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IPM strategies to combat Fall Army Worm (*Spodoptera frugiperda*) menace in maize crop

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Maize (*Zea mays* L.) is third important crop after rice and wheat in India that provides food, feed and fodder. Despite maize's current high productivity, higher than other major cereal crops, it is still below its potential, mainly due to many biotic and abiotic factors causing yield losses. The fall armyworm (FAW, *Spodoptera frugiperda*) is among the major factors which have contributed to the low productivity of maize. FAW, a new destructive insect pest, is one of the major problems for agricultural crop production, especially maize under warm and humid conditions. FAW has the capability to breed rapidly, migrate, and feed on a wide range of host plants, all of which makes it very difficult to control. The caterpillars feed inside the whorl of a maize plant and chews tender leaves during night. Feeding is usually confined to leaf margins, but occasionally they may strip the entire plant leaving only the midrib of the leaves. As they chew away, the leaves continue to grow out, and thus, leave a ragged/ untidiness of the leaves in the spring and early summer are typical symptoms of FAW infestation. At very high population levels, FAW can also penetrate maize ears, causing direct damage to the harvest.

Nonetheless, there are several ways of managing the pest as reported in other parts of the world that can potentially be adapted and/or validated. Hence, to manage this pest we have to use different management options. Integrated pest management (cultural, mechanical, chemical, and biological) is commonly used for controlling FAW infestations. Therefore, in this article, we highlighted the control measures of the fall armyworm, which could be useful to improve its management in maize fields.

Caterpillars feeding inside the whorl

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Integrated pests' management strategies for Fall Army Worm (*Spodoptera frugiperda*)

A systematic plant protection measures is essential for strategic crop management practices where FAW has established. In order to manage FAW population below economically damaging levels, installation of pheromone traps @ 5/acre to monitor the population build up. An integrated pest management (IPM) approach was found the best option for FAW management as described below:

Scouting

Start scouting 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 chemical insecticides. Suitable bio-pesticide may be used in the event of ear/cob damage

Mechanical Method

- Hand picking and destruction of egg masses and neonate larvae in mass by crushing.
- 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.

Monitoring of FAW at farmer's field

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

Cultural Method

- Deep ploughing during summer is recommended to expose pupae of FAW to predatory birds and heat.
- Clean cultivation and weed free to destroy the alternate hosts and balanced use of fertilizer
- Dig trench around the field and fill with water and insecticide to avoid migration of FAW larvae from one to another field
- Timely sowing of maize and avoid staggered sowings
- Intercropping of maize with suitable pulse crops. Use of trap crops (3-4 rows of Napier grass) around maize field and spray with 5% NSKE or *azadirachtin* 1500 ppm @ 5ml/l as soon as the trap crop shows FAW damage symptom.

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- Erection of bird perches @ 10/acre during early stage of the crop (up to 30 days).
- Cultivation of maize hybrids with tight husk cover will reduce ear damage by FAW

Microbial control Method

- If infestation level is at 5% damage in seedling to early whorl stage and 10% ear damage, then use following entomopathogenic fungi and bacteria: *Metarhizium anisopliae*, *Nomuraea rileyi, Beauveria bassiana, Verticilium lecani* (1 × 10 cfu/g) @ 5g/litre whorl application. Repeat after 10 days if required
- *Bacillus thuringiensis* var. kurstaki formulations @ 2g/l (or) 400g/acre
- Apply Azhadirachtin 1% EC @ 10,000 ppm or neem oil @ 5 mL/lit. as oviposition deterrent on one week after sowing

FAW infested plant

Chemical Control:

- Seed treatment with Cyantraniliprole 19.8% + Thiamethoxam 19.8% FS @ 6 ml/kg of seed was reported effective for 15-20 days.
- FAW larvae at 5% damage during seedling to early whorl stage (0-2 weeks after emergence) to reduce hatchability of freshly laid eggs, spray 5% NSKE / Azadirachtin 1500ppm @ 5ml/l of water.
- To manage 2nd and 3rd instars larvae mid whorl to late whorl stage (2-4 weeks after emergence) having more than 10% foliar damage spraying of Spinetoram 11.7% SC or Chlorantraniliprole 18.5% SC or Thiamethoxam 12.6% + Lambda cyhalothrin 9.5% ZC is recommended.
- Poison baiting is recommended for late instar larvae(7 weeks onwards). Keep the mixture of 10 kg rice bran + 2 kg jaggery with 2-3 litres of water for 24 hours for fermentation. Add 100g Thiodicarb just half an hour before application in the field. The bait should be applied into the whorl of the plants.
- All the sprays should be directed towards whorl and either in the early hours of the day or in the evening time.

