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Eco-Friendly Approaches for Managing Major Okra Insect-Pests

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Introduction

Okra (*Abelmoschus esculentus* L.) is an economically important annual plant of Malvaceae family which is widely grown in tropical and sub-tropical parts of the world and is native to Ethiopia. This crop is one of the most extensively known and utilized species of the family Malvaceae. In India, the chief okra growing states are Gujarat, Uttar Pradesh, Bihar, West Bengal, Odisha, Assam, Andhra Pradesh and Karnataka. Okra has nutritional (Table 1) as well as medicinal worth. Okra is low in calories but jam-packed with nutrients. The green tender pod contains oxalic acid, thiamine, riboflavin, nicotinic acid along with vitamin A, B and C and Calcium in very high content as compared to other vegetables. The okra pod is rich source of iodine which is important in treating Goitre disease. The polyphenols in okra fruits decrease risk of heart problems and stroke by preventing blood clots and reducing free radical damage. Mucilage—a thick, gel-like substance found in okra, can bind with cholesterol during digestion and enables its removal from the body.

Ripe seeds of okra are roasted, ground and used as a replacement for coffee in some countries. Dry pods and stems containing crude fibre are used in the paper industry, cardboard making and fibre extraction. Okra's delicious pod is an essential ingredient in stews and curries. Fruits are also dried or frozen for use during off -season. Roots and stems of the plant are used for clearing cane juice for preparation of jaggery.

Table 1: Nutritional status of okra

Nutritive element	Composition of okra pods/100g of edible portion	Composition of okra leaves/100 g of edible portion
Water	88.6 g	81.50 g
Energy	36 Kcal	56.00 kcal
Protein	2.10 g	4.40 g

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Carbohydrate	8.20 g	11.30 g
Fat	0.20 g	0.60 g
Fibre	1.70g	2.10 g
Calcium	84 mg	532.00 mg
Phosphorus	90 mg	70.00 mg
Iron	1.20 mg	0.70 mg
β-carotene	185.00 µg	385.00 µg
Riboflavin	0.08 mg	2.80 mg,
Thiamine	0.04 mg	0.25 mg
Niacin	0.60 mg	0.20 mg
Ascorbic acid	47.00 mg	59.00 mg

Source: (Gemede *et al.* 2015).

In India, area under okra cultivation in 2018-2019 has been reported to be 513 thousand hectare with an annual production of 6176 thousand MT (Anonymous, 2020) which is much lower than that of many countries. One of the major constraints that prevent the realization of higher yields in okra in our country is the attack of innumerable insect-pests throughout the crop growth period right from germination till harvesting. Chemical insecticides are indubitably effective but are associated with a number of side-effects which imbalance the ecosystem. Their indiscriminate use is coupled with serious health complications to man and his environment. This necessitates shift towards eco-friendly approaches which emphasize chiefly on the management of insect-pests instead of eradicating them based on their biological, ecological and behavioural mechanisms. Such methods concurrently take care of the ill-effects of chemical based farming.

Major insect-pests of okra

Okra crop is attacked by more than 72 insect pests which infest the crop from seedling stage to harvest. Amongst them, leafhopper (*Amarasca biguttula*), whitefly (*Bemisia tabaci*), aphids (*Aphis gossypii*), shoot and fruit borer (*Earias vittela* & *E. insulana*), okra fruit borer (*Helicoverpa armigera)* and blister beetle (*Mylabris* spp.) are most serious insect-pests that cause major damage to the crop. The bionomics of okra insect-pests is presented in Table 2.

1. Leafhopper (*Amarasca biguttula*)

Adults are greenish yellow, small, wedge shaped 3 mm long having tiny black spot on each forewing and vertex. Nymphs are pale green, translucent, wingless found between the veins of leaves on the under surface. Adults lay yellowish eggs singly on underside, inside the tissue of leaf blades, but also on leaf stalks or in soft twigs.

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Nature of damage: Both nymphs and adults suck the sap on the underside of tender leaves and move diagonally. The leaf margins curl upwards and develop brown dead spots with a yellow halo at the edges of the leaves. Under severe infestation, leaves turn bronze coloured which is a typical symptom of "hopper burn". The leaf margins start to dry up and finally shed off. Severely affected leaves may desiccate and fall off.

2. Whitefly (*Bemisia tabaci*)

Adults are yellowish, dusted with white waxy powder, 1.0- 1.5 mm long. They have two pairs of white wings and prominent long hind wings. Female lays stalked eggs singly on underside of leaves. Only first instar nymphs are mobile. It moves from egg site to the suitable feeding site on the lower leaf surface. Nymphs are greenish-yellow, oval in shape. The transparent yellow coloured fourth instar nymph (red-eyed nymph) or pupa is thin, flat, oval or elliptical in shape which later becomes convex.

