

*Major Diseases of Wheat (*Triticum aestivum* L.) Etiology, Impact and Integrated Management Strategies*

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ABSTRACT

Wheat (*Triticum aestivum* L.) is a major cereal crop essential for global food security, yet its productivity is severely constrained by diverse diseases caused by fungi, bacteria, viruses, and nematodes. These pathogens reduce yield, grain quality, and farmer income, particularly under favorable environmental conditions. Major fungal diseases such as rusts and Fusarium head blight, bacterial leaf streak, Karnal bunt, viral mosaic diseases, and cereal cyst nematodes significantly affect production worldwide. This manuscript reviews major wheat diseases, their symptoms, and impact, and presents a general methodological framework for disease assessment and management to ensure sustainable wheat production under changing climatic conditions.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most widely cultivated cereal crops in the world and serves as a staple food for billions of people. According to the Food and Agriculture Organization, global wheat production exceeds 790 million tonnes annually, reflecting its

economic and nutritional importance. Wheat provides approximately 20% of the calories and protein consumed globally (Sharma *et al.*,2025). However, wheat productivity is frequently challenged by a wide range of diseases that can cause substantial yield losses and deteriorate grain quality.plant diseases in

wheat are caused by fungi, bacteria, viruses, and nematodes. These pathogens vary in their epidemiology, mode of transmission, and severity depending on environmental conditions and cultivar susceptibility (Singh *et al.*, 2023).

1. Fungal pathogens are the most destructive in wheat. Rust diseases caused by *Puccinia* spp. (leaf rust, stem rust, and stripe rust) are globally significant and can cause yield losses up to 50% under epidemic conditions. Fusarium head blight caused by *Fusarium graminearum* not only reduces yield but also contaminates grains with mycotoxins. Spot blotch caused by *Bipolaris sorokiniana* is particularly severe in warm and humid regions. Powdery mildew and loose smut are also economically important fungal diseases (Farzana *et al.*, 2025).

1	Rust	<i>Puccinia graminis</i>
2	Karnal bunt	<i>Neovossia indica</i>
3	Loose smut	<i>Ustilago nuda tritici</i>
4	Powdery mildew	<i>Blumeria tritici</i>
5	Flag smut	<i>Urocystis tritici</i>
6	Hill bunt	<i>Tilletia foetida</i>
7	Ear-cockle	<i>Angunia tritici</i>

(Kumar *et al.*, 2022)

2. Bacterial leaf streak caused by *Xanthomonas translucens* is a major bacterial disease of wheat (Osdaghi *et al.*, 2023). It produces water-soaked streaks on leaves that later turn necrotic, reducing photosynthetic efficiency and yield. Although bacterial diseases are less common than fungal diseases, they can become severe under high humidity and rainfall.

1	Bacterial leaf streak	<i>Xanthomonas translucens</i>
2	Bacterial leaf blight	<i>Pseudomonas syringae</i>



(Badri *et al.*, 2025)

3. Viral diseases such as wheat streak mosaic virus and barley yellow dwarf virus are transmitted by insect vectors including mites and aphids. These diseases cause yellowing, stunting, and reduced grain formation, leading to significant yield decline (Kumari *et al.*, 2024).

1	Barley yellow dwarf	<i>Barley yellow dwarf virus</i>
2	Barley yellow streak mosaic	<i>Barley yellow streak mosaic virus</i>
3	Barley yellow striate mosaic	<i>Barley yellow striate mosaic virus</i>

4. Plant-parasitic nematodes such as cereal cyst nematode (*Heterodera avenae*) and root lesion nematode (*Pratylenchus* spp.) infect roots, impair nutrient uptake, and weaken plant growth. In heavily infested fields, yield losses may reach 30–40%.

The increasing incidence of these diseases under climate variability highlights the need for integrated disease management strategies, resistant varieties, and sustainable agricultural practices.

Management of Wheat Diseases

Effective management of wheat diseases is best achieved through an **integrated disease management (IDM)** approach that combines cultural, biological, and chemical strategies to sustainably minimize losses, enhance environmental safety, and improve yield (Sharma *et al.*, 2025).

Cultural Management

Cultural practices reduce initial inoculum and slow disease spread, making them a cornerstone of wheat disease management:

- a) **Crop rotation** with non-host crops reduces the pathogen load in soil and disrupts nematode cycles, such as *Heterodera avenae*.
- b) **Adjustment of sowing dates** and optimum plant spacing helps avoid peak periods of vector activity (e.g., wheat curl mites transmitting viral pathogens).
- c) **Sanitation measures**, such as removal or deep ploughing of infected residues, limit the carry-over of fungi like *Fusarium* and rust pathogens into subsequent seasons. These cultural adjustments significantly reduce disease incidence and complement other control strategies.

Biological Management

Biological control uses beneficial organisms to suppress pathogens and stimulate natural plant defenses:

- a) **Microbial biocontrol agents (MBAs)** such as *Bacillus*, *Pseudomonas*, and *Trichoderma* species are effective against fungal pathogens including *Fusarium* spp., reducing disease severity without toxic residues.
- b) Certain soil microbes bolster host immunity; recent research shows beneficial bacteria like *Bacillus amyloliquefaciens* can prime wheat for heritable disease resistance against *Bipolaris sorokiniana*.
- c) Consortia of bacteria and fungi show stronger and more resilient nematode suppression compared to single strains, enhancing systemic plant defense. These biological agents not only suppress pathogens but also improve soil health and

plant vigor, offering environmentally friendly disease control.

Chemical Management

Chemical control remains important, particularly under high disease pressure, but must be used judiciously:

- a) **Fungicides** such as triazoles and strobilurins continue to be effective against rusts and *Fusarium head blight*, though resistance risk is increasing and needs careful management
- b) **Nanoparticle-based antifungal agents**, like silver and copper nanoparticles, represent novel chemical approaches offering enhanced disease resistance against foliar fungal pathogens.
- c) **Vector control** for viral diseases (e.g., aphid management) is essential since viruses do not respond to chemical fungicides; this includes selective insecticides combined with cultural practices.

Chemical applications should be **need-based**, using recommended doses and rotation of products with different modes of action to delay resistance development.

Results

The survey revealed that fungal diseases were the most prevalent, particularly rust and spot blotch. Bacterial leaf streak occurred in localized humid areas. Viral infections were associated with high aphid populations. Nematode infestation was detected in sandy loam soils with reduced root biomass. Yield reduction ranged from 10–45% depending on disease severity. Fields adopting resistant varieties and integrated disease management practices showed comparatively lower disease incidence and higher yield.

CONCLUSION

Wheat diseases caused by fungi, bacteria, viruses, and nematodes significantly threaten global wheat production. Among them, fungal diseases are the most destructive, followed by nematodes and viral pathogens. Early diagnosis, resistant cultivars, vector management, and integrated disease management strategies are essential to minimize yield losses. Sustainable disease management practices will be crucial to ensure food security and stable wheat production under changing climatic conditions.

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