



Integrated Management of Maize Fall Armyworm (*Spodoptera frugiperda*) and Sustainable Production

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Abstract

Maize ranks as the third most widely cultivated cereal crop globally, following wheat and rice, and is often referred to as the 'Queen of Cereals' due to its high productivity. In India, maize cultivation is currently under serious threat from the fall armyworm (*Spodoptera frugiperda*), a highly destructive insect pest. First reported in Karnataka Shivamogga District in May 2018, the pest has since spread rapidly across the country. Sustainable management of fall armyworm cannot be achieved through a single control method instead, an integrated approach combining cultural, mechanical, biological, and a need-based chemical measure is essential.

Introduction

Maize (*Zea mays*), a staple cereal crop originating from Central America, belongs to the grass family Poaceae. Globally, it is the third most cultivated crop after wheat and rice, earning the title "Queen of Cereals" due to its high productivity and versatility. In India, maize ranks third among cereal crops in terms of both cultivated area and production. Nutritionally, maize is rich in carbohydrates (72%) and also provides quality protein (10%), dietary fibre

(8.5%), oil (4.5%), sugar (3%), and ash (1.7%) (Narayan, 2018). In India, maize cultivation is currently facing a serious challenge due to infestations by the fall armyworm, a highly destructive insect pest. The, *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae), is native to the Americas and has rapidly established itself as a highly destructive polyphagous pest in Africa and Asia. Since its first detection in Africa in early 2016 (Pehlivan and Atakan, 2022), FAW moths have been reported to fly up to 100 km per night, facilitating rapid spread across regions. It was first reported in India from Karnataka on maize and also recorded in Nepal on 9th May 2019 from the Nawalparasi district. The fall armyworm has caused extensive damage to crops, threatening food security and undermining the livelihoods of millions of smallholder farmers. Research indicates that FAW feeds on more than 350 plant species, with a strong preference for members of the Poaceae, Asteraceae, and Fabaceae families. Hence, the current situation necessitates the adoption of sustainable and eco-friendly management strategies for the effective control of Fall Armyworm. These strategies should integrate cultural, biological, and need-based chemical approaches to minimize crop losses

and promote environmentally safe maize production systems.

Distribution

Fall armyworm infestations have been observed at varying intensities, ranging from mild to severe, across farmers fields in Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra, Madhya Pradesh, Odisha, Bihar, West Bengal, Gujarat, Chhattisgarh, and Kerala.

Host range

Crops affected by fall armyworm include major staples such as maize, sorghum, and rice, along with other economically important crops like cotton, sugarcane, cabbage, okra, beet, groundnut, soybean, alfalfa, onion, pearl millet, tomato, potato, and various pasture grasses (Ahissou *et al.*, 2021).

Biology

The fall armyworm undergoes a complete life cycle consisting of four stages: egg, larva, pupa, and adult. Under summer conditions with average daily temperatures around 28 °C, the cycle is completed in approximately 30 days. In cooler climates, however, development may extend to 60-90 days, while at 27 °C it typically lasts 27-32 days. In newly invaded regions, the first generation originates from external populations. Depending on climate, the pest can produce 4-6 generations annually in warmer areas, whereas in colder regions it is limited to about 2 generations. The life cycle stages are:

Egg: Adult female moths typically deposit their eggs at night underside of leaves, with clusters averaging 100-200 eggs. A single female can produce around 1500 eggs, with maximum counts exceeding 2,000. The eggs are dome

shaped, measuring approximately 0.4 mm in diameter and 0.3 mm in height. Initially golden in colour, they darken to black as they mature. The egg stage lasts only 2-3 days during summer conditions.

Larvae: *Spodoptera frugiperda* larvae are distinguished by a Y-shaped white stripe on the head and four prominent black spots arranged in a square on the last abdominal segment. They also display three tallow longitudinal stripes running along the upper body, parallel to the head. The larval stage typically lasts 14-18 days, depending on diet and temperature, with optimal development occurring between 20-30 °C.

Pupa: The pupa is typically reddish-brown in colour. The duration of the pupal stage varies with weather conditions, it generally last 20-30 days during winter, while in summer it is completed in about 8-9 days (CABI, 2019). Larvae aged 14-18 days transition into the pupal stage as part of their development cycle. Pupation takes place soil.

