

Fall Armyworm, *Spodoptera frugiperda*: Identification, Nature of damage, Biology and their Management

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Introduction

The fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) is an invasive pest species and has become a threat to farmers and Indian Agriculture. It was first detected in the Indian subcontinent in May 2018 on maize crop at the College of Agriculture, Shivamogga, Karnataka. The infestation of this pest has been reported in Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra, Madhya Pradesh, Odisha, West Bengal, Gujarat, Chhattisgarh, Kerala, Rajasthan, Mizoram, Manipur, Nagaland, Tripura, Meghalaya, Arunachal Pradesh and Sikkim at mild to alarming levels in farmer's fields during Kharif 2019. The pest is rapidly spreading in India due to little characteristic behaviour like voraciousness, fast and rapid flying capacity (up to 100 km per night) and more number of alternate hosts for FAW larvae (more than 80 plant species including maize, rice, sorghum, millet, sugarcane, vegetable crops and cotton) etc. The ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru has reported the damage intensity of FAW as 9 - 62% with the yield loss of 34% in Karnataka. FAW is an insect native to tropical and subtropical regions of the America where it primarily attacks maize crop during the autumn months.

Development of IPM package to manage the pest is in infancy in India for want of basic information about this pest. However, it has been effectively managed in North Eastern states like Mizoram, Manipur, Nagaland, Assam, Arunachal Pradesh, Tripura, Sikkim and Meghalaya due to scouting and monitoring at early stage of the crop. To achieve freedom from FAW in other parts of the country, periodical awareness trainings to maize growers and capacity building on early scouting, surveillance and monitoring of FAW incidence to

extension officers and input dealers are highly required. It is observed that FAW is also found in maize growing areas of Rajasthan and cause damage to the crop.

Identification of fall army worm: Male moth has two characteristic markings *viz.*, a fawn coloured spot towards the centre and a white patch at the apical margin of forewing. Forewing of female is dull with faint markings. FAW larvae appear in shades of green, olive, tan and grey with four black spots in each abdominal segment and three creamy yellow lines running down its back. It is easily identified from any other armyworm species by its tail end, where the black spots are bigger and arranged in square pattern on abdominal segment 8 and trapezoid on segment 9. The head has a predominant white, inverted Y-shaped suture between eyes.



Infested crop: It is primarily a pest of maize. If maize is not available it will look for sorghum. If both are not available it will attack other crops belong to poaceae, the family of grasses, such as sugarcane, rice, wheat, ragi, fodder grasses etc. It may attack cotton and vegetables as well, which is not reported yet.

Nature of damage: The larvae can cause severe damage to maize plants, especially when the growing points of young plants are eaten. Early vegetative-stage FAW infestation can cause more leaf damage and yield losses than late vegetative stage infestation. Fortunately, maize plants can significantly recover (compensate) from early growth stage damage on leaves and short duration defoliation. When the FAW population is high on a plant, the adult larvae might occasionally move to the tassel and the ears, reducing the quality of the produce at harvest.



Damaging symptoms of FAW in maize crop

Life cycle: The Fall Armyworm lifecycle includes egg, 6 growth stages of caterpillar development (instars), pupa and moth. Showing where the Fall Armyworm is usually found on maize plants at any given stage.



Eggs



Larva



Pupa



Male



Female

Life stages of fall army worm

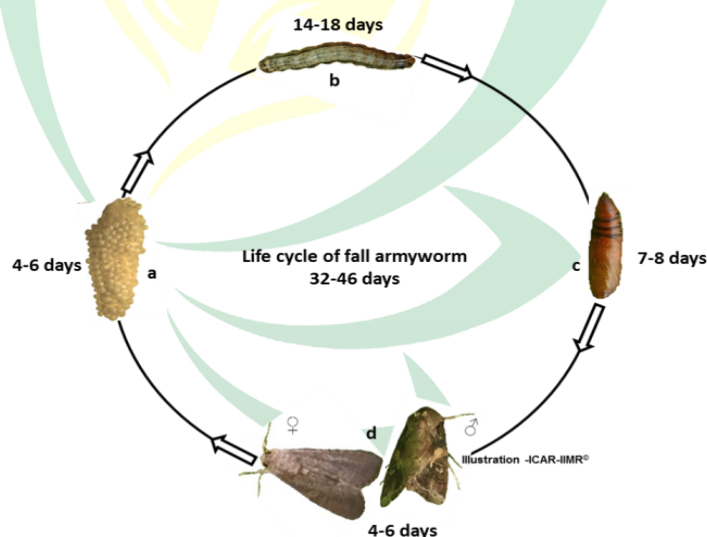
Egg stage: Under warm conditions, a female moth can lay 6 to 10 egg masses of 100 to 300 eggs each, giving a maximum of 1500 to 2000 eggs in her lifetime of 2-3 weeks. As for other pests, most eggs will not develop into adults due to mortality in different parts of the lifecycle. Eggs are generally laid on the underside of the leaves typically near the base of the plant, close to the junction of the leaf and the stem. These are covered in protective scales rubbed off from the moths abdomen after laying. When populations are high then the eggs may be laid higher up the plants or on nearby vegetation.