Result of Demonstration on Fall Army Worm management

Considering all the Integrated Pest Management practices a demonstration was conducted covering an area of 5 ha at three villages of Churachandpur district, Manipur. The maize var. RCM 1-3 was used. Spraying of *Bacillus thuringiensis* var. kurstaki formulations @ 2g/l at 45 days after sowing minimize the pests population and kept below injury level. *Bacillus thuringiensis* (*Bt*) is easily available

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and affordable. The result revealed that spraying of *Bacillus thuringiensis* @ 2g/l proved to be effective with percent infestation of 8.2% as against the farmer practice 20.8% (Fig 1). The crop produce a grain yield of 38.0 q/ha when 34.2 q/ha was received from the farmer practice of (Fig. 2) benefiting 1.88 BC ratio and 1.3 respectively.

Fig 1. Percent infestation of fall army worm

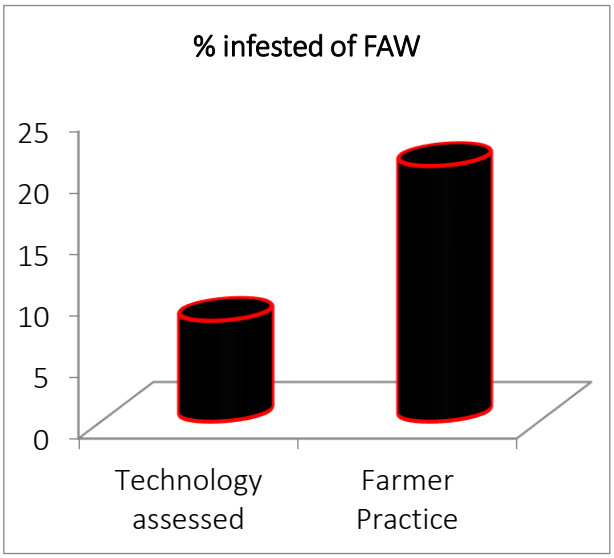

Fig 2. Yield comparison

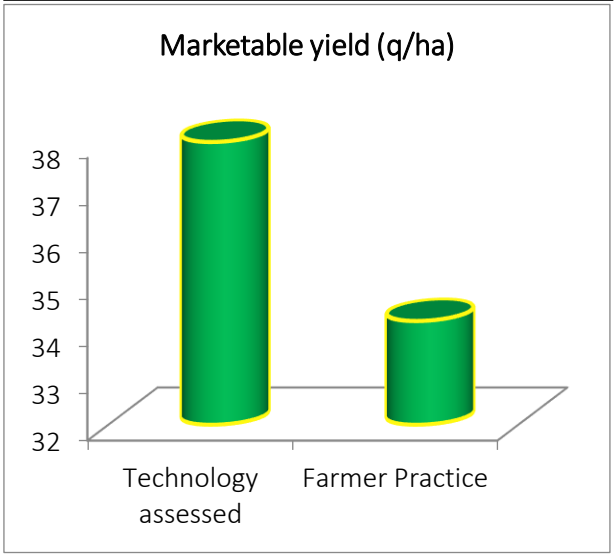

Fig 3. Demonstration on Organic management of Fall Army Worm at farmers' field in different

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Conclusion

Since Fall Armyworm is an invasive pest in India, it can attack more than 80 plant species, causing remarkable damage to economically important cultivated cereals such as maize, rice and sorghum, and also to vegetable crops and cotton. It is the larval stage of the insect that causes the damage of crops and is rapidly spreading in India due to few characteristic behaviours like voraciousness, fast and rapid flying capacity. It is high time to disseminate the techniques of controlling the pest. Development of IPM to manage the pest is in infancy in India for want of basic information about this pest. Agricultural officers, extension workers, farmers, agro-based NGOs and policy makers should be well aware of management tactics of the pest and periodical awareness training to maize growers and capacity building on early scouting, surveillance and monitoring of FAW incidence to extension officers and input dealers are highly required. FAW has developed resistance to many of modes of action (MOA) overseas. Baseline screening of the Australian FAW populations in 2020-21 identified moderate resistance to carbamates and organophosphates and high resistance to synthetic pyrethroids. Ongoing monitoring and implementation of resistance management strategies will be essential to minimising the risk of resistance development in FAW population. Therefore looking all the consequences of using chemicals like environmental pollutions, health hazards and harm the natural enemies it can be concluded that integrated pest management approach is the best option to restrict the spreading of FAW below economic injury level.

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