coloration of larvae is variable, from dirty greenish-gray to reddish.



## Chapter: 3

# NATURAL ENEMIES OF VEGETABLE CROPS IN ARID REGION

### 3.1 Seven-spotted ladybird beetle (*Coccinella septempunctata*)

- A palaeartic species, widely distributed almost throughout India and the Oriental region, North Africa. Advertently introduced in several countries including North America.

#### Prey habitat

- Commonly associated with aphids infesting crops such as ber, aonla, date palm, tomato, brinjal, cucurbits *etc.* in very large numbers, especially during winter months in the northern region.

#### Description

- Body oval, strongly convex.
- Length 5.2-8.6 mm, width 4.0-6.6 mm.





- Head black, with a pair of semicircular frontal spots, one on either side of inner margin of eyes.
- Pronotum black, with a pale yellow or white anterolateral spot.
- Elytral pattern in typical form with seven black spots-one common spot around scutellum, and three on each elytron, with small whitish patches on either side of scutellum, just above scutellar spot.
- Ventral side more or less completely black.
- Larva dark slaty grey to dark brown, with orange yellow or reddish areas.

### 3.2 Zigzag ladybird beetle (*Cheilomenes sexmaculata*)

- Almost throughout India and the Oriental region, Iran, Australasia etc.

#### Prey habitat

- Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf and planthoppers, mites, and early instar lepidopteran larvae.

#### Description

- Body is oval to subrounded, dorsum moderately convex and shiny.





- Length 3.3-6.2 mm and width 3.0-5.3 mm.
- Ground colour orange, light red, yellow or pinkish with the following markings in the typical form.
- Head with a black marking in posterior half.
- Pronotum with a T-shaped median marking connected to a broad black band along posterior margin.
- Elytra with six black maculae including two zigzag lines and a posterior black spot.

### 3.3 Strip lady bird beetle (*Brumoides suturalis*)

- Widespread almost throughout India (Andhra Pradesh, Goa, Jammu & Kashmir, Karnataka, Kerala, Manipur, Punjab, Tamil Nadu, Uttar Pradesh, West Bengal), Nepal, Bhutan, Sri Lanka, etc.

#### Prey habitat

- This species departs from the normal food habits of the other genera of Chilocorini, which are mainly scale feeders.
- It is more polyphagous and largely predatory on aphids, whiteflies, psyllids, scales, mealybugs and mites.

#### Description

- Body is oval, dorsum convex.
- Body length 4.0 mm and width 2.7 mm.
- Head and pronotum orange yellow.
- Scutellum black.





- Elytra satiny white to creamy yellow, with three black stripes, one on each elytron in a mid-dorsal position not extending to apex and one along sutural line nearly extending to apex.



- Apical portion yellowish to reddish brown.
- Last visible abdominal segment with posterior margin emarginate in male and narrowly rounded in female.
- Larva slaty grey, with prominent spiny protuberances on dorsal side.

### 3.4 Green lacewing (*Chrysoperla carnea*)

- It is found in many parts of America, Europe and Asia. It was originally considered to be a single species with a holarctic distribution but it has now been shown to be a complex of many cryptic, sibling species.

#### Prey habitat

- The adults feed on nectar, pollen and aphid honeydew but the larvae are active predators and feed on aphids and other small insects.



## Description

- The green lacewing eggs are oval and secured to the plant by long slender stalks.
- The larvae are brown and resemble small alligators, crawling actively around in search of prey.



- They have a pair of pincer-like mandibles on their head with which they grasp their prey, sometimes lifting the victim off the leaf surface to prevent its escape.
- Adult green lacewings are a pale green colour with long, threadlike antennae and glossy, golden, compound eyes.
- They have a delicate appearance and are from twelve to twenty millimetres long with large, membranous, pale green wings which they fold tent-wise above their abdomens.
- They are weak fliers and have a fluttery form of flight.



