

Introduction

Vegetables being an important component of a balanced diet for man includes carbohydrates, proteins, fats, minerals and vitamins. Vegetables supply important vitamins and minerals that the human body needs for physiological process and metabolic activity. Some tubers like potato, sweet potato, tapioca, *etc.* are rich in carbohydrates specially starch. Leguminous vegetables like pea, cowpea, beans, *etc.*, are rich in proteins and as high as 14% protein is seen in soybean. Vegetables like carrot, pumpkin, peas, turnip, beetroot, tomato, sweet potato, cabbage, greens like spinach, methi, green onion *etc.*, are important source of vitamin A. Ascorbic acid or vitamin C is present in appreciable quantities in chilli, palak, methi (fenugreek), cabbage, tomato, cauliflower, bitter gourd *etc.* Vitamin D is available in greens which are good source of Vitamin E also. Green leafy vegetables are good source of the other essential Vitamins *viz.*, niacin and vitamin K. Vegetables are also having different flavour components, antioxidants and bioflavonoids.

Vegetable crops in comparison to field crops are high output crops. They can be fitted into many remunerative crop rotation and cropping patterns like inter cropping, multiple cropping and companion cropping. Vegetable growing enables maximum utilization of land. India is the world's second largest producer of vegetables next to China. Vegetable crops occupy only 2.8% (10.316 million ha) of cultivated land producing 189.46 million tonnes of vegetables. Uttar Pradesh, West Bengal, Madhya Pradesh and Maharashtra are top most vegetable producing states in India.

Vegetable export includes fresh and processed vegetables and contributed 2822.42 crores in 2019-2020 (according to India stat). Onion alone contributes 75% share in fresh vegetable export. Potato, okra, bitter gourd, chilli, cauliflower and gherkin other major exportable vegetables. Dehydrated onion and garlic, preserved gherkin, canned and frozen vegetables also have good demand in gulf countries and South-East Asian countries.

As with abiotic causes of crop losses, especially the lack or excess of water in the growth season, extreme temperature, high or low irradiance and nutrient supply, biotic stressors have the potential to reduce crop production substantially. Biotic factors like insect pests and diseases cause an average of yield loss of 25-30% in vegetables due to their tenderness and softness of vegetable. The crops are susceptible to the attack of various insect pests and diseases in different stages with varying degree of damage which causes considerable losses by reducing potential yield and quality of the produce. Leaf

defoliators, borers, leaf folders and sap feeders are the different types of insect pest based on the nature of damage.

Diamond back moth is the most important pest of cruciferous crops, which has developed resistance to several classes of insecticides. In cabbage and cauliflower it causes up to 52 % losses in marketable yield in India. In brinjal shoot and fruit borer has remained major pest in the past two decades due to poor natural enemy complex and extensive use of pesticides. The pest starts infesting the shoot tips few weeks after transplanting and bores in to fruits till harvesting. Crop losses in brinjal due to shoot and fruit borer ranges from 25.82-92.50 % and yield reduction of 20 – 60 %. Another key pest of brinjal is the stem borer, which tunnels in to stem and cause plant to wither and die. Of late its infestation is growing to epidemic proportions in some states. In okra, fruit borer is the main pest and the larva bores into shoot or fruit eating on internal contents causing withering up of plant and reduction in marketable value of the fruit. In tomato *Helicoverpa* is the key pest and it feeds on buds, flowers and fruits causing on an average 46% yield loss.

At the same time many sap feeders act as a vector and transmit viral and mycoplasma diseases in crop ecosystem. Plant-virus diseases have now become major threat to agriculture. More than 1000 virus species that infect cultivated plants worldwide have been described. Among the most serious virus diseases causing severe yield losses in different crops are tobamovirus, tospoviruses, begomoviruses, cucumoviruses, ilarvirus, potyviruses, tungro virus, carlavirus, babuvirus, badnavirus, polerovirus, and allexivirus. Most of these viruses are transmitted by whiteflies, aphids, hoppers and few bugs. Tomato leaf curl virus is transmitted by whitefly and causes 19- 33% yield loss with the symptom of necrotic pitting, bronzing, or severe mottling and sometimes irregular shape of the infected fruits. Fruit yield losses in chillies due to chilli leaf curl virus during the summer season ranges from 20 to 80%, as compared with 20 to 74% in the winter season. Loss in yield was reported as 86-90 % in bhendi due to bhendi vein mosaic virus. Scientists reported that Cassava mosaic virus infected cuttings would cause 55-75% yield losses and 35-60% losses by whiteflies in later infections.

