

DOI: 10.55278/VKNO7046

Armoring maize from invasive fall armyworm

R. Beulah Bhakiya Sherlin, N. Balakrisnan and G. Ravi

Department of Agricultural Entomology, Agricultural College and Research Institute,
Killikulam, Tuticorin (628252, India)

* Corresponding author: sherlinento@gmail.com

Introduction

In India the invasive pest, maize fall armyworm (FAW) (*Spodoptera frugiperda* J. E. Smith; Noctuidae, Lepidoptera) was first recorded in May 2018 (Sharanabasappa *et al.*, 2018). It is the second most destructive agricultural pest, native to tropical and subtropical America (CABI, 2018). Due to its migratory behavior, high dispersal capacity and fast multiplication rate the pest spread quickly to many countries worldwide. The insect is capable of migrating 500 km to 1,000 km during its lifetime. Fall armyworm is a polyphagous pest, It is reported on 353 host plant that belongs to 76 plant families (Montezano *et al.*, 2018). Among them, maize is highly favorite host plant. Fall armyworm attacks the maize crop from the first week of germination till maturity and causes severe damage throughout the year. In maize it causes 70-100% yield loss (Acharya *et al.*, 2020). It also causes economic damage in other cereals and millets.

Life cycle

The life cycle (30 days) of the fall armyworm is mostly influenced by climatic

factors. In hot climatic condition fall army worm undergoes 12 generation per year. Its life cycle comprises of eggs, larvae, pupae, and adult stages. Images of several life stages of FAW were collected from mass culture in our laboratory, AC&RI, Killikulam. As an egg laying substrate, nerium plants were used. The institute is located at an altitude of 40 metres above mean sea level, at 8° 46' North Latitude and 77° 42' East Latitude, in the Semi-Arid Tropics, with mean temperatures ranging from 21 to 37 degrees Celsius and an annual rainfall of 786 mm.

Egg

The female moth often deposits her egg masses on the under surface of the two to third leaves of seedlings or inner side of the tender central whorl. It lays egg masses in a single layer or a few layers (2-3 layers) and then covers them with scales. A single egg mass includes 100- 200 eggs. A female lays 1500 to 2000 eggs in her lifetime. The egg period lasts between 2 to 3 days.



Egg mass covered with scales



Egg mass



Eggs ready to hatch



Neonate emergence



Larva (Caterpillar)

The larval stage is the destructive stage on crop plants. After the egg hatches, masses of neonate start to disperse on leaf surface. The neonate used to be white in colour with black head. There are six larval instars. The larval group spread to the surrounding plants by hanging off from the silken thread secreted by them, due to ballooning effect caused by wind force larvae carried over to numerous plants from a single egg mass. Cannibalistic behavior has been documented from third instar, therefore from the third instar onwards each

plant occupied by single larva rarely we can observe two larvae at different region of the same plant. The FAW larva can be easily identified by its morphological features such as 'Y' shape inverted pale marking on its head. On every segment of the larval body, there is a symmetrical distribution of dark black colour raised dots (2 dorsal pairs and lateral pairs). Each spot consist of single hair. The terminal segment has four dark dots that are distributed evenly and in a square form. The larval body has longitudinal pale and dark bands on the dorsal and lateral sides. Larval period is for 14 to 22 days.



First instar



Second instar



Third instar



Fourth instar



Fifth instar



Sixth instar

Larval stages

Pupa

The mature larvae forms earthen cocoon inside the soil at a depth of 2 to 8 cm. Sometimes it pupates within the plant itself. Pupa is reddish brown in color. The pupa measures 2-3 cm in length and 4.5 mm in width. During the summer, the pupal stage lasts for 7 to 13 days.















Adult

Similar to other noctuid moths it possess scaly wings with variegated colours such as black, light to dark brown, grey and straw colour. The forewing of male moth has different markings. The terminal end of the wing contains white inverted triangular marking. At one third portion of the forewing from thorax has golden yellow colour oval/kidney shape marking. The female moths forewing is uniformly grey in colour. Adult moth is nocturnal, hiding under vegetation or inner side of the leaf whorl during the morning hours. The hind wing of both male and female moths used to be small and silvery in appearance. Female moths begin to lay eggs 3 to 4 days after mating (pre oviposition period). Moths can live for about 7-15 days.

**Male moth****Female moth****Damage symptoms**

- ❖ The first and second instar larvae feed on leaf surface epidermal tissue by scraping chlorophyll and makes the leaf surface papery in nature.
- ❖ The third to six instar larvae are voracious defoliators, they mainly feed and damage the tender developing central whorl and makes small to big size holes, it also feeds on tassel and immature cob.
- ❖ Because of the damage to the unopened whorl, it makes parallel circular window holes and random irregular holes on leaves. The holes expand in size as the plant grows.
- ❖ Heavy whorl damage causes ragged, torn or shredded appearance to newly opened top most leaves.
- ❖ FAW infestation can be easily identifiable by the presence of mass larval dropping on leaf surface and central whorls.
- ❖ During vegetative stage, larvae hide inside the leaf whorl and causes whorl damage. At the time of tassel and cob emergence, larvae hide between stem and leaf base.
- ❖ Fall armyworm damage to tassel has an impact on pollination.
- ❖ Larvae affect the tip and inner side of the cob and feed on developing kernels during milky stage, affecting seed development and reducing crop productivity and nutritional status.
- ❖ FAW infestation on maize cob invites secondary fungus infection, resulting in aflatoxin production, which reduces grain quality and quantity.

