AgroScience Today

Popular Article

e-ISSN: 2583-0147

Volume 6 Issue 2
Page: 1084 - 1088

Maize Ear Rot - Identification and their Management Strategies

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Published on: February 28, 2025

ABSTRACT

Maize (*Zea mays* L.) productivity is severely impacted by ear rot diseases, primarily Fusarium ear rot (FER) and Aspergillus ear rot (AER). These diseases not only reduce yields but also lead to mycotoxin contamination, posing significant health and economic risks. Favourable environmental conditions, insect damage, and agronomic practices contribute to disease severity. Integrated management, including host plant resistance, cultural and biological control, and judicious chemical applications, is crucial for disease mitigation. Sustainable pre- and post-harvest strategies can minimize mycotoxin contamination, ensuring food safety. This article highlights the epidemiology, symptoms, and management of maize ear rots to support sustainable maize production.

INTRODUCTION

Maize (*Zea mays* L.), commonly referred to as the "Queen of Cereals," is a globally significant crop belonging to the Poaceae family. It is cultivated for grain, silage, and fodder purposes under Punjab conditions during the spring and Kharif seasons, covering an area of approximately 93.3 thousand hectares with a production of 410 thousand tonnes. Maize productivity is significantly threatened by various biotic and abiotic factors. Among biotic stresses, diseases play a critical role in reducing yields by affecting the crop at various growth stages. In India, disease-related losses account for approximately 13.2 per cent. Among these, maize ear rots viz; Fusarium ear rot (FER), Aspergillus ear rot (AER), Diplodia ear rot (DER), Penicillium ear rot and Rhizopus ear rot caused by different fungal genera cause both quantitative and qualitative losses. Among these, FER caused by *F. verticillioides* and *F. proliferatum* and AER caused by *Aspergillus flavus* are the most prevalent one. Earlier the ear rot disease was considered as of minor importance, however, due to changing environmental conditions, it is now emerging as a significant concern. In India, the ear rot disease resulted in approximately 5 per cent yield loss. Beyond yield reductions, fungal pathogens associated with ear rot produce harmful mycotoxins *viz*; aflatoxins, ochratoxin A, fumonisins, zearalenone, deoxynivalenol, patulin and trichothecenes. These mycotoxins not only reduce the quality of maize but also pose serious risks to human and animal health. According to FAO estimates, mycotoxin contamination contributes to 25 per cent of global crop losses, emphasizing its economic and public health impact. Among the mycotoxins, aflatoxins and fumonisins are particularly concerning, especially in tropical regions with conducive environmental conditions. To address these risks, the Food and Drug Administration (FDA) has established a strict maximum allowable limit of 20 ppb for aflatoxins in food intended for humans, as well as feed for livestock and poultry. Fumonisins, being the second most significant mycotoxins, cause food poisoning, esophageal cancer, neural tube defects, and immunosuppression in humans. However, for fumonisins, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) recommended a maximum tolerable daily intake (PMTDI) of 2 μg/kg body weight per day.

SYMPTOMS

Symptoms of FER typically appears on individual kernels of the ear. A distinguishing feature of this disease is the cottony mycelial growth (Figure 1), which may appear whitish, pale pink, or light lavender, often affecting individual kernels or small clusters. In most cases, the infection remains confined to areas of mechanical injury, such as those caused by insect feeding, rather than spreading across the entire ear.

Figure 1. Whitish mycelial growth on maize ears

Figure 2. Starburst symptoms

However, in severe cases, scattered patches of infection may be observed on the ear surface. A characteristic symptom, known as the "starburst" pattern (Figure 2), is visible as white or pink streaks on the tops of infected kernels. Additionally, symptomless infections can occur through systemic growth of *F. verticillioides*, where the fungus spreads from infected seeds, roots, or stalks to the ear. Aspergillus ear rot (AER) caused by A. flavus is characterized by a powdery, yellow-green to olive-colored mold that develops on maize kernels and cobs. It often starts at the ear tips but can expand to cover the entire ear, especially under favorable environmental conditions. However, in AER caused by *A. niger*, dark blackish powdery mass can be seen at the tips of the ears.

