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# Fall armyworm (*Spodoptera frugiperda*) attack on maize crop in India: A review

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**Abstract**
Fall armyworm (FAW) (*Spodoptera frugiperda*) it is a polyphagous pest with more than 80 species which cause severe damage to different crops. In late 2016, FAW was reported in West Africa for the first time. The larval stage is the most harmful in nature. Both migrate habit and a more localized dispersal habit are performed by the moths. FAW can migrate over 500 km (300 miles) before oviposition which can leads to greater spread and damage in less time. 30% to over 50% yield loss is recorded. The cultural method is most effective, use of methods like hand picking, pheromone traps, light traps etc., Could measures to monitor and control pest. Chemicals and bio control agents also gives good results in field. Integrated pest management is best way of management strategy of fall armyworm.

**Keywords:** *Spodoptera frugiperda*, damage, mechanical, traps, bio control agents

## Introduction
Fall armyworm (FAW) (*Spodoptera frugiperda*) (J.E. Smith) is one of the destructive or damaging insect pest belonging to order Lepidoptera and falls in the family Noctuidae. It Feeds on many different kinds of plants (Baudron *et al*., 2019) [3] with more than 80 species which cause severe damage to different crops. Cereals and fodder grasses are majorly damaged by FAW (IPPC, 2017) [23]. The FAW feeds on leaves, stem and reproductive parts of plant species. Young leaf whorls, ears and tassels are believed as major feed causing significant damage to maize, which results in total yield loss (De Almeida Sarmento *et al*., 2002) [8]. Symptoms start in larval stage by making different sizes of papery windows in leaves which leads to huge defoliation, occurrence of fecal matter and in later stage growth and development of plants is affected. (Reddy, 2019). FAW can migrate over 500 to 550 km before oviposition (Prasanna *et al*., 2018) [7].
In the year 2017-18 FAW was first emerged in Indian subcontinent (Ganiger *et al*., 2018 IITA; Sharanabasappa Kalleshwaraswamy *et al*., 2018) [15, 29, 30] in Karnataka (ICAR-NBAIR, 2018a) [19] and Andhra Pradesh (EPPO, 2018). The pest has been stated in Bihar, Chhattisgarh, Gujarat, Maharashtra, Odisha, Tamil Nadu, Telangana and West Bengal (ICAR-NBAIR, 2018b) [20] (EPPO, 2019). 10772 hectares of maize crop has been affected completely by FAW. The pest has been found from 20 states in India. A tracking tool for fall armyworm has been developed by PEAT, CABI and ICRISAT, CIMMYT.

## Favorable conditions to spread
High humidity and moderately high temperature are more suitable for spread of FAW. Its metabolic rate is well supported in these conditions, sometimes it leads to "intensification of infestation". It means in shorter period of time the pest is able to complete its life cycle resulting in more pests, more quickly.

**Table 1:** Classification (TR *et al.* 1979) [2]

| | |
|---|---|
| Kingdom | Animalia |
| Phylum | Arthropoda |
| Subphylum | Hexapoda |
| Class | Insecta |
| Subclass | Pterygota |
| Order | Lepidoptera |
| Family | Noctuidae |
| Subfamily | Noctuidae |
| Genus | Spodoptera |
| Species | Frugiperda |

**Life cycle**
The *Spodoptera frugiperda* (J.E. Smith) life cycle lasts for 60-65 days during the spring and autumn spells; during the winter, these caterpillar life cycle lasts about 80 to 90 days and less than 30 days span during summer. Based on climate and temperature the number of generations of a moth will have varies. Female lays typically 1500-1600 eggs in life time and they cannot survive chilly temperatures.

**Egg**
The FAW egg is dome-shaped, and estimate around 0.4 mm in width and 0.3 mm in height (Sharanabasappa *et al*. 2018) [29, 30]. Females prefer to put eggs on the lower side of leaves, if the populace is high, it will lay eggs just about any place. In warm weather, the eggs will hatch into larvae within a few days (CABI, 2017b) [6].