Nature of damage: The nymphs and adults feed on cell sap of leaves leading to chlorotic spots which later coalesce forming irregular yellowing of leaf tissue. Later, the affected leaves curl and dry up. Severe infestation results in premature defoliation. The affected plants become stunted. The flies also transmit yellow vein mosaic virus, which is an economically important disease of okra.

3. Aphids (*Aphis gossypii*)

Adults are small, brownish black and soft bodied found in colonies on tender parts of the plant, mostly on undersurface of leaves. Adults are mostly wingless but few winged forms can be seen with thin transparent wings. The females may give birth to young ones directly which mature in about a week, hence population build-up is quick. Nymphs are light yellowish green, greenish black or brownish in colour. Alate and apterous forms multiply parthenogenetically as well as viviparously.

Nature of damage: Both nymphs and adults colonize on undersurface of leaves or tender shoots and suck cell sap. Under severe conditions, aphid feeding results in leaf curling, deformation, stunting and eventual drying of the whole plant. Young plants are more susceptible. The aphids secrete honey dew on which black sooty mould develops, thus restricting the amount of light reaching the leaves thereby reducing photosynthesis and eventually yield. Dry conditions favour the multiplication and spread of the pest.

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

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Adult of *Earias vittella* is 2.5 cm across the wings and have narrow light green band in the middle of forewings. *E. insulana* moth does not have such conspicuous band on forewings. Female moth lays sky blue coloured eggs at night, singly on flower buds and tender leaves. Full grown larvae of *E. vittella* are brown with longitudinal white stripes on dorsal side whereas, those of *E. insulana* are cream coloured with orange dots on pro thorax. Pupation takes place on the plant and rarely in the soil among fallen leaves. An inverted boat shaped greyish coloured silken cocoon is constructed for pupa formation.

Nature of damage: Larvae of both species bore into tender terminal shoots in the vegetative phase resulting in their drooping down, withering and drying up. Later on, when fruit formation starts, larvae bore in to flower buds, flowers and young fruits and fill them with excreta. The infested fruits present a deformed appearance and become unfit for consumption.

5. Okra fruit borer (*Helicoverpa armigera)*

The stout large brown or yellowish-brown moth has long and dark specks on the forewings that make V-shaped marks on the forewings and a conspicuous black spot in the centre. The hind wings are light and dull coloured with black border. It is a polyphagous pest that lays spherical yellow eggs singly on tender plant parts. Eggs are flat at the bottom. Larvae are greenish with dark broken grey lines along the sides of the body and covered with radiating hairs. Pupa develops inside a silken cocoon in soil at a depth of 4-10 cm.

Nature of damage: Upon hatching, young larvae feed on tender foliage, flowers and buds. Later when fruiting initiates, larvae bore into fruits making circular uneven holes, with half portion of their bodies hanging out. The fruits get filled with excreta making them unmarketable.

6. Blister beetle (*Mylabris* spp.)

The adult beetle is 2 to 2.5 cm long and has red or reddish brown and black alternating bands on the forewing. Most are with long, soft bodies and wide heads. The area between the head and the body is narrow and looks like a neck. The beetles come in a variety of dark or bright colours that are variegated, striped or flat. Striped blister beetles are found in shades of grey and brown with yellow stripes running lengthwise on their wing covers. Others are grey to black with a grey or white margin around each wing. The beetle lays eggs usually in the soil. The mobile first instar grub known as triungulin having three-clawed legs,

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is an active predator of soft bodied insects such as aphids. The larvae are insectivorous, mainly attacking bees, though a few feed on grasshopper eggs as well. The later instars are less active. Pupation occurs in soil. *Nature of damage*: The adult beetles appear in large numbers during flowering and are the only destructive stage that feed primarily on pollen, petals and flower buds. The young fruits or stems may also be injured, although very uncommon.

Table 2: Major insect-pests of okra, their damaging stage and duration of developmental stages

Sr. No.	Insect-pest	Order: Family	Damaging stage	Duration of different developmental stages
1	Leafhopper (*Amarasca biguttula biguttula* Ishida)	Hemiptera: Cicadellidae	Nymphs and adults	Egg stage: 4-11 days Nymphal stage: 7-21 days. (5 nymphal instars)
2	Whitefly (*Bemisia tabaci* Gennadius)	Hemiptera: Aleyrodidae	Nymphs and adults	Egg stage: 3-5 days Nymphal stage: 9-14 days Pupal stage:2-8 days (4 nymphal instars)
3	Aphids (*Aphis gossypii* Glover)	Hemiptera: Aphididae	Nymphs and adults	Egg stage:7-8 days Nymphal stage: 7-10 days (4 nymphal instars)
4	Shoot and fruit borer (*Earias vittela* Fab. and *E. insulana* Boisd.)	Lepidoptera: Noctuidae	Larva	Egg stage: 3-4 days. Larval stage: 10-17 days. Pupal stage: 8-14 days. (6 larval instars)
5	Okra fruit borer (*Helicoverpa armigera* Hubner)	Lepidoptera: Noctuidae	Larva	Egg stage: 4-7 days Larval stage: 13-18 days Pupal stage: 8-15 days (6 larval instars)
6	Blister beetle (*Mylabris* spp)	Coleoptera: Meloidae	Adults	Egg stage: 4-7 days Grub stage: 13-18 days Pupal stage: 8-15 days (5 larval instars)

Eco-friendly management approaches for major pests of okra:

- Remove and destroy crop debris, residues, weeds and other alternate hosts to avoid carryover of the pest to the next season.
- Avoid continuous irrigation to crop to prevent excessive vegetative growth and larval harbourage.