EPIDEMIOLOGY

Different weather parameters like temperature, relative humidity and rainfall play an important role in disease epidemics. FER and AER, as well as their mycotoxin production are favoured by warm and dry weather conditions. The temperature of 27 °C and 32-38 °C is found highly congenial for both ear rots and mycotoxin contamination, respectively. The relative humidity of up to 85 per cent results in increasing the incidence of both ear rots. Higher ear rot severities have been observed under drier and warmer years. Other favorable factors include the use of shriveled and poor-quality seeds, as well as high plant density, which are conducive to disease development. Excessive use of fertilizers especially nitrogen applications enhance plant succulence, which has been associated with increased disease susceptibility, leading to a higher incidence of ear rot disease. Pathogen being soil borne in nature subsists on stubbles and leftover material of maize after harvesting the crop. So, mono-cropping in the infected fields results in inoculum buildup leading to higher disease incidence in coming season. Various Lepidopteran insect-pests target maize during its reproductive stage, inflicting damage to the cobs by feeding on the silks and developing kernels. These feeding injuries create entry points that facilitate the invasion of fungal pathogens. The compromised grains and cob tissues provide a conducive environment for fungal colonization and proliferation, thereby exacerbating the incidence of ear rot.

INTEGRATED MANAGEMENT STRATEGIES

1. Host plant resistance

Resistance to FER and AER is polygenic in nature and is governed by many quantitative trait loci (QTL's). A number of inbred lines *viz,* CML 495, CML 444, CML 390, CML 264, CKL 05015 and CB 222 *etc*. have been found resistant to both ear rots and their mycotoxins (fumonisins and aflatoxins). Several studies concluded that the QTL's reported for ear rots (FER and AER) also confer resistance against mycotoxin (fumonisins and aflatoxins) contamination. Presently in countries like USA, many hybrids have been tested against FER, AER and their mycotoxins. However, the adequate level of resistance is still lacking and efforts are being made to identify new sources of resistance.

2. Cultural control

- **Crop rotation:** The ear rot causing fungi namely-*Fusarium* and *Aspergillus* spp. are primarily soil borne in nature. These fungi persist on crop residues left in the field after harvesting till the next season. Therefore, crop rotation with non-host crops such as legumes, can be helpful in reducing fungal inoculum and reduction of disease incidence.
- **Tillage practices:** Tillage practices facilitate the incorporation of crop residues into deeper soil layers, effectively reducing the inoculum of fungal pathogens. Additionally, under certain conditions, these practices enhance water availability to plants by accessing

moisture from deeper soil layers, thereby alleviating water stress and subsequently decreasing the plants' susceptibility to ear rot.

- **Hybrid selection:** Several morphological features of hybrids *viz*; kernel pericarp thickness, coverage of husk on cob and tightness of cob husk were indirectly found effective to manage ear rot disease. As these characters influence the injury caused by insect pests and hence affect the intensity of ear rot. It has been reported that the hybrids tolerant to heat and drought stress are less susceptible to ear rot and mycotoxin accumulation.
- **Seed treatment:** Use healthy seed for sowing. Seed treatment with fungicides effectively mitigates fungal infection at the seedling stage, thereby reducing ear rot severity at later growth stages.
- **Plant population:** High plant density aggravates ear rot intensity by making the microclimate of crop more favorable to the pathogen. Therefore, optimum plant density should be preferred to manage the ear rot disease.
- **Fertilizer dose:** High and low doses of nitrogen application increase the ear rot and mycotoxin contamination in maize crop. So, adequate amount of N fertilizer should be applied to the crop to get rid of the disease.
- **Post-harvest storage:** After harvesting, seed should be dried at appropriate moisture conditions (≤15%) before storage. The harvesting combines should be adjusted to cause minimum grain damage to minimize the mycotoxin contamination under storage conditions.

3. Biological control

Biological control serves as a key component of integrated disease management strategies, offering sustainable and eco-friendly solutions for disease management. The studies have shown that application of atoxigenic strains of *A. flavus* at reproductive stage of the crop reduces the AER and aflatoxin contamination by outcompeting the toxigenic strains of the fungus.

4. Chemical control

- **Insecticidal application:** Insecticide applications aid in reducing incidence of different insect pests during reproductive stage of crop, and indirectly helping in managing the ear rot disease. It has been found that a single application of insecticide at right stage of crop during flowering results in reducing ear rot and mycotoxin accumulation in the maize grains.
- **Fungicidal application**: The application of fungicides like thiophanate methyl, tebuconazole and prothioconazole has been found effective against both FER and AER but not widely recommended due to residue problem and labor cost.

CONCLUSION

Effective management strategies during pre-harvest and post-harvest crop stage not only minimizes yield losses but also reduces mycotoxin contamination during storage and processing, ensuring food safety and quality. By adopting these strategies, we can pave the way for sustainable maize production even under challenging climatic conditions.

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