Fall Armyworm: Diagnosis and Management

(An Extension Pocket Book)

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Preface

The Fall Armyworm (FAW) is the most destructive pest of many economically important crops across the globe. FAW is native to the tropical and subtropical region of America and it has invaded many African countries and caused huge economic losses. FAW has been reported for the first time in India during May 2018 in Karnataka and subsequently it has spread into the 10 Indian states till mid of the March 2019. In northeast India, this invasive pest was reported for the first during late March 2019 in Lunglei district of Mizoram and West Tripura district of Tripura state. Subsequently, it has detected causing massive outbreaks during April in Mizoram state and Nagaland state. Later, it was detected causing damage to maize crop during early May in Meghalaya, Manipur, Sikkim and Arunachal Pradesh states of northeast India.

Considering the invasiveness and spread of FAW, it is essential to prevent its infestation in early stages in the field. In this backdrop, this pocket book is prepared to strengthen the field diagnosis procedure of FAW for the farmers, extension workers, students and other stakeholders etc. Efforts have also been made to provide the information on native bio-control agents and basic management practices to be followed in time.

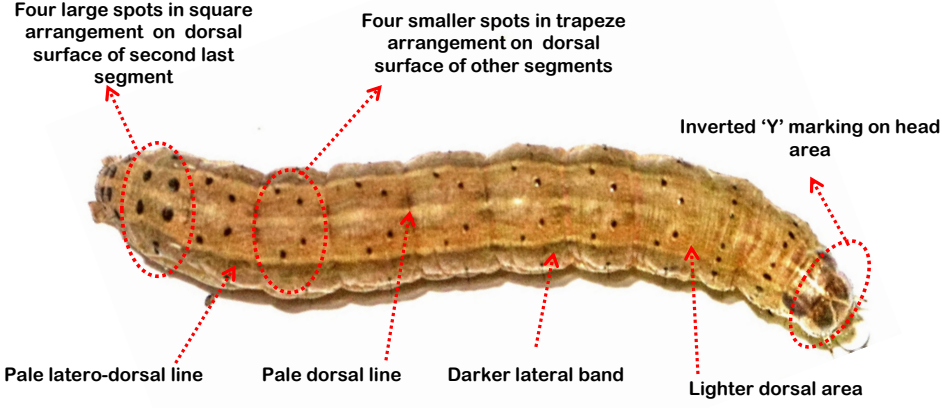
Editors

Content

Introduction

- Scientific name : *Spodoptera frugiperda*
- Order : Lepidoptera
- Family : Noctuidae
- Native to the tropical and subtropical region of America. It has invaded many African and Asian countries and caused huge economic losses.
- Fall Armyworm has infested crops in over 50 countries across two continents in just over two years
- Incidence of FAW reported in **India during May 2018** and the phylogenetic analysis has revealed that Indian Maize FAW clustered with **Florida (rice strain), Ghana, Nigeria, Uganda on maize.**

Detection of Fall Armyworm larva



Appearance of Fall Armyworm Eggs

Egg mass of fall armyworm is difficult to distinguish from other two related worm/ moth species commonly found on maize. Fall armyworm eggs are laid in mass inside the whorls or on undersurface of leaf or on stem. Eggs may be laid on single or multiple layers. Eggs are creamy colored with anal tuft of hairs or sometimes without hair covers

Eggs of fall armyworm
Spodoptera frugiperda

Eggs of Oriental leaf worm
Spodoptera litura

Eggs of Oriental armyworm
Mythimna separata

Appearance of Fall Armyworm larva

How it differs from other related worms feed on maize crops?

Fall armyworm
Spodoptera frugiperda

Oriental leaf worm
Spodoptera litura

Oriental armyworm
Mythimna separata

Fall armyworm adult identification

How it differs from other related worms feed on maize crops?

Fall armyworm (Male)
Spodoptera frugiperda

Oriental leaf worm
Spodoptera litura

Oriental armyworm
Mythimna separata

Life stages of Fall Armyworm

Egg
(Incubation period: 4-6 days)

Caterpillar
(Larval period: 14-17 days)

Pupa
(Pupal period: 7-8 days)