## PREPARATION OF BIOPECTICIDES AT FARMER'S FIELD LEVEL

### 1. Preparation of neem formulations

#### A. Neem Seed Kernel Extract (NSKE 5%)

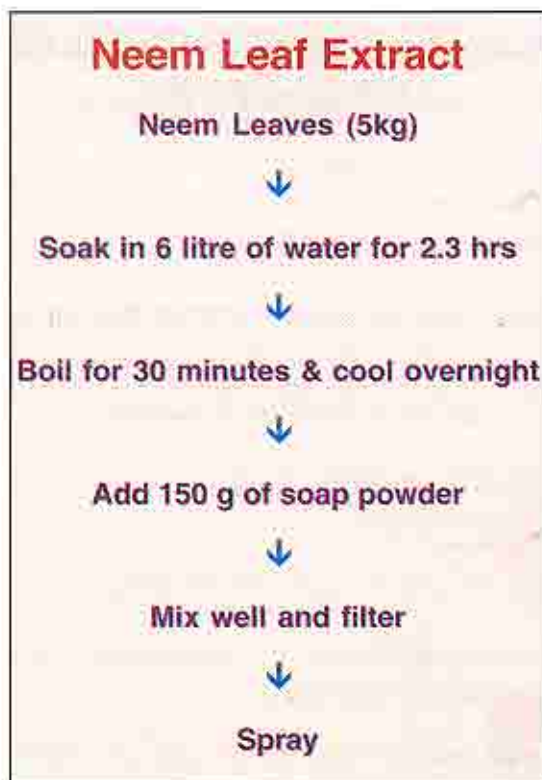
- Take dried neem seed kernel 500g are grinded to coarse powder.
- The powder obtained will be taken in muslin cloth and tied to get a pouch, which is allowed to soak in 500 ml of water for overnight.
- The pouch is thoroughly squeezed for four to five times to get the extract into water to make 1000 ml volume.
- Add 2g detergent to the solution and use for spray.
- NSKE 5% is use for management of *Helicoverpa*, *Spodoptera*, leaf folders, sucking pests, mites and others pests.
- The leaves and other parts of the plant sprayed with the extract repel the larvae from feeding resulting in death due to starvation.

#### Precautions for neem formulation

- Collect the Neem fruits during bearing season and air-dry them under shade.
- Do not use the seeds over eight months of age. The seeds stored over and above this age lose their activity and hence not fit for NSKE preparation.
- Spray the extract after 3.30 P.M. to get effective results.



## B. Neem Leaf Extract



## C. Tobacco extracts solution

- Tobacco has excellent insecticide properties and farmers use for killing of insect pests since time immemorial.
- Take 250g tobacco waste and boil it in 4 liters of water for half an hour.
- Cool it and filter through muslin cloth.
- Add 30g soap and mix well.
- Dilute 1part extract with 4 parts of water and use as spray.



- Adding a little lime powder increases the efficacy of the extract.
- This preparation is effective against white fly, aphids, leafhoppers and soft body insects.
- Note: Tobacco extracts should not be used for more than one, as it is toxic to natural enemies.

#### **D. Cattle dung and urine solution**

- Farmers can use this spray to nourish the crop plants besides reducing the pest attack.
- The spray discourages the infestation and improves the crop health and flower retention of the stand by means of trace elements presented in it.
- The cattle urine of 3 to 5 liters mixed with 3 to 5 kg of dung is allowed to ferment for four days in a tank covered with a lid.
- The slurry is allowed to pass through a diaphanous cloth to get the stock solution.
- Adding 200 to 250 g of quick lime neutralizes the acidity of the solution.
- The stock solution thus obtained is adequate to be sprayed on one acre of field after diluting it with 50 to 80 liters of water.
- Spraying cow dung urine solution prevents egg laying by the moth like *Helicoverpa*, *Spodoptera* etc.
- It is found to give protection against some diseases and the sprayed crop looks green and healthy.

#### **E. Chilli and garlic extract solution**

- Take 3 -4 kg of green chillies and 400-700 grams of garlic cloves.
- Grind them separately.



