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Integrated Management of Fall Armyworm In Maize Crop

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Introduction :

In India, maize (*Zea mays* L.) is third important crop after rice and wheat that provides food, feed and fodder and serves as source of basic raw material for the number of industrial products, viz., starch, oil, protein, alcoholic beverages, food, sweeteners, cosmetics, bio-fuel, etc. Thus, Maize has attained an important position as industrial crop because 83% of its products are used in starch and feed industries. Andhra Pradesh, Karnataka, Bihar, Maharashtra, Rajasthan, Madhya Pradesh and Uttar Pradesh are the major maize producing states of India.

A new American fall armyworm outbreak is being detected in the maize crop. The fall armyworm (FAW), an invasive pest has become a threat to farmers and Indian Agriculture and first detected on the Indian subcontinent in May 2018 in maize fields at the College of Agriculture, Shivamogga, Karnataka.

Scientific name of American fall armyworm is *Spodoptera frugiperda* (Smith) (Noctuidae : Lepidoptera). FAW is an insect native to tropical and subtropical regions of the Americas where they primarily attacked maize crops during the autumn months. The early emergence in crop life cycle, voracious feeding habit, large-scale aggressive behaviour, high fecundity, fast migration, wide host-range and irreparable nature of crop damage make FAW as a key pest on maize. Details of the pest FAW have been discussed below.

Life stages of FAW :

The life cycle FAW is completed in about 30 days during the summer, but 60 days in the spring and autumn, and 80 to 90 days during the winter. The ability to diapause is not present in this species.

Egg :

- The egg is dome shaped; the base is flattened and the egg curves upward to a broadly rounded point at the apex. The number of eggs per mass varies considerably but is often 100 to 200, and total egg production per female averages about 1500 with a maximum of over 2000.
- The eggs are sometimes deposited in layers, but most eggs are spread over a single layer attached to foliage.
- The female also deposits a layer of greyish scales between the eggs and over the egg mass, imparting a furry or mouldy appearance. Duration of the egg stage is only two to three days during the summer months.

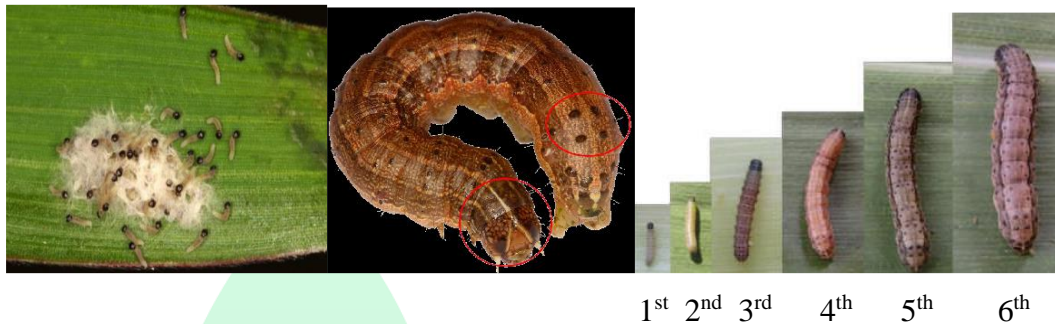


Fall Armyworm Egg masses

Larva :

- There are six instars in fall armyworm.
- Young larvae are greenish with a black head, the head turning orangish in the second instar.
- In the third instar, the dorsal surface of the body becomes brownish, and lateral white lines begin to form.
- In the fourth to the sixth instars the head is reddish brown, mottled with white, and the brownish body bears white sub-dorsal and lateral lines.
- Elevated spots occur dorsally on the body; they are usually dark in colour, and bear spines.
- The presence of four black spots arranged in square shape on dorsal aspect of the penultimate abdominal segment is another important mark to differentiate it from other cutworms.

- The face of the mature larva is also marked with a white inverted "Y". Duration of the larval stage tends to be about 14 days during the summer and 30 days during cool weather.



Instars of Fall Armyworm

Pupa :

- Pupation normally takes place in the soil, at a depth 2 to 8 cm.
- The larva constructs a loose cocoon, oval in shape by tying together particles of soil with silk. If the soil is too hard, larvae may web together leaf debris and other material to form a cocoon on the soil surface.
- The pupa is reddish brown in colour.
- Duration of the pupal stage is about eight to nine days during the summer, but reaches 20 to 30 days during the winter.



Fall Armyworm pupa

Adult :

- In the male moth, the forewing generally is shaded grey and brown, with triangular white spots at the tip and near the centre 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 preoviposition 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 up to three weeks.
- Duration of adult life is estimated to average about 10 days, with a range of about seven to 21 days.



Male

Female

Fall Armyworm Adults

Marks of Identification :

- The eggs are semi-spherical and lay 100 to 200 eggs in a cluster on a leaf. A female can lay an average of 1500 and a maximum of 2000 eggs. The egg clusters are hairy and covered with grey/brownish buff or soft hair. Incubation period is only 2 to 3 days in summer.
- A fully grown larvae has a whitish inverted 'Y' shaped mark on its mouth. On the eighth segment of the abdomen there are four dark or light-coloured puffy round spots in a square. During the day, the larvae hide. The larval stage lasts 14 days in summer and up to 30 days in winter or cold weather.
- The larvae form a loose cocoon around itself by combining ovules, soil particles and silk threads.
- **Adults :**
 - Males have greyish and brownish tinges on the forewings with triangular white spots at the tips and near the middle. The front wings in the female are less

marked than in the male. It is a uniform grey brown colour with grey and brown spots. Both hind wings are elegant silvery white with a dark border. Adults are nocturnal and are most active in hot and humid environments.

- Females are usually the majority of eggs are laid during the first four to five days. The moth stage lasts an average of 10 days and can range from 7 to 21 days.