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- Carry out deep summer ploughing to expose insect-pests to scorching sunlight causing their dessication and death.
- Follow suitable crop rotation and do not grow crops belonging to Malvaceae family in sequence.
- Use resistant/ tolerant varieties to different insect-pests. Grow YVMV resistant hybrids viz. Makhmali, Tulsi, Anupama-1, Pusa A 4, Arka Abhay, Arka Anamika, Varsha Uphar, Hisar Unnat, Hisar Naveen, Gujarat Anand Okra-5 etc especially during *kharif* season of the crop.
- Follow early sowing and close spacing of okra to reduce leafhopper infestation particularly if the rainfall is heavy.
- Add organic matter in the form of well decomposed FYM @ 8-10 t/acre or vermicompost @ 5 t/acre, treated with *Trichoderma* spp. or *Pseudomonas* sp @ 2 kg/acre so as to enhance the below ground biodiversity of natural enemies.
- Apply neem cake @ 100 kg/acre at the time of transplanting for reducing borer damage.
- Perform weeding and earthing up in rows at 25-30 days after sowing.
- Plant tall crops like maize, sorghum and pearl millet on borders of the field as barrier/trap crops to trap and reduce the population of white fly and shoot & fruit borer adults.
- Optimize the use of nitrogenous fertilizers to disfavour the multiplication of various insect-pests.
- Reduce weedy host plants and carry out harvesting prior to bloom to reduce blister beetle menace.
- Install pheromone traps for *Helicoverpa armigera* and *Earias* sp. at 30 cm above the plant canopy height @ 4-5 traps per acre to monitor moth emergence. Replace the lures at 2-3 weeks interval.
- Install yellow pan water traps/ sticky traps, 15 cm above the crop canopy @ 10-20 traps per acre for monitoring and mass trapping of sucking pests viz. leafhoppers, white flies and aphids
- Install light traps @ 1-2 traps per acre, 15 cm above the crop canopy at night for monitoring and mass trapping of *Helicoverpa* and *Earias* moths and leafhoppers.

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Light traps with exit option for natural enemies of smaller size should be installed and operate between 6 pm and 11 pm.

- Erect bird perches @ 10/acre in the field for facilitating predation of insect-pests by predatory birds viz. King crow, mynah, sparrows, cuckoo, woodpecker etc.
- Periodically collect and destroy the infested shoots, buds and fruits having larvae of *Helicoverpa and Earias.*
- Collect and destroy adult blister beetles using gloves/ insect-nets and drop them into a container of soapy water. Picking is easiest in the morning when the beetles are sluggish.
- In mid-summer, cover the plants with garden fabric to prevent beetles from feeding.
- Rogue out the YVMV affected plants, if any, from time to time.
- Destroy affected plant parts as soon as aphid infestation is observed.
- Knock off the aphids from the plants with a strong, steady stream of water.
- Conserve the bio-control agents like spiders, coccinellids, chrysopids, syrphid flies etc. in the field by avoiding the use of chemical pesticides and promoting the use of botanicals like neem oil, neem seed kernel extract, neem extract concentrate and microbials like NPV, *Beauveria bassiana* for effective pest control.
- Augment the bio-control agents like egg parasitoids, *Trichogramma chilonis, Trichogramma achaea, Trichogrammatoidea sp., Telenomus* sp., *Encarsia* spp.; larval parasitoid *Bracon* sp., *Campoletis chlorideae, Chelonus blackburni* and predators like *Chrysopa sp., Coccinella sp.*etc.
- Release *Chrysoperla carnea* (25,000 larvae/ha/release) + Econeem 0.3% (0.5 l/ha) for three times at 15 days interval starting from 45 days after sowing to reduce the population of sucking pests as well as the fruit borers.
- Apply nuclear polyhedrosis virus (NPV) at 3 x 10^{12} POB /ha during evening at 7th and 12th week after sowing for managing *Helicoverpa*.
- Spray *Bt* formulation such as Dipel @ 2 g /l and Azadirachtin 5% @ 400 ml in 500-700 L water/ha for managing borers.
- Reports suggest the use of *Beauveria bassiana* and *Verticillium lecanii* against adults of *M. pustulata* under field conditions (Sahayaraj and Borgio, 2010).

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