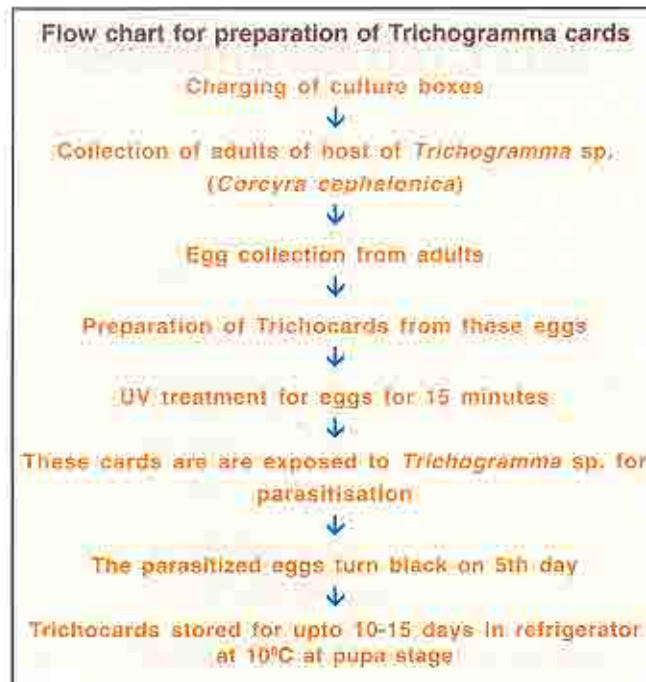
- Dissolve the green chillies paste in 8-10 liters of water and garlic paste in 150-200-ml kerosene, separately.
- Filter them separately by means of thin muslin cloth.
- Mix both the extract and also add 50g soap to the filtrate.
- Dilute 1 part of the extract with 4 parts of water to spray.
- It acts as ovi-position deterrent and female moths would not like to lay eggs on treated surface.
- Further if any early stages of larvae were present, they get killed due to pungent properties of extract.

#### **F. Nuclear Polyhedrosis Virus (NPV)**

- Collect 400 NPV infected *Helicoverpa* or 200 *Spodoptera* larvae from field.
- Grind the collected larvae.
- Filter the solution obtained using a thin cloth.
- Dilute the NPV solution to 100 liters and add 100g of robin blue to protect from UV light in the field.
- Spray this solution during evening hours
- It is use to management of *Helicoverpa armigera* and *Spodoptera litura* pests in the field.
- In the fields, natural mortality of *Helicoverpa* can be seen due to infestation of disease causing virus particles. Such larvae can be collected and may be utilized again for checking *Helicoverpa* populations.
- Virus infected dead larvae are observed hanging head upside down from top branches.



## G. Preparation of Tricho-cards



### Precautions in release of Trichocard

- For field release, the Trichocards are cut into small pieces and the pieces are stapled underneath the leaves.
- This method is relatively easier and the distribution of the parasitoid is uniform.
- *Trichogramma* should preferably be released in the evening hours.
- Thirty minutes after emergence, the parasitoids actively search for their hosts.
- Trichocards are released @ 1 trichocard per acre.



## SELECTED REFERENCES

- Atwal, A. S. and Dhaliwal, G. S. 2005. *Agricultural Pests of South Asia and their Management*. Kalyani Publishers, New Delhi.
- Chatterjee, V. C. 1983. *Nesidiocoris caesar* (Ballard) (Heteroptera: Miridae), a new pest of bottle gourd and tobacco in western Uttar Pradesh. *Uttar Pradesh J. Zool.* **3**: 2, 149-153.
- Chatterjee, V. C. 1985. Biological control of the Hemipteran pests of *Lagenaria vulgaris* Ser. (Cucurbitaceae). *Proceedings of a national symposium on pesticide residues and environmental pollution, Muzaffarnagar, India, 2-4 October, 1985*; 223-227.
- Choubey, P. K. and Yadav, H. S. 2000. Screening of different cucurbits against melon fruit fly. *JNKVV Res. J.* **33**(1/2): 17-21.
- David, B. V. and Ananthakrishnan, T. N. 2004. *General and Applied Entomology*. Tata McGraw Hill Publishing Co Pvt. Ltd., New Delhi.
- Dhaliwal, G. S. and Arora, R. 2006. *Integrated Pest Management: Concepts and Approaches*. Kalyani Publishers, New Delhi.
- Dhillon, M. K., Naresh, J. S., Singh, R. and Sharma, N. K. 2005a. Evaluation of bitter melon (*Momordica charantia* L.) genotypes for resistance to melon fruit fly, *Bactrocera cucurbitae*. *Indian J. Pl. Prot.* **33**(1): 55-59.
- Dhillon, M. K., Naresh, J. S., Singh, R. and Sharma, N. K. 2005b. Influence of physico-chemical traits of bitter melon, *Momordica charantia* L. on larval density and resistance to melon fruit fly, *Bactrocera cucurbitae* (Coquillett). *J. Appl. Ent.* **129** (7): 393-399.





