Monitoring

- Installation of pheromone traps @ 5/acre for monitoring of adults

Scouting

- Start scouting once 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

Mechanical control

- Collection and destruction of egg masses and neonate larvae in kerosine water
- Install pheromone traps @15/acre for mass trapping of adult moths
- Application of dry sand in to the whorl of affected maize plants soon after observation of FAW incidence in the field
- Application of sand + lime in 9:1 ration in whorls in first thirty days of sowing

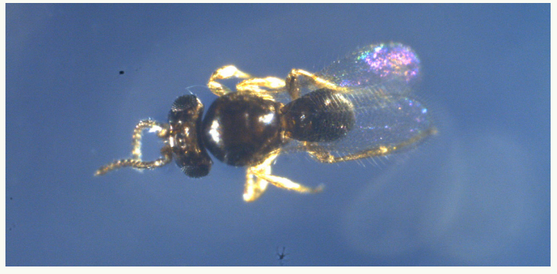
Biological control

Habitat management: Enhance the activities of natural enemies like parasitoids and predators through intercropping maize with pulses and other legumes

- Augmentative release of *Trichogramma pretiosum* or *Telenomus remus* @ 50,000 per acre at weekly intervals or based on trap catch of 3 moths/trap
- Spray *Bacillus thuringiensis* var. *kurstaki* formulations @ 2g/l (or) 400g/acre
- Use entomopathogenic fungi *Metarhizium anisopliae* or *Nomuraea rileyi* or *Beauveria bassiana* or *Verticilium lecani* (1×10^8 cfu/g) @ 5g/ litre whorl application.
- Apply Azhadirachtin 1% EC @ 10,000 ppm or neem oil @ 5 ml/lit as oviposition deterrent on one week after sowing

Trichogramma spp

Rove beetle



Telenomus spp

Fungus infected larva

- Erect bird perch @ 25-50 numbers/ha to attract predatory birds

Chemical control

- **First Window (seedling to early whorl stage):** spray 5% NSKE or Azadirachtin 1500 ppm @ 5ml/ litre of water
- **Second window (mid whorl to late whorl stage):** 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 Chlorantraniliprole 18.5% SC @ 0.4 ml/litre of water.
- **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.

Prepared by

Maruthadurai. R

R. Ramesh

Published By:

Dr. Parveen Kumar

Director, ICAR-CCARI, Old Goa, Goa-403402

Telephone-0832-2993097, Email: director.ccari@icar.gov.in

Website: https://ccari.icar.gov.in

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Integrated Management of invasive Fall *armyworm Spodoptera frugiperda* (J. E. Smith)

भा.कृ.अनु.प.-केंद्रीय तटीय कृषि अनुसंधान संस्थान

(भारतीय कृषि अनुसंधान परिषद)

ओल्ड गोवा ४०३ ४०२, गोवा, भारत

ICAR - Central Coastal Agricultural Research Institute

(Indian Council of Agricultural Research)

Old Goa - 403 402, Goa, India.

Introduction

The fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) is a highly polyphagous, migratory pest native to the tropical and subtropical region of Americas. The FAW has a very wide host range and recorded on more than 353 host plants. In India, FAW was first reported on maize from Shivamogga district of Karnataka (Sharanabasappa et al., 2018). The pest has further spread to almost entire maize growing states of India. The damage incidence of FAW on fodder maize ranged from 16 to 52%. FAW consists of two strains that are morphologically indistinguishable but differ in their host plant preference. The Rice (R) strain most consistently feeds on rice, bermuda grass, and other small grasses while the Corn (C) strain prefers maize, sorghum and other large grasses.

Identification of fall armyworm

- Presence of inverted "Y" line on the head with distinct black spots on the body.
- Four black spots on the 8th abdominal segment were arranged in a square pattern and on 9th segment arranged in a trapezoidal pattern.

Damage Symptoms

- Early instar FAW larvae mostly found scrapping on the leaves of maize plants.
- Presence of characteristic pin holes or shot holes is the typical damage symptoms by young larvae
- Late instar larvae are mostly confined to the deep whorls and caused a distinctive symptom of ragged appearance
- A moist sawdust-like faecal matter in the form of lumps accumulated within the whorl.

Damage at seedling stage

Pin-hole symptoms

Ragged appearance

Cobdamage

Completely damaged plant

Life cycle and Biology

- Eggs are laid in clusters on the under surface of leaves, creamy white in colour covered with scales. Each female lays an average of 1200 eggs. The egg incubation period was 2.4 days.
- Grown-up larvae are brownish black in colour. The mature larva had a white inverted "Y" line on the head with distinct black spots on the body.
- The four black spots on the 8th abdominal segment are arranged in a square pattern and on 9th segment arranged in a trapezoidal pattern. The larval period lasts for 13.80 days.
- Pupae are reddish brown in colour and recorded in the soil around the host plants. Pupal period lasts for 9-10 days.
- Adult moths had characteristic greyish brown forewings with reniform spot, partially outlined in black, with a small V-shaped mark. Female moths lacked distinct markings on the forewings with uniform greyish brown colour.
- The fall armyworms complete its life cycle in 25 days on fodder maize.

Egg mass

Emerged caterpillars

Matured larva

Pupae

Male

Female

Integrated management of fall armyworm

Cultural control

- Deep summer ploughing to expose the pupae of FAW to natural predators and sun light
- Clean and weed free cultivation to destroy the alternate host plants
- Intercropping of maize with suitable legume or pulse crops. (Eg. Maize + cowpea/ground nut/ green gram/ pigeon pea / black gram). Incidence of FAW was less in intercropping system than the sole crops.

Push pulls strategy: Intercropping maize with Desmodium and border crop with Napier. Volatiles emitted by the intercrop repel or push the adult moths, and the trap crop will attract the adult moths.

Intercrops

Pheromone trap