Fusarium Head Blight: A Significant Wheat Disease and its Management

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Fusarium Head Blight (FHB) is a devastating disease of wheat crop which severely affects wheat, barley, oat, rye, corn and some forage crops. This disease is predominantly caused by the fungus Fusarium graminearum where as other Fusarium spp. such as Fusarium avenacearum, Fusarium culmorum, Fusarium poae, Fusarium acuminatum and Fusarium reticulatum are also reported to be associated with FHB. FHB is reported to cause significant yield loss ranges of 20-100%. In India this disease causes significant yield losses in foot hills of Punjab, Himachal Pradesh, Uttarakhand and hilly areas of Tamil Nādu. First symptoms of Fusarium Head Blight (FHB) disease occurs soon after flowering. Under moist condition, pinkish to orange mycelium is observed at the base of the florets. On the progress of disease, the pathogen causes shrinkage and of light brown discolouration of grains. Fusarium graminearum overwinters on infested crop residues such as corn stalks, wheat straw, sorghum straw and other host plants. The pathogen requires 25 to 28°C temperature and >90% humidity for rapid spore germination and infection. As the pathogen is soil borne in nature, crop rotation with nonhost crop such as pulses is recommended for disease management. Among the chemicals, Triazole group of fungicides such as Propiconazole, Prothioconazole and Tebuconazole perform best. Several biocontrol agents such as Bacillus species, Penicillium olsonii etc also contribute to control FHB and the reduction of mycotoxin (Deoxynivalenol) contamination.

Introduction

Fusarium Head Blight (FHB) is also called scab is a devastating disease of Wheat crop. It can also affect barley, oat, rye, corn and some forage crops. This disease was first recognised in North America in 1900. Over the past several years, severe outbreaks of FHB have been reported from Canada, Europe, Asia, Australia and South America. Since 1990, wheat and barley farmers in the United States have incurred losses exceeding $3 billion due to FHB epidemics. This disease is predominantly caused by the fungus *Fusarium graminearum* where as other *Fusarium* spp such as *Fusarium avenacearum*, *Fusarium culmorum*, *Fusarium poae*, *Fusarium acuminatum* and *Fusarium reticulatum* are also reported to be associated with FHB. A mycotoxin called Deoxynivalenol (DON) is considered as primary toxin associated with FHB pathogen. This mycotoxin is also called as vomitoxin as it causes harmful effects on digestive system of vertebrates. According to USDA recommendation, the DON levels in human being should not exceed 1 ppm whereas DON levels in FHB infected wheat are more than 20 ppm. FHB is reported to cause significant yield loss ranges of 20-100%. In India this disease causes significant yield losses in foot hills of Punjab, Himachal Pradesh, Uttarakhand and hilly areas of Tamil Nadu.

Symptomatology

First symptoms of FHB disease occurs immediately after flowering. Under moist condition, pink to orange mycelium is observed at the base of the florets. On the rachis, glumes and spikelets, light pinkish sporodochia may appear. Later, bluish to black spherical bodies (Perithecia) may appear on the surface of affected spikelet. On the progress of disease, the pathogen causes shrinkage of grains due to which, infected kernels impart rough, shrivelled, pink to light brown discolouration (Fig. 1).

Premature bleaching occurs in diseased spikelets which may progress throughout the entire head and forms Fusarium damaged kernels which are also known as "Tombstone Kernels" that can result in a poor yield.

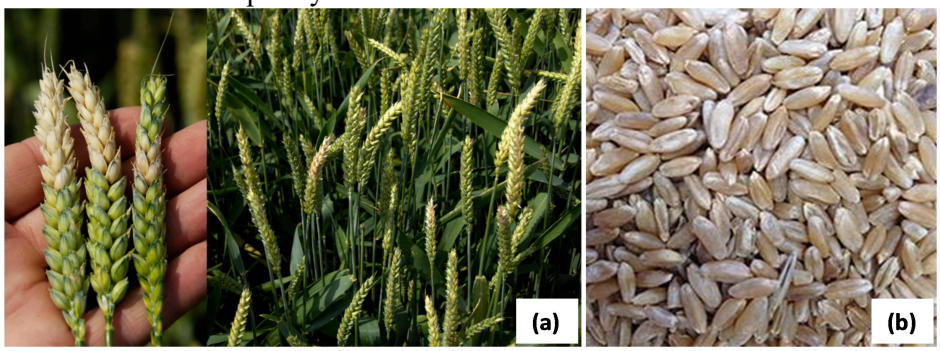

Fig 1: Symptomatology of Fusarium Head Blight of Wheat (a) Symptoms on plant and (b) Wheat seeds

Etiology

Macroconidia are produced by *Fusarium graminearum* in its asexual stage. The canoe shaped, hyaline macroconidia typically have five or more septa. Conidium-producing cells, known as phialides, are grouped together in a cushion-shaped structure called sporodochia. The fungus's sexual stage is *Gibberella zeae*, which produces brightly coloured fruiting bodies known as perithecia. As they mature, the perithecia of *G. zeae* turn dark blue. Inside an ascus-like structure, sexual spores, or ascospores, develop. These ascospores are hyaline to light brown, slightly curved, and have rounded ends (Fig. 2).