Caterpillar: is the most damage stage, resulting in ragged holes in the leaves. Feeding on young plants can kill the growing point resulting in no new leaves or cobs developing. Often only 1 or 2 caterpillars found in each whorl, as they become cannibalistic when larger and will eat each other to reduce competition for food. Large quantities of frass present. When

this dries it resembles sawdust. If the plant is older and has already developed cobs then the caterpillar will eat its way through the protective leaf bracts into the side of the cob where it begins to feed on the developing kernels. Feeding is more active during the night.

Pupal Stage: The caterpillar will then burrow 2-8 cm into the soil before pupating. The loose silk oval shape cocoon is 20-30 mm in length. If the soil is too hard then the caterpillar will cover itself in leaf debris before pupating.

Adult: The moths have a wingspan of 32 - 40 mm. In the male moth, the forewing generally is shaded grey and brown with triangular white spots at the tip and near the center of the wing. The forewings of females are less distinctly marked, ranging from a uniform greyish brown to a fine mottling of grey and brown. The hind wing is iridescent silver-white with a narrow dark border in both sexes. Adults are nocturnal and are most active during warm, humid evenings. After a pre-oviposition period of three to four days, the female normally deposits most of her eggs during the first four to five days of life, but some oviposition occurs for upto three weeks. Adult longevity varies from 4-7 days. The adult moth can fly upto 500 km before oviposition. The total life cycle completes in about 30-35 days which vary according to climatic conditions.



Management of fall army worm:

(i) Monitoring and Scouting: Installation of pheromone traps @ 5/acre in the current and potential area of spread in crop season and off-season.

Start scouting as soon as maize seedlings emerge

1. At Seedling to early whorl stage (3-4 Weeks after emergence)- Action can be taken if 5% plants are damaged.
2. At Mid whorl to late whorl stage (5-7 weeks after emergence) –Action can be taken if 10 % whorls are freshly damaged in mid whorl stage and 20% whorl damage in late whorl stage.
3. At tasseling and post tasseling (Silking stage) - Do not spray chemical insecticides. Suitable bio-pesticides may be used in the event of ear/cob damage.

(ii) Cultural Control

- Deep ploughing is recommended before sowing. This will expose FAW pupae to the predators.
- Use high quality seed. The seed should germinate well, be disease-free and be of the variety the farmer wants to plant. Good pest management depends on healthy plants.
- Timely and uniform sowing over a large area is advised. Avoid late planting or staggered planting (plots of different ages). When moths are looking for their favorite stage of maize to lay eggs on, if yours is the last-planted plot in an area, it will attract many female moths.
- Intercropping of maize with suitable pulse crops of particular region. (eg. Maize + pigeon pea/ black gram / green gram). Maize mixed in plots with cassava or yams or other crops may be less attractive to female FAW moths. Some plant species repel female FAW moths. This is the basis of the ‘push-pull’ technology including a plant species that ‘pushes’ FAW away from maize and to plants that ‘pull’ them (attract them), where they can be easily controlled.
- Plant diversity can also increase the populations of farmer’s friends – those organisms that are naturally in the environment and can kill a high proportion of FAW eggs and larvae. Predators (ants, earwigs, etc.), parasitoids (wasps that kill FAW), and pathogens (virus, bacteria, fungi, etc. that kill FAW) are in and around farmers’ fields.
- Using different maize varieties and/or intercropping maize with other crops (for instance with cassava, which is not a host plant of the FAW Observe which plants growing near or in your maize fields are attracting natural enemies, and how you can

manage them to reduce FAW populations, without interfering with maize growth. Consider stimulating the growth of “weedy” plants in certain rows in between the crop, or to grow them around the plot.