**Larva**
Varying on temperatures the larvae go through six kinds instars each varies marginally in physical form and pattern. The process of larva lasts from 15 to 30 days. The adult caterpillar is about 1.5–2 inches (38–51 mm) in length (Luginbill 1928, Hogg *et al*. 1982) [17]. It is terribly detrimental stage in life cycle as it has biting mouth parts. Y shaped suture on the forehead (Prasanna *et al*. 2018) [7] of larvae.

**Pupa**
The pupation takes place in the soil. If the soil is hard then larvae may web together leaf debris and other material to form a cocoon on the soil surface (Capinera, 2000) [5]. Duration and survival of the pupal stage depend on the temperature of the native environment (CABI, 2017b) [6].

**Adults**
Adults are active at night and fare best during warm and humid evenings (CABI, 2017b) [6]. They live for about 10 days, and sometimes up to 21 days (Shranabasappa *et al*., 2018). Female lays most of eggs in early stage of life cycle.

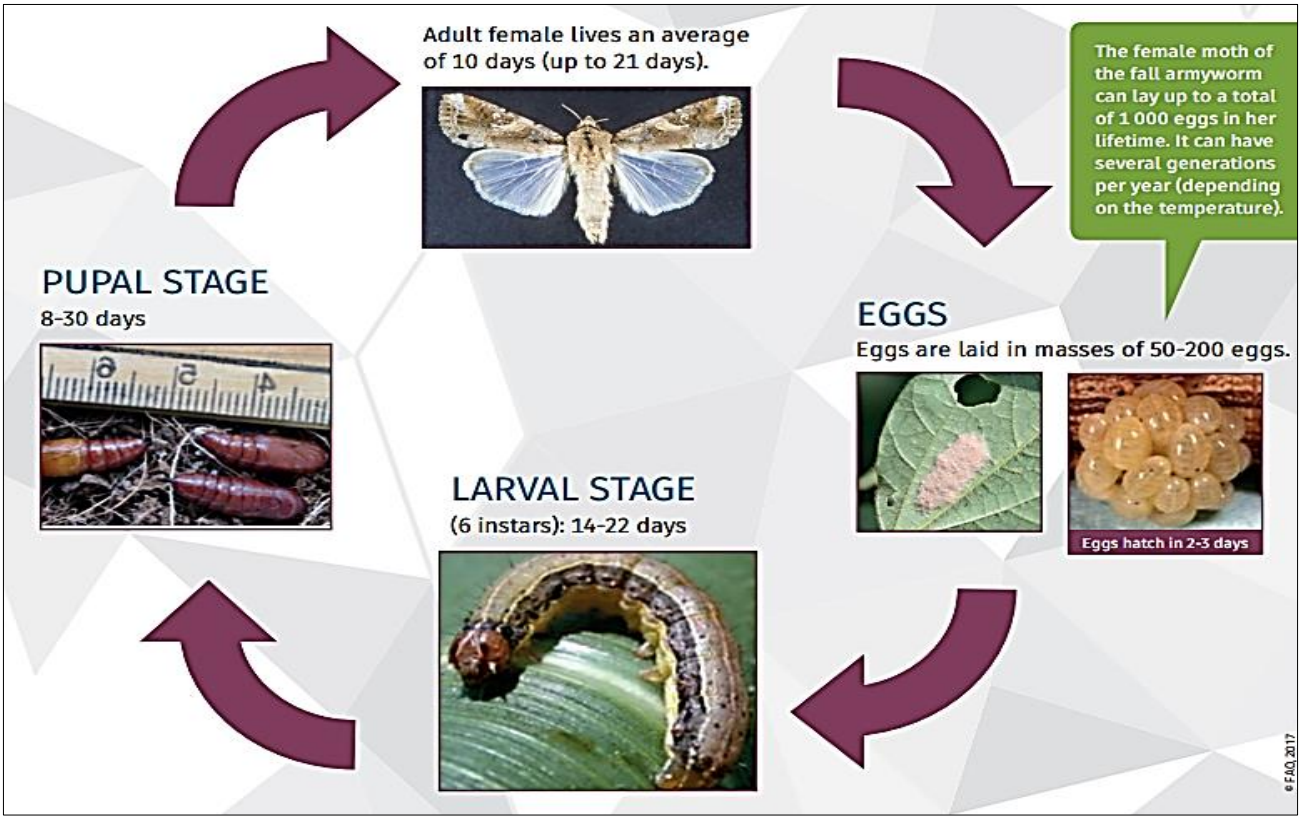


**Fig 1:** Life-cycle of fall armyworm (*Spodoptera frugiperda*)

**Control measures for fall armyworm**
The most common management policy for the FAW before they cause damage is key to their management. On maize, if 5-7% of seedling are cut or 20-25% of whorls of small plants are damaged with FAW, it is suggested to apply an effective control measure to prevent further damage (Fernandez, 2002). Different Strategies have been used to control FAW which includes cultural practices, biological control, predators (Pair and Gross, 1986) and pathogens and botanicals (Gross and Gross, 1986).

**Cultural method**
It is most significant method for pest management strategy for FAW. Maize only cropping systems offer a favorable environment for FAW to spread fast. Avoid late planting since the maize ears would be heavily attacked by higher FAW infestation than those of the early plantings.
Use of pheromone trap. Intercropping and crop rotation of maize with non-host crops like sunflower and bean may be helpful to reduce the attack of FAW (FAO, 2018) [9]. Early developing varieties. Deep ploughing helps destroying eggs and establishing bird perches.

**Biological control**
It is an important tool and one of the most important alternative control measures providing environmentally safe and sustainable plant protection. Biological control agents (BCAs) comprise predatory insects that eat their prey,

parasitoids (insects that feeds on other insects) and entomopathogens such as fungi, bacteria, viruses and protozoa, nematodes, that are harmful to FAW (Kumela *et al*., 2018) [27].

