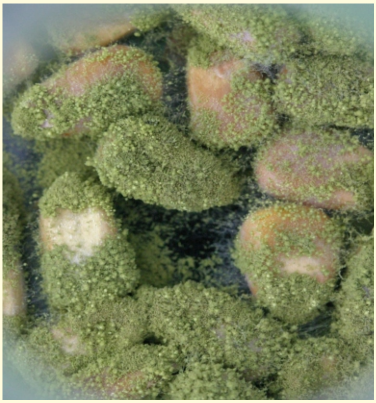
MANAGEMENT OF FALL ARMYWORM & AFLATOXIN IN MAIZE



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Citation:
HS Jat, JC Sekhar, Soujanya PL, Suby SB, SK Aggarwal, SL Jat, Bhupender Kumar, Sridevi, Ranjit Singh,SC Dubey, SK Pardhan & PK Singh (2024), Management of Fall Armyworm and Aflatoxin in Maize. Bulletin 01/2024. pp 22. ICAR-Indian Institute of Maize Research, Ludhiana

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MANAGEMENT OF FALL ARMYWORM AND AFLATOXIN IN MAIZE

INFORMATION ON FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* (J.E. SMITH)

Fall armyworm (*Spodoptera frugiperda* J. E. Smith) is an important insect pest of maize, that causes significant damage to all stages of its growth. Its recent emergence and rapid spread in India are a serious threat to the food and income security of smallholder maize farmers. As we know maize is a potential crop for doubling farmer's income owing to its multiple types and industrial uses. Insect pests are the major biotic constraints affecting the productivity of maize, which in turn threatens food security under changing climate scenarios. Since report of the invasive pest fall armyworm (*Spodoptera frugiperda* J. E. Smith) in maize in May 2018, it has spread rapidly to all maize growing ecologies of India casting a shadow on maize production.

The fall armyworm (FAW) was first officially reported in West Africa in early 2016 followed by central, southern and eastern sub-Saharan Africa from early 2017 to 2018. After its detection in India in mid-2018, the pest moved swiftly to various countries in the Asia-Pacific between August and December 2018, followed by southern China in early January 2019, southward to Malaysia (March 2019), Indonesia (April to July 2019) Hong Kong (April 2019), Taiwan (May/June 2019); Laos and Vietnam (April 2019), Philippines (June 2019), South Korea (June 2019), and Japan (June 2019). As of August 2019, a total of 64 African and Asian nations have reported the incidence of FAW while Australia reported the pest in February 2020. By January 2021, it spread to west Asia and by 2023 it invaded parts of Europe. Currently, FAW has spread to more than 80 countries. Being a polyphagous pest, FAW presents significant challenges with potential adverse impacts, particularly in maize-based agro-ecologies.

Different life stages of fall armyworm

Egg mass: a single egg mass can contain anywhere from a few dozen to more than thousand eggs arranged in single to four layers.

Egg mass of FAW

Larvae: The larvae are smooth-skinned, vary in colour from light tan or green to dull grey body with three creamy yellow dorsal and lateral lines. The larva contains reddish brown head with predominant white, inverted Y-shaped suture between the eyes.On 8th and 9th abdominal segment at dorsal side, four large spots are arranged in a square shape on segment 8 and in trapezoid pattern on segment 9. The larval stage contains 6 instars and larval period varies from 15-18 days depending upon prevailing temperature.

Fall armyworm larvae can be differentiated from spotted stem borer and pink stem borer with peculiar morphological features as mentioned below:

Fall armyworm

Spotted stem borer

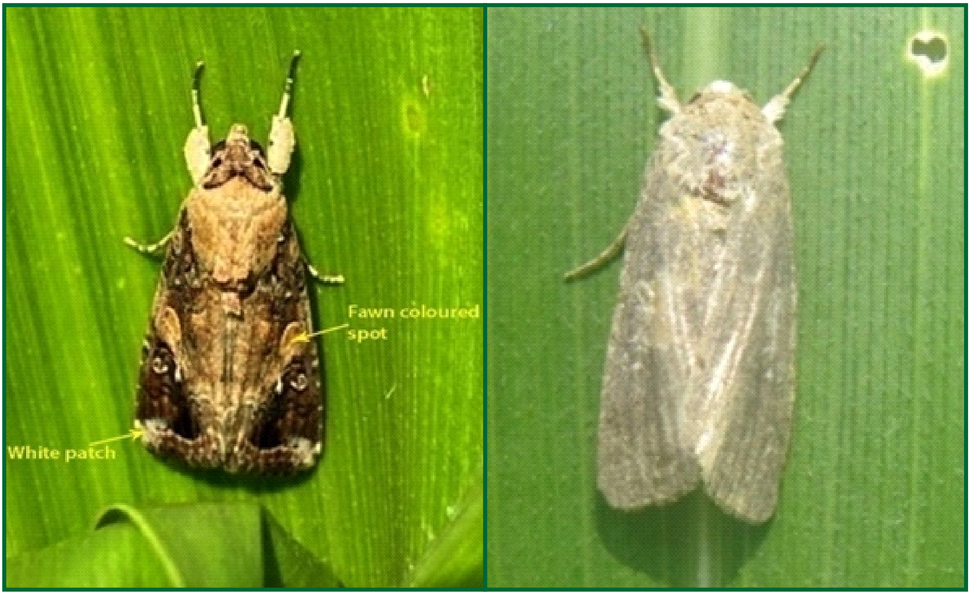
Larva is creamy pink to yellowish brown with 4 rows of dotted stripes along the back with reddish brown head.

Pink stem borer

Larva is light pink in colour with a purplish tinge

Pupa: Pupa is reddish brown in colour.

Adult: The forewing of male moth consists of fawn coloured spot and a white patch at the apical margin of the wing. Female moths are less distinctly marked ranging from uniform greyish brown to a fine mottling of grey and brown.



Male moth Female moth

Key to the successful management of FAW depends upon the logical integration of region-specific sustainable management tools in a time critical manner. Integrated Pest Management (IPM) integrates different strategies including monitoring, appropriate cultural practices, host plant resistance-based approaches, biological control, agro-ecological measures and need based use of ecofriendly insecticides. Indian Council of Agricultural Research (ICAR)-Indian Institute of Maize Research (IIMR) in collaboration with ICAR-National Research Centre for Integrated Pest Management (NCIPM) and ICAR-National Bureau of Agricultural Insect Resources (NBAIR) has developed package of practises to control FAW separately for grain corn, sweet corn, baby corn, popcorn, fodder and silage maize and has been adopted by Department of Agriculture & Farmers Welfare (DAC&FW). The developed package of Practices was disseminated to all concerned stake holders including State Department of Agriculture, All India Coordinated Research Projects (AICRP) centres and various State Agricultural Universities (SAU'S) as well as other partners including own network of the institute.

Damage symptoms comparisons for fall armyworm vis-à-vis other key pest in maize.

Spotted stem borer	Pink stem borer	Fall armyworm
Pin holes and papery windows are first symptoms of spotted stem borer attack. After a week onwards, larvae move out of whorl and bore upwards the developing stalk. The leaf whorl dries resulting in 'dead heart' formation and often gives rise to tillers.	After hatching, pink borer larvae feed inside the leaf sheath in groups and feed on the epidermal layer of the leaf sheath preferably on first three leaf sheaths. The larva bores into the central shoot as a result, growing point dries up resulting information of dead heart in young plants. The larva feed in groups forms circular shaped tunnels inside the stem and exit holes at the surface. Due to larval feeding, circular ring like cuts occur on lower inter nodes.	Early instars feed in and around the whorl by scraping and skele-tonizing the upper epidermis of leaves leaving a silvery tran-sparent membrane resulting into papery spots. The damage results in pinhole symptoms on the leaves. Later instars remain and feed inside the whorl. The damages by late instars (4^{th} instar onwards) result in extensive defoliation of leaves and presence of large amounts of faecal pellets in the plant whorl. During reproductive stage the larvae damage tassels or may bore inside the corn ear and feed on kernels, making control very difficult.

Spotted stem borer | Pink stem borer | Fall armyworm


Pinholes


Dead Heart


Foliage damage

Dead Heart

Exit holes on stem


Tassel damage

Management of fall armyworm in maize

Based on available information, experimental findings and expansion of label claims by Central Insecticides Board & Registration Committee (CIB&RC) IPM strategies have been formulated, and validated by ICAR-IIMR in collaboration with ICAR-NBAIR and ICAR-NCIPM.