Nature and symptom of damage :

- Young larvae initially consume leaf tissue from one side, leaving the opposite epidermal layer intact.
- By the second or third instar, larvae begin to make holes in leaves, and eat from the edge of the leaves inward.
- Feeding in the whorl of corn often produces a characteristic row of perforations in the leaves (shot holes).
- Larval densities are usually reduced to one to two per plant when larvae feed in close proximity to one another, due to cannibalistic behaviour.
- Older larvae cause extensive defoliation, often leaving only the ribs and stalks of maize plants, or a ragged, torn appearance.
- The early whorl stage is least sensitive to injury, the mid-whorl stage intermediate, and the late whorl stage is most sensitive to injury.
- The mean densities of 0.2 to 0.8 larvae per plant during the late whorl stage could reduce yield by 5 to 20 percent.
- Larvae also will burrow into the growing point (bud, whorl, *etc.*), destroying the growth potential of plants, or clipping the leaves.
- In maize, they sometimes burrow into the ear, feeding on kernels.
- The FAW feeds by burrowing through the husk on the side of the ear.



Cob Damage



Scrapping



Shot Whole



Whorl Damage



Stem Damage

Cob tip Damage

Favourable climate conditions for development :

- More cloud cover, coupled with low temperature and high rainfall favour the rapid increase of population of FAW to an outbreak.

Host range :

- This insect is omnivorous.
- In addition to maize (major host), FAW can eat more than 80 plant species.
- But grasses are the favourite food of this insect.
- This pest is mostly found feeding on maize, sweet corn, sorghum.
- Commonly infests grass, sorghum, cotton, wild fenugreek, maize, oat, millet, pea, paddy, sorghum, sugar beet, Sudan grass, soybean, sugarcane, tobacco and wheat.
- Among vegetables only aphids are regularly affected. But among other vegetables, fruit crops, grape, orange, papaya, peach, strawberry and other flowers are sometimes damaged.

Damage potential :

- Fall armyworm has caused extensive damage to crops, especially maize, which is very critical for the animal feed industry and also crops such as sugarcane and millets.
- Consequently, India is forced to import maize for feed and starch industries, which together consume nearly 80 percent of the domestic production.
- Due to the FAW infestation and unfavourable weather, maize production fell by about 15-20 percent during 2018. As a result, prices have shot up turning the economics of the fast-growing feed industry unviable.
- This pest can cause substantial harm to the harvest and eventually, profitability of the farmers. Ultimately, rise in raw material prices will push the prices of meat, egg and milk up and will negatively impact the consumers.



Ragged appearance of maize leaves



Fall Armyworm damaged corn

Economic threshold :

- On maize, if 5% of seedlings are cut or 20% of whorls of small plants (during the first 30 days) are infested, it is recommended that an insecticide be applied. In sorghum, the pest threshold level is as one (or two) larvae per leaf whorl and two per head.

Integrated Management of FAW in Maize :

- Deep ploughing of soil should be done.
- Egg masses and larvae should be removed by hand.
- Spray 5 % NSKE.
- Installation of pheromone traps @ 5/ha in the current and potential area of spread in crop season and off-season.
- Natural enemies of this insect like parasitic insects (*Trichogramma*, *Tillenomus*, *Chilonus*) and predatory insects should be conserved.
- Biopesticides like *Bt* (*Bacillus thuringiensis*), *Nomuria relay* should be sprayed.
- Light traps and pheromone traps for moth surveillance should be used.
- Pheromone traps should be placed at the height of the crop circle preferably at the stage of pod bearing.
- The eggs of insect parasites like, *Trichogramma species*, *Telenemus remus* should be released @ 50 thousand eggs per acre. Then 4 to 5 days, don't spray chemical insecticide until daylight.
- Early maturing varieties should be selected and sown early and adopted at village or district level.
- Timely harvesting of the crop that helps to avoid large number of infestations later in the season.
- Select resistant varieties of sweet corn.
- Chemical pesticides should be used as recommended.
- The following insecticides have been provisionally recommended for this pest by the

Central Insecticide Board, Faridabad. (Ad-hoc approval for Fall Army Worm),

1. Chlorantreniliprole 9.3 % + Lambda Cyhalothran 4.6% @ 250 ml per ha.
2. Spinotorum 11.7 % @ 256 ml per ha
3. Chlorantreniliprole 18.5% @ 216 ml per ha
4. Emamectin benzoate 5% @ 4000 g per ha
5. Thidicarb 75% @ 1000 g per ha
6. Novelurone 5.25% + Emamectin Benzoate 0.9% Yes @ 567 ml per hectare
7. Biological fungicides *Metarhizium anisoplii*, *Beveria bassiana*, *Verticillium lecani* 1x10⁸ CFU per gram 5 gm per litre should be sprayed in maize pods.

Conclusion :

The fall armyworm incidence was first reported in Karnataka state on maize during 2018, thereafter it spread all over southern states except Telangana in a short span of time. Since it is an invasive pest in India, identification of the pest seemed to be difficult due to lack of reference materials or type specimens. The pest is rapidly spreading in India due to few characteristic behaviours like voraciousness, fast and rapid flying capacity, more 80 alternate hosts etc. Development of IPM to manage the pest is in infancy in India for want of basic information about this pest. The infestation of FAW has been reported during kharif 2019 in Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Rajasthan, Madhya Pradesh, Uttar Pradesh and Bihar. To achieve such freedom from FAW in country, periodical awareness training to maize growers and capacity building on early scouting, surveillance and monitoring of FAW incidence to extension officers and input dealers are highly required.

Reference :

- <https://nibsm.icar.gov.in/images/Technical-Bulletin-Integrated-Management-of-Fall-Armyworm-in-Maize.pdf>