- Dig trench around the field and fill with water and insecticide to avoid migration of FAW larvae from one to another field
- Erection of bird perches @ 25-50/ha to attract predatory birds during early stage of the crop (upto 30 days).
- Sowing of 3-4 rows of trap crops (e.g. Napier) around maize field and spray with 5% NSKE or azadirachtin 1500 ppm as soon as the trap crop shows symptoms of FAW damage.
- Clean cultivation and balanced use of fertilizers.
- Apply charcoal, soil, ash, local plant extract on the whorl of maize, as an ITK method.
- Cultivation of maize hybrids with tight husk cover will reduce ear damage by FAW.
- Field observations also help farmers to check the overall state of crop development, soil moisture, presence of other pests and diseases.

(iii) Mechanical Control

- Hand picking and destruction of egg masses and neonate larvae in mass by crushing or immersing in kerosined water.
- Application of dry sand into the whorl of affected maize plants soon after observation of FAW incidence in the field.
- Application of sand + lime in 9:1 ratio in whorls in first thirty days of sowing.
- Mass trapping of male moths using FAW specific pheromone traps @ 15/acre.

(iv) Biocontrol:

- *In situ* protection of natural enemies by habitat management: Increase the plant diversity by intercropping with pulses, oil seeds and ornamental flowering plants which can help in build up of natural enemies.
- Augmentative release of egg parasitoid, *Trichogramma pretiosum* or *Telenomus remus* @ 1,50,000 per ha at weekly intervals or based on trap catch of 3 moths/trap.
- Biopesticides: If infestation level is at 5% damage in seedling to early whorl stage and 10% ear damage, then use following entomopathogenic bacteria and fungi, *Metarhizium*

anisopliae, *Metarhizium rileyi* (*Nomuraea rileyi*), *Beauveria bassiana*, *Verticillium lecani* 1×10^8 cfu/g) @ 5g/litre whorl application. Repeat after 10 days if required.

- *Bacillus thuringiensis* v. *kurstaki* formulations @ 2g/l (or) 400g/acre.
- Apply Azadirachtin 0.15 EC @ 10,000 ppm/ 5 ml/l or neem oil @ 5 mL/l as oviposition deterrent after one week of sowing.

(v) Chemical Control

Farmers can take many actions to protect and favour populations of natural enemies in their fields. Measures include avoiding overuse of synthetic insecticides that can have detrimental effects on natural enemies ensuring diverse boundaries around fields including open flowers and shrubs as habitat or food for natural enemies trees or bird perches in or near fields if pesticides are considered necessary, selecting products that are compatible with biological control such as Bt and botanicals based formulations. Chemical control should be considered as the last resort.

1. **Seed treatment:** Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed will be effective for 15-20 days.
2. **First Window (Seedling to early whorl stage):** To control FAW larvae at 5% damage to reduce hatchability of freshly laid eggs, spray 5% NSKE / Azadirachtin 1500 ppm @ 5 ml/l of water.
3. **Second window (mid whorl to late whorl stage):** To manage 2nd and 3rd instars larvae having more than 10% foliar damage the following chemicals may be used upto early tasselling stage: Spinetoram 11.7% SC or Chlorantraniliprole 18.5% SC or Thiamethoxam 12.6% + Lambda cyhalothrin 9.5%.
4. **Poison baiting:** Poison baiting is recommended for late instar larvae of second window. Keep the mixture of 10 kg rice bran + 2 kg jaggery with 2-3 litres of water for 24 hours to ferment. Add 100g thiodicarb just half an hour before application in the field. The bait should be applied into whorl of the plants.
5. **Third Window (8 weeks after emergence to tasseling and post tasseling):** Insecticidal management is not cost effective at this stage. Biopesticides as recommended above are to be applied. Hand picking of the larvae is advisable.

All the sprays should be directed towards whorl and either in the early hours of the day or in the evening time.

Important Considerations for managing FAW

1. Application and timely plant protection measures to avoid spread of the insect from the abandoned crop.
2. Creation of mass awareness among important stake holders through trainings /group discussions/ capacity building.
3. Community based and area-wide approach for implementing management strategies.
4. Monitoring teams should be constituted immediately for visit to different places/ areas.
5. All the sprays should be directed towards whorl either in the early hours of the day or in the evening time.
6. All necessary measures suggested are required to be adopted by states such as Rajasthan, Madhya Pradesh and Uttar Pradesh where the invasion of FAW has occurred first time.
7. Only recommended pesticides should be used for management of pest.
8. Integrated pest management approach is required to be adopted.