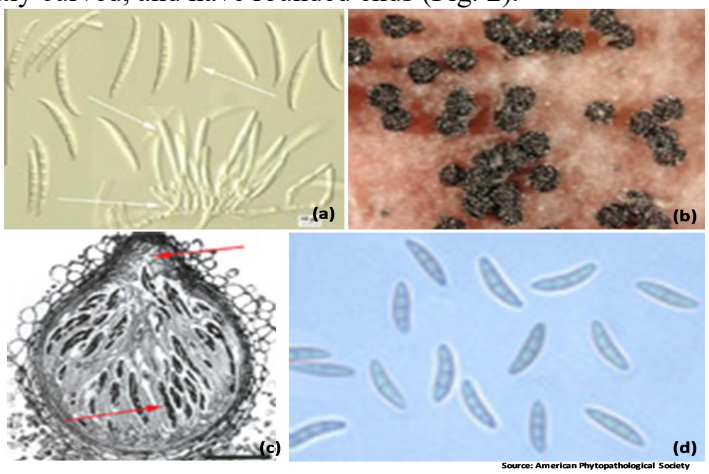

Fig 2: *Fusarium graminearum* (Teleomorph- *Gibberella zeae*) (a) Macroconidia is produced on conidiogenous cells called Phialides, (b-c) Perithecia (d) Ascospores.

Disease cycle

Fusarium spp can survive as saprophytes or act as pathogens on various crops. *Fusarium graminearum* survives on infected crop residues, including corn stalks, wheat straw, sorghum straw, and other host plants. On these residues, the fungus produces asexual

spores (macroconidia), which are spread by wind or rain-splash. Under favorable conditions, the fungus enters its sexual stage on the infested plant debris. Bluish-black perithecia develop on the surface of these residues and actively release sexual spores (ascospores) into the air. The ascospores violently discharge from perithecia and carried off by strong wind or can be spread by rain splashes (Fig. 3).

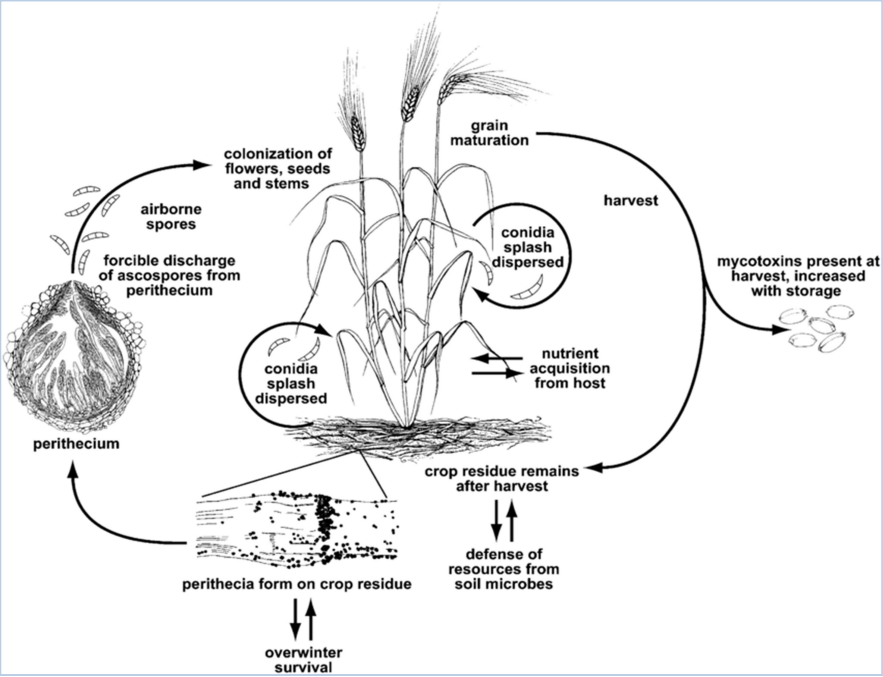

Fig 3: Disease cycle of Fusarium Head Blight (FHB)

Pre disposing factors

Temperatures between 25-28 °C and high humidity (>90%) for at least 12 hours are favourable for spore germination and disease establishment. FHB infection is most likely to develop in July when the florets are open during flowering, providing an opportunity for spores to reach them. Additionally, wounds caused by birds, insects, or hail can serve as entry points for the FHB fungus. If warm and humid conditions persist after seed formation, mycotoxin production increases significantly.

Note: FHB forecasting models can assist (such as www.wheatscab.psu.edu) to forecast the probability of infection.

Management strategies

Cultural methods

- As the pathogen is soil borne in nature, crop rotation with non-host crop such as pulses is advisable.
- Disease intensity can be lowered by rotating away from cereal crops for at least one year and ideally two years.
- Avoid planting cereals close to fields that experienced substantial FHB infection in the previous year.
- Removal of cereal crop residue, tillage of soil at regular interval reduces the amount of resting spore that can infect a subsequent wheat crop.
- Avoid irrigation during flowering to reduce humidity therefore, infection period can be reduced.

Biological control

- Spore producing bacteria such as *Bacillus* species and yeasts such as *Cryptococcus flavescens* contributes for the control of FHB and the reduction of mycotoxin contamination.
- Endophytes such as *Sarocladium strictum*, *Anthracocystis floculoss* aand *Penicillium olsoniiare* identified as potential biocontrol agents against FHB in wheat.

Chemical control

- The best timing of application of fungicide is early flowering but application up to 7 days after initiation of flowering canal so reduce FHB and mycotoxin contamination.
- Triazole group of fungicides such as Propiconazole @ 41.8% Prothioconazole @ 41%, Tebuconazole @ 38.7% work best when applied at or within a week of early flowering whereas Strobilurin fungicides are not recommended against FHB as these can increase mycotoxins accumulation.

Disease resistance

- Root application of Silicon @ 1.7mM enhances host resistance hence reduces FHB incidence and severity.
- Wheat genotype Sumai 3 and Ning 7840 are recommended as very important resistant sources for FHB and have been used worldwide.

Conclusion

FHB continues to pose a significant danger to wheat production globally. While certain disease management measures have reduced disease, but the present reliance on fungicides raises concerns. There are worries about fungicide resistance and its impact on human, animal and environmental health. Therefore, further study is needed to improve FHB management techniques.