- Predators of the FAW can destroy several individuals either as eggs, larvae, pupae and adults. Following are predators for FAW in different life stages that is earwigs, ladybird beetles, ground beetles, assassin and flower bugs, predatory wasps, Spiders, birds and bats are predators of the FAW.
- Parasitoids are organisms whose adults lay eggs on inside or attached to a sole host organism. To enhance development, the subsequent larvae feed on the tissues of the host until they are fully grown and pupate. Parasitoid larvae periodically destroy their host as the outcome of their development. The majority of parasitoids known to be associated with the FAW are wasps, and less frequently flies (Birhanu *et al*., 2018) [4].
- Entomopathogens are pathogens which include bacteria, fungi, viruses and nematodes that influence insects and can control FAW. Viruses like nuclear polyhedrosis virus (NPVs) and *Spodoptera frugiperda* multicapsid nucleopolyhedrovirus (SfMNPV) are injurious to the FAW. Fungi like *Metarhizium anisopliae*, *Metarhizium rileyi* and *Beauveria bassiana* destroys the FAW. In the case of bacteria like *Bacillus thuringiensis* (Bt), found in Bt maize, also destroys the FAW (Agudelo-silva *et al*., 2018; Fuxa, 1982; Gardner and Fuxa, 1980; Molina Ochoa *et al*., 1996; Richter and Fuxa, 1990).

**Chemical control**

Application of synthetic insecticide (Blanco *et al*., 2014, 2010; Hruska and Gould, 1997) [18], but it involves high cost, environment contamination (Togola *et al*., 2018) [31]. It should be based on threshold level. High volume of liquid insecticide is required to obtain adequate penetration and kill larvae feeding deep in the whorl of the plants. In situations where overhead sprinklers are used for irrigation, insecticides can also be applied in the irrigation water (Abraham *et al*., 2017a; Yu *et al*., 2003) [1].

During the vegetative period keep plants away from larvae can help to reduce the number of sprays needed at the silking stage (Foster, 1989) [14]. Hence, spraying should be periodically given during the growing period instead of concentrating at silking period.

**Conclusion**

The fall armyworm (FAW) (*Spodoptera frugiperda*) has recently has been introduced some parts of India and favorable environment for insect helps them to multiply quickly and spread to vast areas. There we should give awareness to farming communities about life cycle and control measures, at the same it is important to introduce, validate, and deploy low cost, environmentally safer, and effective technology to control pest.

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