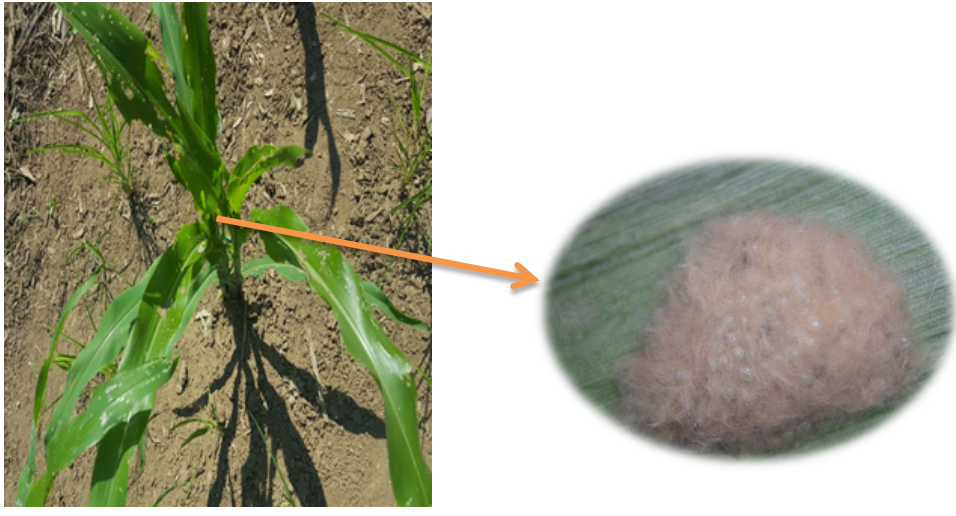
Male moth

Female moth

(Adult longevity: 7-9 days)

Egg mass of Fall Armyworm

Female moth lays more than 1000 eggs in single or in multiple clusters on maize or other host plants



First instar caterpillars of Fall Armyworm

Gregarious larvae feed superficially on one side of leaf (or inside whorls) and spread to new host plant through ballooning mechanism

Initial sign of infestation

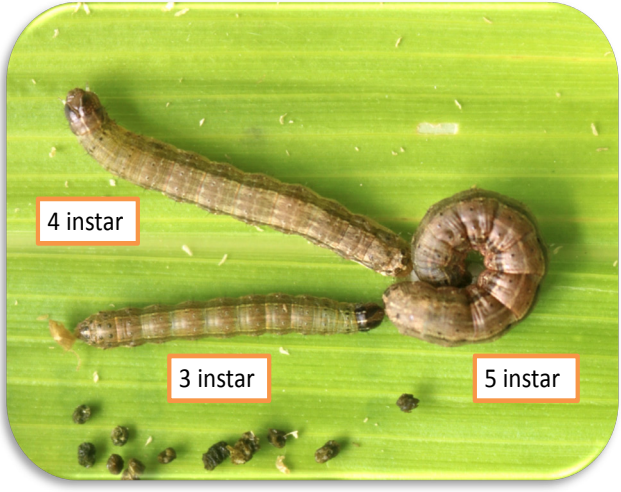
Papery windows on leaf & defoliation

Second instar caterpillars of Fall Armyworm

Feed gregariously in initial phase and make small leaf holes/papery windows

Third, Fourth and Fifth instar caterpillars of Fall Armyworm

Often feed solitarily inside the whorls and cause large holes accompanied by larval droppings (excreta)



Colorations in fall armyworm caterpillars

Caterpillars show different colorations and hide inside the whorls during day time. Saw dust like appearance of dry excrement often seen on leaves, which protect them from natural enemies (by camouflage)

Cannibalism in Fall Armyworm

Caterpillars show high degree of cannibalism. Large larva often eats smaller one, differs them from true armyworm

Mature caterpillars and Pupa of Fall Armyworm

Often hide inside the whorls and drop down to make earthen cocoons inside the soil

Management strategies of Fall Armyworm on Maize

How do we fight it?

A meticulous and step wise plan is needed to prevent outbreaks, further spread and protection of the environment

Management plan suggested by Govt of India

(Ref: OM: F. No. L3-L60/2019-SD.lV, dated 6th May 2019 and OM : F. No 12080/37/2018-PPl, dated 28th May 2019)

Integrated pest management strategies

1. Monitoring
2. Scouting
3. Cultural control
4. Mechanical control
5. Biological control
6. Stage wise options including chemical control

Monitoring

Installation of pheromone traps @ 5/acre in the current and potential area of spread in crop season and off-season.

Scouting

- Start scouting in **'W'** manner as soon as maize seedlings emerge
- **At seedling to early whorl stage** (3-4 weeks after emergence). Action can be taken if 5% plants are damaged.
- **At Mid whorl to late whorl stage** (5-7 weeks after emergence) - Action can be taken if 10% whorls are freshly damaged in mid whorl stage and 20% whorl damage in late whorl stage.
- **At tasseling and post tasseling (Silking stage)-**

  Do not spray insecticides (No insecticide application). But 10% ear damage needs action.


SCOUTING
Pictorial
representation

Cultural Measures

- Deep ploughing is recommended before sowing. This will expose FAW pupae to predators.
- Timely sowing is advised. Avoid staggered sowings.
- Intercropping of maize with suitable pulse crops of particular region. (eg. Maize + pigeon pea/black gram /green gram).
- Erection of bird perches @ 10 /acre during early stage of the crop (up to 30 days)
- Sowing of 3-4 rows of trap crops (eg. Napier) around maize field and spray with 5% NSKE or azadirachtin 1500 ppm as soon as the trap crop shows symptom of FAW damage.
- Clean cultivation and balanced use of fertilizers.
- Cultivation of maize hybrids with tight husk cover will reduce ear damage by FAW.