Quick action strategy for FAW management in maize

- Seed treatment with cyantraniliprole 19.8% + thiamethoxam 19.8% @ 6 ml/kg seed or chlorantraniliprole 50 FS @ 5.6 ml/kg seed provides protection up to two weeks after germination, especially in late planted *kharif* maize
- Monitor the FAW population using pheromone traps; 4 traps are to be installed in any one acre of the first planted crop in a contiguous maize field.

- First blanket spray with 5% neem seed kernel extract (NSKE) on 10% plant infestation at 10 days after germination (DAG) and/or observation of one moth/trap/day.

OR

- Whorl application of any of the biopesticides *viz., Bacillus thuringiensis* formulations @ 2g/litre (400 g/acre) or *Metarhizium anisopliae* or *Beauveria bassiana* (1×10^8 cfu/g) @ 5g/litre (1 kg/acre) or entomopathogenic nematode (*Heterorhabditis indica*) @ 20 g/litre of water (4 kg/acre) on 10-20% plant infestation at 15 DAG.

OR

- Whorl application of any of the synthetic insecticides *viz.*, Spinetoram 11.7% SC (100 ml/acre) @ 0.5ml/litre, Chlorantraniliprole 18.5 SC (80 ml/acre) @ 0.4 ml/litre, Novaluron 5.25% + Emamectin benzoate 0.9% SC 3 ml/litre (600 ml/acre), Chlorantraniliprole 9.3% + Lambda Cyhalothrin 4.6% ZC (100 ml/acre) @ 0.5 ml/litre, Emamectin benzoate 5% SG (80 g/acre) @ 0.4 g/litre on 20% plant infestation at 20-25 DAG.
- Repeat the spray if a fresh infestation is there in 20-30% of plants after 12-15 days of the first spray. If a spray is needed after 45 DAG, use a green label pesticide or pesticide with the shortest waiting period.
- If required, use any of the above mentioned biopesticides at 50-60 DAG depending upon crop maturity to reduce ear damage.

Integrated Management of FAW in maize

Pre-planting practices

- Deep ploughing to expose pupae to sunlight and predatory birds (no required for conservation agriculture).
- Application of neem cake @ 200 kg/acre.
- Seed treatment with Cyantraniliprole 19.8%+Thiamethoxam 19.8% @ 6 ml/kg seed or chlorantraniliprole 50 FS @ 5.6 ml/kg seed provides protection up to two weeks after germination, especially in late planted kharif maize.

- Planting of flowering plants around the bunds such as marigold, sesame, niger, sunflower, coriander, fennel, etc. to attract natural enemies.

Crop management practices

- Select tight husk cover genotypes.
- Timely and uniform sowing over larger area.
- Ridge and furrow planting method to be followed.
- Application of recommended dosage of NPK as basal dose.
- Planting of 3-4 rows of napier grass/hybrid napier as trap crops.
- Intercropping of maize with legumes, *viz.*, pigeonpea, cowpea, black gram, groundnut, red amaranth, kidney bean etc. in 2: 1 to 4: 1 ratio.
- Erection of bird perches @ 10/acre to encourage natural FAW predation by birds.
- Monitor FAW population using pheromone traps; 4 traps are to be installed in any one acre of first planted crop in a contiguous maize field.
- Scouting: survey fields thoroughly on a weekly basis from the very beginning. During the survey, three to four outer rows of the field should be left out and crop shall be observed in a 'W' pattern for presence of damage by the insect pest. Management operation should be undertaken as soon as the insect is observed to prevent its multiplication and spread.
- Adoption of clean cultivation for better crop health and to eliminate weeds that serve as FAW alternate hosts.
- Crushing of egg masses and larvae.
- Application of sand or soil mixed with lime in a 9:1 or 8:2 ratio into whorl of maize plants.
- First blanket spray with 5% neem seed kernel extract (NSKE) on 10% plant infestation at 10 days after germination (DAG) and/or observation of one moth/trap/day. Alternatively, release the egg parasitoids, *Trichogramma chilonis* @ 1,00,000 adults/ha, in those geographies where it works. In northwest India, *Trichogramma* was

found competitively displaced by the egg-larval parasitoid *Chelonus* spp.