		
Leaf chlorophyll scraped by the neonates		Leaf holes
		
Whorl damage	Whorl covered by insect excreta	
		
Shredding of leaves	Tassel damage	Silk damage
		
Cob damage		
Crop damages		

Scouting: ‘W’ pattern of scouting from early seedling stage helps to find FAW

Economical Threshold Limit for FAW damage: 10% whorl and cob damage

Integrated fall armyworm management

The Tamil Nadu Agricultural University has conducted a wide range of research and has recommended the following strategies to control the maize fall armyworm.

- ❖ Deep summer ploughing to expose FAW pupa to predators and to kill by scorching sun.
- ❖ In the last ploughing, apply neem cake at the rate of 100 Kg / acre and plough well for providing pest resistance to plants.
- ❖ Avoid staggered sowing; timely and uniform sowing over large area reduces FAW incidence.
- ❖ Seed treatment: Seed treatment should be done with the mixture of Cyantraniliprol 19.8% and Thiamithoxam 19.8% FS at the rate of 4 ml per kg of maize seed. This will reduce the damage caused by fall armyworm as soon as the crop germinates.
- ❖ In irrigated condition, cowpea, sesame, sunflower and redgram should be cultivated as border crop, grow the fodder sorghum as in case of rainfed maize cultivation. Thus increasing the number of natural enemies.
- ❖ Installing sex pheromone traps at the rate of 5 traps per acre can be used to monitor the movement of fall army worm.
- ❖ Regular hand picking and destroying of FAW egg masses and larvae prevents severe damage.
- ❖ Augmentative release of egg parasitoid *Telenomus remus* @ 50,000 per acre based on pheromone trap catches prevents FAW multiplication.
- ❖ Crop spacing: Irrigated condition- 60x25 cm, Rainfed condition- 45x20 cm.
- ❖ Biopesticide such as *Metarhizium anisopliae*, *Nomuraraea rileyi*, *Beauveria bassiana* and *Bacillus thuringiensis* also controls fall armyworm growth and development.
- ❖ Recommended chemical pesticides only recommended pesticides should be used at the respective time. Doing so may reduce the insect resistance to the pesticides.
- ❖ Recommended insecticides should be sprayed at the recommended rate. The entire whorl region should be sprayed properly.

Crop age	Recommended pesticides	Hand sprayer	Power sprayer	Pesticide Per acre
15-20 Days after emergence	Chlorantraniliprole 18.5 SC	0.4 ml/lit	1.2 ml/lit	80 ml/acre
	Flubendiamide 480 SC	0.5 ml/lit	1.5 ml/lit	100 ml/acre
30-35 Days after emergence	Azadirachtin 1500 ppm (If necessary, when FAW damage crosses the ETL 10% level)	5 ml/lit	15 ml/lit	1 lit/acre
40-45 Days after emergence	Emamectin benzoate 5 SG	0.4 g/lit	1.2 g/lit	80 g/acre
	Spinetoram 11.7 SC	0.5 ml/lit	1.5 ml/lit	100 ml/acre
	Novaluraon 10 EC	1 ml/lit	3 ml/lit	200 ml/acre

❖ 60 DAE: Any one of the insecticides which is not sprayed previously, Emamectin benzoate 5 SG @ 0.4 g/lit or Spinetoram

11.7 SC @ 0.5 ml/lit or Novaluraon 10 EC @ 1ml /lit



Telenomus remus - egg parasite



FAW egg mass parasitized by *Telenomus remus*



Pulses as border crop



Pheromone trap

Fall armyworm naturally infected by some beneficial microbes



Bt infected FAW larva

Metarhizium infected FAW larva

Fungus infected FAW egg mass

Note: Field photos were taken from AC&RI, Killikulam research plot.

Acknowledgements:

We would like to acknowledge Government of Tamil Nadu -Sponsored Research Scheme on “Developing Integrated Pest Management Module for Maize Fall Armyworm and validation under Area wide Integrated Pest Management (AWIPM) through Farmer Participatory Approach in Tamil Nadu” (F36OT) for providing us this opportunity to work and gain knowledge about this invasive pest.

References

- Acharya, S., Kaphle, S., Upadhyay, J., Pokhrel A. and Paudel, S. 2020. Damaging Nature of Fall Armyworm and Its Management Practices In Maize: A Review. *Tropical Agrobiodiversity (TRAB)*. 1(2): 82-85.
- CABI. 2018. Invasives species compendium. URL: www.cabi.org/isc/fallarmyworm [accessed 2018 Aug 15].
- Montezano, D.G., Specht, A., Sosa-Gómez, D.R., Roque-Specht, V.F., Sousa-Silva, J.C., Paula-Moraes, S.V., Peterson, J.A. and Hunt, T.E. 2018. Host plants of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in the Americas. *African Entomology*, 26, 286–301.
- Sharanabasappa, Kalleshwaraswamy, C.M., Maruthi, M.S. and Pavithra, H.B. 2018. Biology of invasive fall army worm *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae) on maize. *Indian journal of entomology*. 80(3): 540-543.

MS Received 16 April 2022

MS Accepted 29 April 2022