Farmers have had to compete with harmful organisms – pests and diseases. These organisms may be controlled by applying physical (cultivation, mechanical weeding etc.) biological (cultivar choice, crop rotation, antagonists, predators etc.) and chemical measures (pesticides). Simple single static method to manage pest, never be a significant method. It should be an integrated approach. Knowledge on different pest, infecting stage of pest, susceptible stage of crop, symptoms shown by affected crop helps to identify the problem in field condition.

Insect Pests of Brinjal

Brinjal, *Solanum melongena* L. is a solanaceous vegetable also known as “King of vegetables”. It is a major vegetable crop in India. The production of the crop is regulated by different biotic and abiotic factors and amongst those factors, insect pests play a pivotal role for lowering the yield of brinjal, by attacking the crop right from the nursery stage to till harvesting. Several insects like fruit and shoot borer, white fly, leaf hopper, leaf roller, red spider mite etc. are found to cause loss in brinjal in different parts of the world. It can reduce yield up to 60-70%. The list of major pest is as follows:

Sl.No.	Common name	Scientific name	Family	Order
1.	Shoot and fruit borer	<i>Leucinodes orbonalis</i> Guenee	Pyralidae	Lepidoptera
2.	Epilachna beetle	<i>Henosepilachna vigintioctopunctata</i> (Fabricius)	Coccinellidae	Coleoptera
3.	Brinjal stem borer	<i>Euzophera perticella</i> Ragonot	Pyralidae	Lepidoptera
4.	Brinjal leaf roller	<i>Eublemma olivacea</i> Walker.	Pyralidae	Lepidoptera
5.	Brinjal white fly	<i>Bemisia tabaci</i>	Aleyrodidae	Hemiptera
6.	Jassids	<i>Amrasca biguttula biguttula</i> Ishida	Cicadellidae	Hemiptera
7.	Brinjal tingid bug	<i>Urentius hystricellus</i> Richter and <i>U.sentis</i> D.	Tingidae	Hemiptera
8.	Brinjal mealy bug	<i>Coccidohystrix insolita</i> (Green)	Pseudococcidae	Hemiptera
9.	Red spider mite	<i>Tetranychus urticae</i> (Koch)	Tetranychidae	Acarina

1. SHOOT AND FRUIT BORER

This insect is considered as a monophagous pest, yet, this insect attacks occasionally potato, tomato and wild races of brinjal. This pest is seen in both *kharif* and Rabi crop. However, late Rabi crop or summer crop is heavily infested by this pest as compared to *kharif* crop. This is the most important insect pest of brinjal that depletes the yield to the tune of 50-70 per cent.



Fig.1. Infested fruit of brinjal by shoot and fruit borer

DAMAGE SYMPTOMS

Brinjal shoot and fruit borer is one of the most destructive insect pests of brinjal. This pest starts infestation after transplanting of the seedlings to harvesting of fruits. First instar larva bore into the growing tips of young shoots during earlier stage of plants and young stage of plant, drooping of shoot is the typical damage symptom of this pest. The affected shoots wither and die also. At the time of flowering and fruiting stage, the larvae prefer flower buds and young fruits and bore into the young fruits. It completes its larval stage within the fruit and the last instar matured larva comes out from the fruit for pupation.

BIOLOGY

Adult: The adults are medium sized moths having a wing expansion of nearly 30-35 cm. The adults are grey-brown coloured with white wings containing orange, yellow, rusty red specklings. The tip of the abdomen of males is blunt whereas, the tip of the female adults is pointed. The males can bend their abdomen more than the females. A single female

can lay 200-300 eggs either singly (more frequent) or in groups on all terminal plant parts with more preference on calyx.