OR

- Whorl application of any of the biopesticides viz., *Bacillus thuringiensis* formulations @ 2g/litre (400g/acre) or *Metarhizium anisopliae* or *Beauveria bassiana* (1×10^8 cfu/g) @ 5g/litre (1 kg/acre) or entomopathogenic nematode (*Heterorhabditis indica*) @20g/litre of water (4 kg/acre) on 10-20% plant infestation at 15-20 DAG.

OR

- Whorl application of any of the synthetic insecticides *viz.*, Spinetoram 11.7 % SC (100 ml/acre) @ 0.5 ml/litre, Chlorantraniliprole 18.5 SC (80 ml/acre) @ 0.4 ml/litre, Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 3 ml/litre (600 ml/acre), Chlorantraniliprole 9.3% + Lambda Cyhalothrin 4.6% ZC (100 ml/acre) @ 0.5 ml/litre, Emamectin benzoate 5% SG (80 g/acre) @ 0.4 g/litre on 20% plant infestation at 20-25 DAG.
- Repeat the spray if a fresh infestation is there in 20-30% of plants after 12-15 days of the first spray of synthetic pesticide. If a spray is needed after 45 DAG, use a green label pesticide or pesticide with the shortest waiting period.
- If required, use any of the above mentioned biopesticides at 50-60 DAG depending upon crop maturity to reduce ear damage.

Notes and precautions

Pheromone traps- Funnel traps with FAW lure should be installed at a height adjusted each week to match with crop canopy. Traps should be separated by a minimum distance of 75 feet. Observe traps for the number of moths caught twice or once a week and work out the catch/day. FAW lures should be changed once in 30 days.

Preparation of Neem Seed Kernel Extract (NSKE) for one acre- 10 kg of neem seed kernel is required for one acre. Grind 10 kg of neem seed kernels to make powder. Soak the powder in 50 litres of water overnight. Stir and filter the contents using a cotton cloth. Add 200 g detergent powder or 200 ml of soap solution to the filtered solution. Make up the volume to 200 litres by adding water.

Caution upon release of egg parasitoids - A minimum one week interval should be there between parasitoid release and application of neem or chemical insecticides.

Precautions for pesticide use- Sprays should always be directed towards whorl and applied either in the early hours of the day or in the evening time. Use protective clothing, facemasks and gloves during preparation and application of pesticides. Enter the field only 48 hours after spraying pesticide. The interval between application of chemical insecticide and harvest of corn should be minimum 30 days or as per waiting period in the label claim.

AFLATOXIN MANAGEMENT IN MAIZE

Aflatoxin is an important quality issue for utilization of the maize grain in food, starch, distiller's dried grains with solubles (DDGS) and feed uses. This is major issue in kharif season crop particularly as the temperature at crop harvesting is down in Northern and Central India. The uneven crop growth, maturity and cob damage before harvesting causes aflatoxin contamination. It increases further with harvesting at higher grain moisture and improper post-harvest management.

Factors for aflatoxin contamination:

- Favourable environment: High humidity and erratic rainfall during later stages of crop maturity
- Water stress, pest damage (cob borers & maize weevil) and nutrient deficiencies.
- **Improper agronomic practices:** late planting, incorrect planting density, poor irrigation and insect control practices, crop rotation with aflatoxin-susceptible crops, untimely harvest, mechanical damage to grains during harvesting.
- Inappropriate levels of moisture for safe storage (> 13 %)
- Poor storage conditions

Integrated management of Aflatoxins in maize:

❑ **Crop Management:**

- Use of heat, drought and insect-pest resistant genotypes. Select tight husk cover genotypes.
- Avoid late planting; uniform crop establishment/germination
- **Avoid Stresses:** Proper water drainage, proper irrigation and avoid drought stress condition
- Proper weed management
- Manage insect-pests (cob borers & maize weevil) to avoid cob damage.
- Adopt proper nutrient management for better and uniform crop growth.

- Follow crop rotation with aflatoxin-non-susceptible crops, avoid crops like groundnut, etc.
- Synchronous crop maturity
- **Detopping:** Cutting of the top above the cob at brown husk stage and feed to cattle for fast drying

- **Dehusking in standing crop:** Opening of the cob in the field itself for quicker drying after brown husk stage. To be done in main free season/areas.

- Many atoxigenic strains such as Alfasafe SN01, Alfa guard, K 49, etc. are effective to reduce aflatoxin. The broadcasting of these strains @ 10 kg/ha at knee high stage of the maize crop found effective in aflatoxin management (This is used commercially at abroad, however in India the results are needed to be validated)

Post harvest operations:

- Avoid heaping of cobs/whole plants; regular rotation of cob during drying is required. May use hanging of cobs tied together with husk under shed.