- Dhillon, M. K., Singh, R., Naresh, J. S. and Sharma, H. C. 2005c. The melon fruit fly, *B. cucurbitae*: A review of its biology and management. *J. Insect Sci.* **5**: 40-60.
- Gaston, K.J. and Lawton, J.H. 1988. Patterns in the distribution and abundance of insect populations. *Nature*, **331**: 709-711.
- Ijoyah, M. O. and Rakotomavo, H. 2010. Effectiveness of three insecticides to control melon fruit fly (*Bactrocera cucurbitae* Coq.) in cucumber crop at Praslin, Seychelles. *J. of sust. Develop. Agri. & envir.*, **5** (1): 10- 20.
- Jacob, J., Leela, N. K., Sreekumar, K. M., Anesh, R. Y. and Heema, M. 2007. Phytotoxicity of leaf extracts of multipurpose tree against insect pests in bitter gourd (*Momordica charantia*) and brinjal (*Solanum melongena*). *Allelopathy J.* **20** (2): 1-2.
- Lall, B. S. and Sinha, R. P. 1975. Reaction of different cucurbit varieties to invasion by melon fly, *Dacus cucurbitae* Coq. Proceedings of the Bihar Academy of Agricultural Sciences. **22-23**: 100-103.
- Pedigo, L. P. 2002. *Entomology and Pest Management*. Prentice-Hall of India Pvt., New Delhi.
- Pradhan, R. B. 1976. Relative susceptibilities of some vegetables grown in Kathmandu valley to *D. cucurbitae* Coq. *Nep. J. Agric.* **12**: 67-75.
- Reddy, D. S. 2005. *Applied Entomology for Competitive Examiners*. Pusa Agricultural Books Service, New Delhi.
- Singh, R and Patel, H. K. 1972. Record of some new host plants of, and biological notes on, *Gampsocoris pulchellus* (Dallas) (Hemiptera: Neididae-Berytidae). *Indian J. Agric. Sc.* **42**: 11.
- Sinha, S. N. and Chakrabarti, A. K. 1983. Effect of seed treatment with carbofuran on the incidence of red pumpkin beetle, *Raphidopalpa foveicollis* Lucas on cucurbits. *Indian J. Ento.* **45**: 2, 145-151.



## Appendices

### Appendix: 1. List of insect –pests of vegetable crops in arid region

S. No.	Insect-pests of vegetable crops	Family	Order
<b>1.</b>	<b>Cucurbits pests</b>		
1.	Melon fruit fly ( <i>Bactrocera cucurbitae</i> )	Tephritidae	Diptera
2.	Hadda beetle ( <i>Epilachna vigintioctopunctata</i> )	Coccinellidae	Coleoptera
3.	Melon aphid ( <i>Aphis gossypii</i> )	Aphididae	Hemiptera
4.	Leaf eating caterpillar ( <i>Diaphania indica</i> )	Pyralidae	Lepidoptera
5.	Red pumpkin beetle ( <i>Aulacophora foveicollis</i> )	Chrysomelidae	Coleoptera
6.	Thrips ( <i>Thrips tabaci</i> )	Thripidae	Thysanoptera
7.	White fly ( <i>Bemisia tabaci</i> )	Aleyrodidae	Hemiptera
8.	Leaf minor ( <i>Liriomyza trifolii</i> )	Agromyzidae	Diptera
9.	Two-spotted spider mites ( <i>Tetranychus urticae</i> )	Tetranychidae	Acarina
<b>2.</b>	<b>Brinjal pests</b>		
10.	Brinjal fruit and shoot borer ( <i>Leucinodes orbonalis</i> )	Pyraustidae	Lepidoptera
11.	Brinjal thrips ( <i>Scirtothrips dorsalis</i> )	Thripidae	Thysanoptera
12.	Brinjal bollworm ( <i>Helicoverpa armigera</i> )	Noctuidae	Lepidoptera
13.	Brinjal jassids ( <i>Amrasca devastans</i> )	Cicadellidae	Hemiptera
14.	Brinjal lace wing bug ( <i>Urentius hystricellus</i> )	Tingidae	Hemiptera
15.	Brinjal leaf roller ( <i>Eublemma olivacea</i> )	Noctuidae	Lepidoptera
16.	Brinjal stem borer ( <i>Euzophera perticella</i> )	Pyralidae	Lepidoptera
17.	Brinjal blister beetle ( <i>Mylabris pustulata</i> )	Meloidae	Coleoptera
<b>3.</b>	<b>Tomato pests</b>		
18.	Tomato pod borer ( <i>Helicoverpa armigera</i> )	Noctuidae	Lepidoptera



