

Integrated management

strategies of fall armyworm in *rabi* maize

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Maize is the most versatile and widely distributed food crop in the world. Many biotic factors adversely affect the production of maize; in that biotic factor 'Fall Armyworm (FAW)' is the most important factor now days. FAW was first time reported in Chikballapur district of Karnataka during 2018 then spread in the entire Country. FAW scientifically called Spodoptera frugiperda is an insect-pest native to tropical and subtropical regions of America. FAW is one of the most dangerous insect pests of maize. The larvae of FAW are capable of feeding more than 100 plants as maize being the most preferred host. FAW can cause severe yield losses if not well managed. Severe infestation of FAW may cause complete yield loss.

Keywords: Fall armyworm, Integrated pest management, Larvae, Maize

MAIZE (*Zea mays* L.) is the third most important cereal crop next to rice and wheat in India, and an important cereal in the world agricultural economy. It is the most important cereal crops, having the wide distribution and varied uses as food, feed and fodder. In India, ~70% area and ~75% production of maize is confined only in seven states viz. Andhra Pradesh, Karnataka, Rajasthan, Maharashtra, Bihar, Uttar Pradesh and Madhya Pradesh. Globally, maize is known as “queen

of cereals” due to its highest genetic yield potential. Being a potential crop, it is consumed as a source of human food (24%), poultry feed (52%), animal feed (11%), industrial products (12%) and seed (1%). In India, annual production of maize is ~28.7 million tonnes, from 9.47 m ha; with productivity of 3.03 tonnes/ha. FAW, scientifically called *Spodoptera frugiperda* is an insect-pest native to tropical and sub-tropical region of America. FAW is one of the most dangerous insect pests of maize.

This insect was first time reported in Chikballapur district of Karnataka during 2018, then, it spread very fast thought the country. Larvae of FAW can feed on >100 plant spp. with maize being most preferred plant. FAW can cause severe yield losses if not well controlled and may cause complete crop losses (Fig. 1).

Morphology and life cycle of FAW

Female insect lays ~ 50-200 eggs in one time. Eggs of FAW are creamish white or grey in color



Fig.1. Infested maize crop with fall army worm and adult

covered by whitish wool like material and turn brown before hatching. Eggs are laid in clusters (~10 clusters during whole life) on lower, upper sides of leaf, stalk and funnel of maize plant. Young caterpillars are pale colored and they are spin silken threads that they use to move from one plant to another by wind. They become brown to pale green, then to dark at last stages (Fig.2). Larvae stages last 12-21 days depending on surrounding temperature and environmental conditions. The larvae are characterized by 3-yellow stripes on back, followed by a black, then a yellow stripe on side. Head is dark; it shows a typical upside down Y-shaped pale marking on front. Pupa is dark brown and oval in shape found in soil and rarely in maize stalk. Adult moth is 3-4 cm wide. Its front wings are dark brown and rear wings are grey white. It will live 2-3 weeks before dying.

Symptoms and damage of FAW

Small holes and window pane feeding in leaves emerging from whorl are cause by small FAW while large irregular elongated holes on leaves are caused by big FAW. Sawdust like material (frass) in maize funnel or on cob leaves and tassels showing heavily infestation in plant. FAW feeds during day and night, but are usually most active in morning/late afternoon. Larvae will also move to ear as plants start tasseling and young ears become available. Damage to ear may be much more important than leaf damage.

INTEGRATED PEST MANAGEMENT STRATEGIES OF FAW

Integrated Pest Management (IPM) is the backbone of sustainable agriculture. Though, IPM manages natural resources without much troubling the agro-ecosystem, farmer practices for higher income. The need for control is taken into account when 5% of maize plants have egg masses or when 25% maize plants show signs of damage and live larvae are present. For successful pest control, correct timing for the implementation of the management options is very critical, even taking

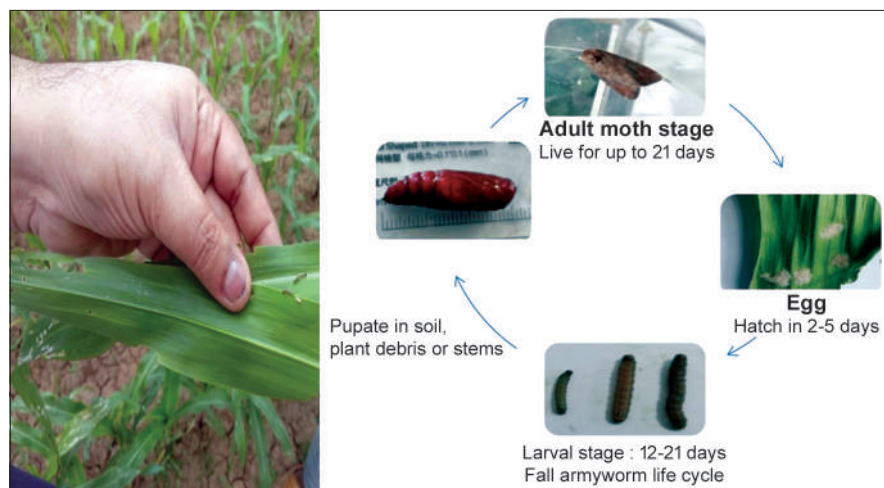


Fig. 2. Life-cycle of fall army worm

into account FAW larval stage period and the time of day for application.

Mechanical and cultural control

Deep burying of crop residues after crop harvesting kills eggs, larvae and pupae. If there is a small number of eggs or larvae, handpick them and crush them. FAW is prey for some birds and insects, so number of these pests that can feed on FAW and help minimize FAW infestation in maize is increased by trees and a variety of crops on the field. The cultural control involves preventing late planting because a higher FAW infestation would strongly assault the maize ears than those of early plantings. In order to mitigate FAW invasion, intercropping and rotating maize with non-host crops i.e. sunflower and bean may also be useful. In case of foliar damage, it can compensate by keeping adequate moisture and nutrition in field.

