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Powdery Mildew of Wheat: Symptoms and Control

Dr. Meghaa Sharma¹ and *C.V. Abhinetra Reddy²

¹Assistant Professor, Faculty of Agriculture, Jagannath University, Jaipur, India

²Student, B.Sc. (Hons.) Agriculture, Jagannath University, Jaipur, India

*Corresponding Author's email: cvabhinetrareddy@gmail.com

Powdery mildew of wheat, caused by the obligate biotrophic fungus *Blumeria graminis* f. sp. *tritici*, is recognized as one of the most widespread and economically significant foliar diseases of wheat worldwide [1]. Substantial yield losses are recorded in many wheat-growing regions, particularly in areas characterized by cool temperatures and high relative humidity during the crop season [2]. A broad range of susceptibility is exhibited by commonly cultivated wheat varieties to the virulent isolates of the powdery mildew pathogen [3]. The economic stability of wheat farmers is seriously undermined when epidemics develop rapidly under favorable environmental conditions, reducing grain filling and overall productivity [4].

Epidemiology of Powdery Mildew

Pathogen Lifecycle

An entirely epiphytic existence is maintained by *Blumeria graminis* f. sp. *tritici* on the surface of the host plant, with specialized infection structures known as haustoria penetrating epidermal cells to absorb nutrients [5]. Asexual reproduction occurs rapidly through the production of conidia in long chains on erect conidiophores, enabling explosive multiplication of the pathogen within a single growing season [1]. Sexual reproduction is accomplished through the formation of chasmothecia (formerly cleistothecia), which serve as overwintering survival structures on crop debris [6]. Primary inoculum in the following season originates from ascospores released from overwintered chasmothecia, while secondary spread is accomplished by wind-dispersed conidia throughout the season [5].

Environmental Requirements

Infection is most favoured by cool temperatures ranging between 10°C and 22°C, with optimum disease development occurring around 15°C to 18°C [7]. Unlike most foliar fungal diseases, free water on the leaf surface is not required for conidial germination; instead, high relative humidity between 85% and 100% is sufficient for infection [6]. Shaded, dense crop canopies with poor air circulation are identified as critical microenvironmental conditions that greatly accelerate epidemic development [2].

Symptoms and Diagnosis

Superficial, white to grayish-white powdery colonies are observed initially on the upper surface of lower leaves, sheaths, and subsequently on stems, upper leaves, and heads [3].

The powdery appearance of lesions results from the dense mass of conidiophores and conidia produced on the surface of infected tissues [8].

Chlorotic yellowing of the tissue beneath fungal colonies is commonly observed as the disease progresses, caused by the diversion of host nutrients by haustoria [1].

In severe infections, the affected tissues turn brown and necrotic, leading to premature senescence of leaves, reduced photosynthetic area, and significant grain shriveling [7].

Distinct dark-brown to black chasmothecia embedded within the white mycelial mat are diagnostic features observed as the crop approaches maturity [5].

Management Strategies

Host Resistance

The deployment of resistant cultivars carrying specific powdery mildew resistance (Pm) genes is considered the most economical and environmentally sustainable management strategy [9].

Pyramiding of multiple Pm genes in a single cultivar is recommended to broaden the spectrum of resistance and delay the emergence of virulent pathogen races [10].

Chemical Control

Foliar application of systemic fungicides, including triazoles (e.g., propiconazole, tebuconazole) and strobilurins (e.g., azoxystrobin), is recommended when disease incidence exceeds established economic threshold levels [11].

Seed treatment with systemic fungicides is practiced in regions with a history of early-season powdery mildew outbreaks to provide initial protection to seedlings [12].

Cultural Practices

Optimum plant density is maintained by following recommended seed rates to reduce canopy humidity and minimize the microenvironmental conditions that favor disease development [2].

Balanced fertilization with particular attention to avoiding excess nitrogen application is advised, as lush vegetative growth promotes dense canopies susceptible to mildew infection [7].

Timely sowing within recommended windows is encouraged to enable the crop to avoid the most critical periods of high humidity and cool temperatures during which the pathogen thrives [12].

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