S. No.	Insect-pests of vegetable crops	Family	Order
19.	Tobacco caterpillar ( <i>Spodoptera litura</i> )	Noctuidae	Lepidoptera
20.	Tomato serpentine leaf miner ( <i>Liriomyza trifolii</i> )	Agromyzidae	Diptera
21.	White fly ( <i>Bemisia tabaci</i> )	Aleyrodidae	Hemiptera
22.	Cotton aphid ( <i>Aphis gossypii</i> )	Aphididae	Hemiptera
<b>4.</b>	<b>Khejri pests</b>		
23.	Coreid bug ( <i>Homoeocerus variabilis</i> )	Coreidae	Hemiptera
24.	Galls on rachis of leaflets ( <i>Contarinia prosopidis</i> )	Cecidomyiidae	Diptera
25.	Induce galls on branches ( <i>Pediobopsis</i> sp.)	Chalcididae	Hymenoptera
26.	Galls on leaflets ( <i>Eriophyes prosopidis</i> )	Eriophyidae	Acarina
27.	Termite ( <i>Odontotermes obesus</i> )	Termitidae	Isoptera
<b>5.</b>	<b>Beans pests</b>		
28.	Gram pod borer ( <i>Helicoverpa armigera</i> )	Noctuidae	Lepidoptera
29.	Leaf minor ( <i>Chromatomyia horticola</i> )	Agromyzidae	Diptera
30.	Whitefly ( <i>Bemisia tabaci</i> )	Aleyrodidae	Hemiptera
31.	Leaf hopper ( <i>Empoasca kerri</i> )	Cicadellidae	Hemiptera
32.	Aphid ( <i>Aphis craccivora</i> )	Aphididae	Hemiptera
33.	Pod borer ( <i>Maruca vitrata</i> )	Pyralidae	Lepidoptera
34.	Red spider mites ( <i>Tetranychus urticae</i> )	Tetranychidae	Acarina
35.	Pod borer ( <i>Etiella zinckenella</i> )	Pyralidae	Lepidoptera



## Appendix: 2. List of natural enemies of horticultural crops in arid region

S. No.	Name of natural enemies	Host
1.	<i>Cheilomenes sexmaculata</i> (Fabricius)/ <i>Menochilus sexmaculatus</i> (Fabricius)	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
2.	<i>Coccinella septempunctata</i> Linnaeus	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
3.	<i>Brumoides suturalis</i> (Fabricius) ( <i>Brumus suturalis</i> (Fabricius))	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
4.	<i>Cymnus coccivora</i> Ayyar	Aphidophagous, also feeds on psyllids, whiteflies, mealybugs, tingids, leaf-hoppers and mites.
5.	<i>Chrysoperla carnea</i>	Soft body insects
6.	Preying Mantids	Soft body insects and larvae of lepidopteron pests
7.	Spiders	Insect-pests of arid vegetable crops
8.	Syrphid fly	Feeds on aphids
9.	Rove beetle	Feed on soft body insects
10.	Birds (King crow and Indian Mynah)	Insect-pests of arid vegetable crops



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