Plant diversity control

Plant diversity, particularly intercropping, increases population of natural enemies and decreases crop damage. Maize intercropping with pumpkin or beans decreased FAW infestations in maize monocrop compression by ~20 to 30%. In this system, 'push-pull' system uses two kinds of plants: one that releases volatile chemicals that repel pest insects, such as desmodium (push); and other is to plant an attractive trap plant, such as Napier grass (pull), as a border crop around this intercropped area. Moths are pushed away by repellent plant from main crop and

are simultaneously drawn to trap plant. It is found to be effective in reducing FAW infestations and plant damage caused by FAW.

Biological control

Biological management can be considered a strong tool and one of the most effective alternative control measures for protection of plant that environmentally healthy and sustainable. FAW has many 'natural enemies' that arise naturally. These biological control agents are species that feed on FAW, which can be active during all development phases of FAW. There is a possibility for natural enemies to reduce FAW population. The following are biological control agents: predatory insects and mites, which consume their prey. Parasitoids, which are insects with an adult stage of free living and a larval stage of another insect that is parasitic. Bio-pesticide i.e. bacterial group *Bacillus thuringiensis* (Bt), fungi (*Beauveria bassiana*), Baculo-viruses, nematodes and protozoa, which cause lethal infections. FAW predators include earwigs, ground beetles, ladybird beetles, flower bugs, birds, spiders, ants, and bats that kill FAW during growth process of caterpillars, pupae, or adults. Parasitoids are those that lay eggs inside a host organism/attached to it. Parasitoid larvae destroy their hosts. Wasps and flies are the majority of the parasitoids believed to be associated with FAW.

Botanical pesticides

Use of plant-derived pesticides in

the control of pests in maize is a cultural practise. Several plant extracts have been reported to have FAW-insecticidal properties. Neem seed powder has been shown to be effective in destroying FAW larvae, clover plant oils, neem (water neem oil @2.5 ml/l), turmeric, *Eucalyptus urograndis*, *Eucalyptus urograndis*, and *Corymbia citriodora* to help protect maize from FAW larvae. Aqueous *Carica papaya* seed extract for the killing of FAW larvae. For low-cost efficient pest management of FAW, it is important to assess the compatibility of botanical pesticides with other pest management options, i.e. pheromones and entomo-pathogens. In order to achieve successful FAW control, incorporation of botanical pesticides with management options, i.e. push-pull/intercropping; pheromones and chemical pesticides as a last resort, is crucial.

Use of Soil for FAW Control

In infested whorls of maize plants, farmers may place soil through abrasiveness or absorption of wax from insect cuticles, soil can destroy FAW larvae directly, causing water loss from body as a consequence of insect death. There are also a large number of micro-organisms in the soil, some of which can kill FAW larvae.

Pheromone trap

Pheromones are natural compounds released for mating by female FAW moths in order to attract male moths. To attract male moths, synthetic compounds that imitate natural FAW pheromones, also referred to as lures, are put in traps. In traps, rubberized septa containing



Fig. 3. Pheromone trap

the lure of pheromones are kept. The preferred FAW trap is a funnel or bucket (Fig. 3). For effective control of FAW, 12-15 pheromone traps per hectare should be used by a farmer.

Chemical control

If the pest becomes a severe problem and leads to an outbreak, we can even use synthetic insecticides as a last resort. As a result, all of these strategies should be used judiciously and smartly as and when needed, so that a combination of these methods not only decreases pest population to a reasonable level, but also keeps ecosystem and non-target organism's health clean and safe. Carbamate insecticides i.e. Pyrethroid, Cyfluthrin and Methomyl as well as organophosphate insecticides such as methyl parathion, can be used to manage FAW pest. Spraying of Emamectin benzoate 5% SG @ 0.5 g/liters of water, Chlorpyrifos 50% +

Cypermetharin 5% EC @ 2 ml/liters of water, azadirachtin 1% EC @ 2 ml/liters of water, lambdacyhalothrin 5% EC @ 2 ml/liters of water, Azadirachtin @ 2 ml/liter of water, Chloranth. Both sprays should be aimed at whorl and applied early in morning or in evening. Seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed will also be beneficial for 15-20 days.

CONCLUSION

FAW one of the most dangerous insect pest of maize crop now a day. It can cause severe yield losses in maize if not well managed at proper time. Farmer should use IPM practices to save maize crop from FAW damage because IPM controls FAW without much disturbing agro-ecosystem.

Farmer should avoid late sowing/planting of maize because their larvae preferred vegetative stage of crop. Intercropping, bio-pesticide, plant derived pesticides, pheromone-trap and for chemical control; Flubendiamide, Spinosad 45 EC, Etofenprox 10 EC, Azadirachtin 5 SG, Thiobencarb, Chlorpyrifos with cypermethrin and Rogour is very effective to manage FAW. Apart from pesticide sprays, put some sand or soil into plant whorl when whorl is well formed. This will directly harm larvae and increase the effectiveness of pesticides.

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Know Krishi Unnati Yojana

The Krishi Unnati Yojana, a central sector scheme, is envisaged as umbrella programme for focusing on food security, by merging schemes on Soil-health Card, Integrated Scheme on Agricultural Co-operation and Agricultural Marketing, National Mission on Agriculture Extension, Horticulture Development, Price Stabilization Fund, National Mission on Sustainable Agriculture and other programmes.