Egg: Eggs are white and oval in shape. The eggs hatch in about 2-6 days depending upon the prevailing temperature.

Larva: The first instar larvae are white in colour. The young larvae enter into the tender and succulent terminal shoot and make feeding tunnel inside as a result the infested shoot droop down. As the larvae grow, the colour changes and at third instar stage, the colour changes to pink. When the plants bear the fruits, at that time the larvae enter below the calyx into the fruits and feed inside leaving excreta which become unfit for consumption. A single fruit may be infested by more than one larva. There may be generally 4 instars in the larval period with a fifth instar occasionally. The entire larval period is completed within 18-21 days. The full grown larvae come out of the fruits by making holes and fall on the ground for pupation.



Fig. 2. Larva of shoot and fruit borer

Pupa: The pupae may construct a gallery within which they pupate. Sometimes the pupation is seen within the fallen leaves. The pupae are brown in colour and the pupal period lasts for nearly 7-10 days.

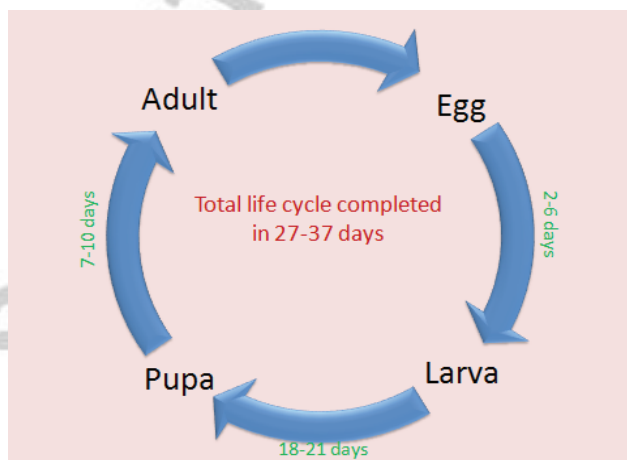


Fig. 3. life cycle of shoot and fruit borer

MANAGEMENT

- Clean cultivation and removal of old crop remnants.
- Discourage rationing.
- Apply neem cake @ 1 q/ha in two splits; half at transplanting and the other half after three weeks of transplanting.
- When the shoot damage crosses 4 per cent, remove the drooped shoots and bury them inside the ground or set fire to them. After removal of the affected shoot, spray the crop with neem oil (300 ppm azadirachtin) @ 5 ml/l.
- Install pheromone trap with leucilure in the field @ 10/acre for mass trapping of the males and their destruction. The lures should be changed at 3 weeks interval.
- Release *Bracon brevicornis* @ 40000/ac; 3-4 times at an interval of 7 days to parasitize early instar larvae.
- During fruiting if the fruit damage exceed 14 per cent, then apply insecticides in rotation at an interval of 10 days with cartap hydrochloride 50 SP @ 2 g/l or Acephate 75 SP @ 2 g/l or Flubendiamide 39.35 EC @ 1 ml/3 l or Chlorantraniliprole 18.5 WSC @ 1 ml/l or Emmamectin benzoate 5 SG @ 1 g/2 l or Spinosad 45 SC @ 0.5 ml/l.

2. EPILACHNA BEETLE

This is one polyphagous pest of brinjal. This insect attack mostly gourds, potato, cowpea excluding brinjal.

DAMAGE SYMPTOMS

Beetle causes considerable economic losses to brinjal depending on place and season for variations of prevailing environmental conditions. It is highly destructive at both, adult and larval stages which feed on the epidermal tissues of leaves, flowers, and fruits by scrapping the chlorophyll content and cause a big yield loss. The affected leaves of the plant become skeletonized, gradually dry and drop down. The larvae confine their attack to the lower surface while adult beetles usually feed on the upper surface of the leaves.



Fig.4. Beetle feeding on crop

Source: https://apps.lucidcentral.org/ppp/text/web_mini/entities/eggplant_28spot_ladybird_beetle_058.htm