Mechanical control

- Hand picking and destruction of egg masses and neonate larvae in mass by crushing or immersing in kerosine water.

Mechanical control

- Application of dry sand in to the whorl of affected maize plants soon after observation of FAW incidence in the field.

Mechanical control

Soil application inside the whorls

Mechanical control

Mass trapping of male moths using pheromone traps @15/acre.

Bio-control strategies

In *situ* protection of natural enemies by habitat management: Increase the plant diversity by intercropping with pulses and ornamental flowering plants which help in build-up of natural enemies

Bio-control strategies

Augmentative release of *Trichogramma pretiosum* Or *Telenomus remus* @ 50,000 per acre at weekly intervals or based on trap catch of 3 moths/trap

Bio-control strategies

Biopesticides:

Suitable at 5% damage in seedling to early whorl stage and 10% ear damage with entomopathogenic fungi and bacteria

Entomopathogenic fungal formulations:

- Application of *Metarhizium anisopliae* talc formulation ($1x10^8$ cfu/g) @ 5g/litre whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage

OR

- *Nomuraea rileyi* rice grain formulation ($1x10^8$ cfu/g) @ 3g/litre whorl application at 15-25 days after sowing. Another 1-2 sprays may also be given at an interval of 10 days depending on pest damage

Bio-control strategies

- Application of *Bacillus thuringiensis* var *kurstaki* formulations @ 2g/litre (or) 400g/acre

Healthy pupae of FAW

Infected caterpillars unable to form pupa

Native bio-control agents in agro-ecosystems of Northeast India

Native parasitoids which have potential to reduce invasive fall armyworm population

Grub of Ichneumon wasp

Cotesia spp. cocoons

Parasitized S. *litura* larvae by *Chelonus formosanus*

Metopius rufus

Microplitis manilae

Tachinid parasitoids in agro-ecosystems of Northeast India

Tachina sobria

Cuphocera varia

Turanogonia chinensis

Blepharella spp.

Exorista spp.

Source: ICAR-NEH, NPIB insect collection data

Wasp diversity in agro-ecosystems of Northeast India

Delta pyriforme

Vespa tropica

Dolichovespula media

Polistes olivaceus

Chrysis nitidula

Phimenes flavopictus

Priocnemis bicolor

Chrysis inaequalis

Scolia soror

Priocnemis monachus

Source: ICAR-NEH, NPIB insect collection data

Predatory beetles in agro-ecosystems of Northeast India

Ophionea indica

Cicindela duponti

Cicindela sexpunctata

Source: ICAR-NEH, NPIB insect collection data

Predatory spiders in maize ecosystem of Northeast India

SN	Spider types	Scientific names
A	Jumping spiders	*Marpissa calcuttaensis* *Phidippus* spp
B	Lynx Spiders	*Argiope pulchella* *Oxyopes rubisternum*
C	Wolf spiders	*Lycosa pseudoannulata*
D	Orb Spinners	*Lecauge decorata* *Larinia tabia* *Cyrtophora carrisae*

Potential Entomopathogens of *Spodoptera* spp. in Northeast India

Metarhizium (=Nomuraea) rileyi

Metarhizium anisopliae

Beauveria bassiana

Bt infected caterpillars

Baculovirus infected larvae

Stage wise options including chemical control

(Ref: OM: F. No. L3-L60/2019-SD.IV, dated 6th May 2019 and OM : F. No 12080/37/2018-PPI, dated 28th May 2019 and ICAR-IIMR Folder Publication No./2019/02)

- **First Window (seedling to early whorl stage):**

  To control FAW larvae at 5% damage to reduce hatchability of freshly laid eggs, spray 5% NSKE OR Azadirachtin 1500 ppm @ 5ml/ litre of water.

- **Second window (mid whorl to late whorl stage):**

  To manage 2nd and 3rd instars larvae at 10-20% damage spray Spinetoram 11.7% SC @ 0.5 ml/litre of water OR Thiamethoxam 12.6% + lambda cyhalothrin 9.5% @ 0.25 ml/l of water OR Chlorantraniliprole18.5% SC @ 0.4 ml/litre of water.

Poison baiting:

Poison baiting is recommended for late instar larvae of second window. Keep the mixture of 10 kg rice bran + 2 kg jaggery with 2-3 litres of water for 24 hours to ferment. Add 100g thiodicarb just half an hour before application in the field. The bait should be applied into the whorl of the plants.

Third Window (8 weeks after emergence to tasseling and post tasseling):

Insecticide management is not cost effective at this stage. Hand picking of the larvae is advisable

Important considerations

1. All the sprays should be directed towards whorl and either in the early hours of the day or in the evening time.
2. Capacity building and mass awareness
3. Application and timely plant protection measures to avoid spread of the insect from the abandoned crop.
4. Creation of awareness among important stake holders through trainings /group discuss ions.
5. Community based and area-wide approach for implementing management strategies.

Photo credit; Shri P K Lynshing

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