- Proper sun drying of the cob (<15% moisture) & shelling thereafter. Normally around 10 days plus proper sun drying is required for getting desired moisture content for shelling.
- Drying of the cob/grain by dryer: Installation of dryer at marketing yard & mobile dryer in growing areas.
- Shelling properly dried cob (<15% grain moisture cobs) gives lesser cut grain and reduced chances of aflatoxin development.
- Avoid mechanical damage to grains during harvesting and shelling.

Storage:

- Dry grains at appropriate levels of moisture (<13%) for safe storage at clean threshing floor/ dryers.
- Maintain proper aeration in storage/ prevent insect damage during storage.
- Avoid heaping of grain.
- Avoid high humidity at storage (should be less than 70%).

Table. Step-wise strategies to reduce aflatoxin contamination (synthesized after Nada *et al*. 2022)

Activities/Production step of the crop	**Factor/reason for aflatoxin production/contamination**	**Strategy**
Pre-harvesting operations		
Land preparation / Pre-Planting (Tillage, crop rotation)	Aspergillus survive in crop residue and the chances for survival and dispersal of these fungi are greatest if the crop residue is left on the soil surface, especially if maize/wheat is grown in the same field continuously. Fungi on crops can produce mycotoxins in the field (Accinelli *et al*., 2008). Fungal spores remain dormant in soil from crop to crop and from year to year, present in layers of infected crop residues (Abbas *et al*., 2009).	Follow crop rotation and tillage practices that bury the residue. Increasing adherence to no-till cultivation aimed at preserving top soil, can increase soil contamination with fungal spores. Crops such as potato, other vegetables, clover and alfalfa that are not hosts to Fusarium species or mycotoxin producing fungi should be used in rotation to reduce the inoculum in the field.
Land preparation / Pre-Planting (Fertilization)	Susceptibility of plants to mycotoxin contamination can be influenced by soil fertility levels but the effects are not constant and may depend on other interacting factors.	Follow standard agricultural practices with optimum recommended doses of fertilizer for the ecology.
Land preparation / Pre-planting (Cultivar selection)	Selection of a hybrid adapted for local conditions and suitable for the proposed end-use is a key decision.	Select the variety/hybrid which is resistant to major insects-pests and diseases and also to infection and colonization by mycotoxin genic fungi. The hybrids with tight, husk/full covered with no tip filling should be preferred. Planting pathogen-free seed and apply seed treatment as used in standard agronomic practices.

Activities/Production step of the crop	Factor/reason for aflatoxin production/contamination	Strategy
Application of fungal biocontrol agents to reduce aflatoxins.	Aspergillus species survive in crop residue and the chances for survival and dispersal of these fungi are greatest if the crop residue is left on the soil surface. The conditions required for the production of mycotoxins are complex and involve a combination of conditions favourable to fungal infection and growth and those conducive to mycotoxin formation.	Efficacy of two aflatoxin biocontrol products, Alfasafe GH01 and Alfasafe GH02, were evaluated during 2015 and 2016 in Ghana. Total aflatoxin reduction was reported in the range 80-100 %. Aflatoxins were not detected in 95% of the maize treated with Alfasafe GH02 (Agbetiameh *et al.*, 2020). Mytoolbox Af01, a native toxigenic A. *flavus* strain, was obtained from maize grown in Serbia and used to produce a biocontrol product that was applied in irrigated and non-irrigated Serbian fields during 2016 and 2017. The application of this biocontrol product reduced aflatoxin levels in maize kernels (51-83%). The biocontrol treatment had significant effect of reducing total aflatoxin contamination by 73% (Savic *et al.*, 2020). However, these results to be validated in Indian conditions.
Weeding	Weed contribute indirectly to mycotoxin risk through their competition with crop plants. This competition can induce the moisture and nutrient stresses that increase the risk of mycotoxin accumulation.	Some weeds may also serve as alternative hosts for mycotoxin producing fungi, providing an additional inoculum source for the crop. Effective weed control is usually a high priority in maize production, in order to maintain crop yields and minimizes mycotoxin. The recommended herbicides may be use at different growth stages for effective management of weeds in maize.