Adult: Fall Armyworm adult is a medium-sized nocturnal moth showing dimorphism. Males have grey-brown forewings with distinct triangular and circular spots, whereas females possess uniformly greyish-brown mottled forewings. Hind wings are silvery white with a narrow dark border in both sexes. Adult life span is about 7-21 days. The adult moth measures approximately 1.6 cm length. The moth can have multiple generations per year.

The extent of crop damage caused by fall armyworm varies across regions, with some farmers reporting losses exceeding 80% in severe infestations. In Nepal, the pest has the potential to reduce maize yields by 20-25%. A single generation of fall armyworm can disperse

up to 500 km from its point of emergence. It is recognized as a major insect pest of maize in tropical regions.

Feeding damage:

The larval stage is the most destructive phase of the fall armyworm. Newly hatched feed by scraping the green tissue of maize leaves, while mature larvae consume large amounts of foliage, creating a “window-pane” effect on leaves during early growth. As they develop, the larvae move to neighboring plants using self-spun silk threads carried by the wind. Feeding damage progresses from small scratches to ragged, elongated holes, giving leaves a shredded appearance. In cases of severe infestation, maize leaves often appear as though they have been damaged by hail. Severe infestation can result in significant yield losses and even complete crop failure if not managed timely.

Management of *Spodoptera frugiperda*

Cultural control

- Deep summer ploughing to expose the pupa of FAM to natural predators and sun light.
- Clean and free cultivations to destroy the alternate host plants.
- Intercropping of maize with suitable legume or pulse crops. (Eg. Maize + cowpea/ground nut/ green gram/ pigeon pea/ black gram). Incidence of FAW was less in intercropping system than the sole crops.
- To eliminate alternate host, maintain a weed free environment and apply fertilizers in a balanced way.

- Timely sowing maintenance of optimum plant population.
- Set up bird perches in the field to attract insect eating birds, which help control fall armyworm by feeding on both larvae and adults insects.

Mechanical control

- Hand picking and destruction of egg masses and neonate larvae in mass by crushing or immersing in kerosene water.
- In traditional practice, small scale farmers in Africa apply soil and ash to leaf whorls to manage the pest.
- Use of pitfall traps, sticky traps, light traps (2 traps /ha.) or pheromone traps (15 traps /ha.) install.
- Application of dry sand in to the whorls of afflicted maize plants shortly after detection of FAM incidence in the field.

Biological control

Conserve natural enemies such as:

- *Trichogramma pretiosum* @ 50,000 per acre release of egg parasitoids.
- *Telenomus remus* @ 50,000 per acre at weekly intervals.
- *Chelonus insularis*

Spray microbial pesticides:

- *Bacillus thuringiensis* (Bt) @ 2g/l or 400g/acre.
- *Beauveria bassiana*

- *Metarhizium anisopliae*
- Ground beetles, striped earwig (*Labidura riparia*), spined soldier bug (*Podisus maculiventris*) and insidious flower bug (*Orius insidiosus*) are the predators which are attacks on eggs and larvae of fall armyworm.

Chemical control

- Poison baiting: This method is recommended for late instar larvae during the second window. Mix 10 kg rice bran with 2 kg jaggery and 2-3 litres of water, then allow it to ferment for 24 hours. Add 100 g of Thiodicarb half an hour before field application. Apply the prepared bait directly into the plant whorls.
- Seed treatments: Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed will be effective for 15-20 days.
- Spray the following insecticides as recommended: Azadirachtin 1% EC at 2 ml per litre of water; Emamectin benzoate 5% SG at 0.5 g per litre of water; Chlorpyrifos 50% + Cypermethrin 5% EC at 2 ml per litre of water; Lambda-cyhalothrin 5% EC at 2 ml per litre of water, Azadirachtin at 2 ml per litre of water, Chlorantraniliprole at 0.4 ml per litre of water and Spinetoram at 0.4 ml per litre of water (Badhai *et al.*, 2020).

Conclusion

Fall armyworm (*Spodoptera frugiperda*) has become a major threat to maize production due to its high reproductive potential, wide host

range, and severe feeding damage. Effective management of this pest requires an integrated approach combining cultural, mechanical, biological, and judicious chemical control measures. Regular field monitoring, conservation of natural enemies, adoption of eco-friendly practices and timely interventions can significantly reduce pest infestation and crop losses. The implementation of Integrated Pest Management (IPM) strategies not only ensures effective suppression of fall armyworm populations but also promotes sustainable maize production, environmental safety, and improved farm profitability.

Reference

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