Activities/Production step of the crop	Factor/reason for aflatoxin production/contamination	Strategy
Irrigation	Drought-stressed maize crops are thought to be more susceptible to aflatoxin contamination. Most work on irrigation and mycotoxin risk has focused on alleviating drought stress as a tactic to avoid mycotoxin contamination, especially for aflatoxins.	Irrigate adequatly to prevent drought stress can lower aflatoxin levels in grain. The proper irrigation should be applied at all critical growth stage of maize e.g. seedlings, pre-flowering, flowering and grain fillings stages.
Pest control	Insect management is the most important practice for reducing risk for aflatoxins. Insects act as vectors for fungal spores, they cause damage to maize kernels, creating infection sites for toxigenic fungi, and they induce plant stress that may predispose the plants to infection.	The ways to reduce mycotoxin risk associated with insects include: application of synthetic insecticide; or using of certain cultural or biological control methods. Efficient control of FAW, stem borers, aphids, etc. should be done using various chemical and biological control. Further, integrated pest management can help in this. Removal and destruction of dead hearts and spraying of Chlorantraniliprole 18.5 SC @150 ml/ha when infestation crosses 10% of plants, i.e. 10% of plants show visible leaf feeding damage controls spotted stem borer and pink stem borer damage. For aphid management, mechanical removal of infested shoots and conservation of natural enemies such as coccinellids, chrysopids and syrphids that are found to feed on the aphids will reduce the population considerably without any insecticidal spray.

Activities/Production step of the crop	Factor/reason for aflatoxin production/contamination	Strategy
Harvesting	Maize fields should be inspected at physiological maturity to determine whether there are severe mold problems and to make decisions about harvest timing, postharvest handling, storage, and marketing strategy. If 10% or more of the ears have 10-20% mold damage, or are lodged, the field should be scheduled for the earliest possible harvest.	Maize crops left to dry in the field can be exposed to temperature and moisture conditions that are favourable for continued growth of toxigenic fungi and the accumulation of their mycotoxins in grain. Therefore, harvest timing can have a major impact on the final levels of mycotoxins accumulated in the grain. Further, one can proceed for harvesting at physiological maturity (75 % husk gets dry) where moisture should be below 25% moisture. The final harvest should be dried to extent of 15% grain moisture and then should only be proceed for shelling. It will help to avoid the grain damage during shelling.
Post harvest operations		
Grain reception	a) The most critical factor during harvest is accurate determination of moisture content, and ensuring that the entire crop meets desired moisture targets. (b) Mycotoxin-producing fungi present in the received grain can contribute to formation of AFs at unacceptable levels due to improper storage practices.	Inspection for total impurities, damaged kernels, presence and traces of pests and vermin, presence of molds, moisture and temperature of grain.

Activities/Production step of the crop	Factor/reason for aflatoxin production/contamination	Strategy
Pre-cleaning	Mycotoxin production during the actual harvest operation is unlikely, unless the process is interrupted and prolonged by rain; however, contamination with soilborne spores and damage to kernels may make mycotoxin formation more likely during subsequent storage. Also, mechanical harvesters can cause damage to kernels and leave them more vulnerable to fungal invasion.	Pre-cleaning implies rough removal of impurities, trash and weeds.
Drying	The risk of mycotoxin formation at unacceptable levels is increased in case of increased moisture content in grains.	If moisture content (MC) $\leq$ 14% no drying is required and grain can be stored immediately upon reception. In the case of 14 to 18% MC maize can be temporary stored and dried to 13% MC. If MC $\geq$ 18% maize is, to be immediately dried to 13 MC.
Storing	The factors conducive to fungal growth during storage are related to the amount of inoculum present, temperature, relative humidity, moisture content and insect activity. Fungal infection usually occurs prior to harvest, but can also occur from dormant fungal spores present in grain dust residues in storage silos, which can also be transported through grain by insects or rodents.	Avoiding mycotoxin production in storage involves ensuring that aw <0.70. This value corresponds to MC <13% for maize. Good aeration is essential when ambient temperatures are high, but is only effective when the external air has a relative humidity <80% and temperature of <20 °C.

Activities/Production step of the crop	Factor/reason for aflatoxin production/contamination	Strategy
Storing (Fumigation)	Insects play a role in rendering stored maize susceptible to fungal invasion. There are five major insect pests of stored cereal grain: moths, weevils, the lesser grain borer, flour beetles, the saw-toothed grain beetle and flat grain beetles. Moths and the saw-tooth grain beetle multiply rapidly at temperatures 30-35^{0}C and humidity 75-80%.	The most effective and widely accepted method of control of insect invasion is prevention through using airtight storage, hygiene, aeration, controlled atmosphere and drying. Market restrictions and grain-specific chemical registrations limit other pest control options. Insecticidal spray is recommended on floors, walls, containers and storage facilities. Dose for organophosphates as per malathion- 150 mg/m^2 or Dose for synthetic pyrethroids as per deltamethrin- 30 mg/m^2 and 5% NSKE should be sprayed as a thin film on bags before use during storage. Neem based products work effectively due to their repellent action and are relatively safe. Storing of maize in double layered bags provide protection from storage pests infestation. Seed stored gunny bags should be kept few inches above the ground. Fumigation with periodical prophylactic treatment with insecticides is very useful. Dosage of Aluminium phosphide tablets: 3 tablets/ tonne. In fumigation structure should be properly sealed for complete effect.

Annexure: Discussion of management practices recommended for fall armyworm and aflatoxin in various programme throughout India.

Date	Place	Programme	No. of participants
22 February 2024	Kokri Kalan, Moga, Punjab	Training cum input distribution programme on Improving the livelihood of schedule caste farmers through improve maize technologies	95
26- 28 February, 2024	Jeypore, Koraput, Odisha	Training on "Best Management Practices in Maize Cultivation and Entrepreneurship Development to Enhanace Farmer Livelihoods in Koraput District, Odisha"	44
03 March 2024	RMR&SPC, Begusarai	Farmer awarness on Farmer's right under PPV&FR and training on scientific maize cultivation	35
09 March 2024	Chokkar Village, Ludhiana, Punjab	Training cum input distribution programme on "Improving the Livelihood of Schedule Caste Farmers through distribution of Improve Maize Technologies"	50
11-12 March, 2024	CAU, Imphal	Workshop on " Maize for North east Hill Region: challenges and opportunities"	150
18 March 2024	Mehndali village, Ropar, Punjab	Training programme on "Promotion of Bio-fortified Maize for Entrepreneurship Development through Value Addition for Nutritional and Livelihood Security"	100
19 March 2024	Bhotna Village, Barnala, Punjab	Training programme on "Promotion of Bio-fortified Maize for Entrepreneurship Development through Value Addition for Nutritional and Livelihood Security"	100
20th March 2024	Lapon Village, Moga District, Punjab	Training programme on "Promotion of Bio-fortified Maize for Entrepreneurship Development through Value Addition for Nutritional and Livelihood Security"	100

Date	Place	Programme	No. of participants
23 March 2024	Balliewal village, Ludhiana, Punjab	Training cum input distribution programme on Improving the Livelihood of Schedule Caste Farmers through distribution of Improve Maize Technologies	100
27 March 2024	Ludhiana, Punjab	Training programme on "Promotion of Bio-fortified Maize for Entrepreneurship Development through Value Addition for Nutritional and Livelihood Security"	46
3 April 2024	NASC, New Delhi	Brainstorming on maize to Ethanol in India: Prospects and strategies	28
25 April, 2024	Gehlewal, Machiwara Sahib, Ludhiana & Pahadpur, Ropar	Two workshops on Promotion of Climate resilient technologies of maize among the farmers of Punjab under under Awareness/Campaign Programs on Mission LiFE (Lifestyle for Environment)	120
05 May 2024	ICAR-IIMR, Ludhiana	Exposure visit of students of BFIT University, Dehradun	23
08 May 2024	PJTSAU, Rajendranagar, Hyderabad	67th Annual Maize Workshop-2024 was jointly organized by ICAR-IIMR and PJTSAU	250
09 May 2024	PJTSAU, Hyderabad	Brainstorming on road map for increasing maize production to address EBP 30	130
06 June 2024	ICAR-IIMR, Ludhiana	Exposure visit of students of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut	16
10 June, 2024	Online platfrom	Online training “Training on FAW and aflatoxin awareness for state official of Odhisha	35
21 June 2024	ICAR- IIMR Ludhiana	Stakeholders meet for summarising about project on Catchments area on maize	86

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