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Blast Disease of Pearl Millet in Western Rajasthan: Identification, Pathogen Biology, Disease Cycle and Integrated Management

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Pearl millet (*Pennisetum glaucum* L.), popularly known as Bajra, is one of the most important cereal crops grown in the arid and semi-arid regions of India. Rajasthan is the leading pearl millet-producing state in the country, and the crop occupies a substantial area in the western districts such as Jodhpur, Barmer, Jaisalmer, Bikaner, Nagaur, Churu, Jalore, Pali and Sikar. Pearl millet is highly valued because of its ability to tolerate drought, high temperatures and poor soil fertility. It serves as an important source of food, fodder and livelihood security for farming communities. In recent years, blast disease has emerged as a serious threat to pearl millet cultivation in Western Rajasthan. Changes in weather patterns, intermittent rainfall, increased humidity and cultivation of susceptible hybrids have contributed to the increasing occurrence of the disease. Under favourable environmental conditions, blast disease can spread rapidly and cause severe losses in grain and fodder yield. Therefore, awareness regarding symptoms, pathogen biology, disease cycle and management practices is essential for successful disease control.

Importance of Pearl Millet in Western Rajasthan

Pearl millet is often called the "lifeline crop" of arid Rajasthan because it performs well under moisture-stress conditions where many other cereals fail. The crop contributes significantly to Food and nutritional security, Livestock fodder availability, Income generation for farmers and sustainable agriculture in drought-prone regions. The increasing incidence of blast disease poses a serious challenge to the productivity and profitability of pearl millet cultivation.

Causal Organism

Blast disease of pearl millet is caused by the fungus *Magnaporthe grisea* (Cooke) Sacc. (anamorph: *Pyricularia grisea*). The fungus belongs to the phylum Ascomycota and is one of the most destructive pathogens affecting cereal crops. It infects several grasses and millet species and is capable of causing disease at different stages of crop growth. The pathogen reproduces mainly through asexual spores called conidia, which are responsible for rapid disease spread in the field. These spores are produced abundantly on infected plant parts and can be carried over long distances by wind.

Morphological Characteristics of the Pathogen

Mycelium: The vegetative body of the fungus consists of branched and septate hyphae.

- Young mycelium is hyaline (transparent).
- Mature mycelium becomes grayish to olive-colored.
- The fungus grows both within and on the surface of plant tissues.

Conidiophores

- Conidiophores arise from infected tissues.
- They are simple, slender and septate structures.
- Each conidiophore bears several conidia.

Conidia: The conidia are the most important structures involved in disease spread. Pear-shaped (pyriform) or spindle-shaped.Generally two- to three-celled. Light gray to olive-colored. Easily detached and dispersed by wind and rain.

Sexual Stage: The sexual stage (*Magnaporthe grisea*) is rarely observed under field conditions. Therefore, disease spread occurs mainly through the asexual stage (*Pyricularia grisea*).

Survival of the Pathogen

The blast fungus survives between crop seasons through several means:

Infected Crop Residues: The fungus survives in infected leaves, stems, ear heads and stubbles remaining in the field after harvest.

Volunteer Plants: Self-sown pearl millet plants can harbor the pathogen and serve as a source of infection.

Alternate Grass Hosts: Several wild grasses growing around fields may carry the fungus and help it survive during the off-season.

Seed-Borne Survival: In some cases, the pathogen may survive on seed surfaces and initiate primary infection in the next crop.

Symptoms of Blast Disease

Leaf Blast

Leaf blast is usually the first symptom observed in the field. Small water-soaked spots on leaves. Enlargement of spots into spindle-shaped lesions. Gray or whitish center with dark brown margins. Merging of lesions under severe infection. Drying and death of affected leaves.

Severe infection greatly reduces the photosynthetic area of the plant.

Node Blast

The pathogen may infect stem nodes. Brown to black discoloration of nodes. Weakening of affected portions. Reduced transport of water and nutrients.

Neck Blast

Neck blast is one of the most damaging forms of the disease. In which Brown or black lesions at the neck region below the ear head. Premature drying of ear heads. Incomplete grain filling. Reduced grain weight.

Ear Head Blast

Ear head infection causes serious economic losses. Drying of spikelet's. Shrivelled grains. Poor grain development. Premature bleaching of ear heads.

Disease Cycle of Blast

The disease cycle consists of survival, spore production, dissemination, infection and secondary spread.

Primary Inoculum

The fungus survives on crop debris, volunteer plants and alternate hosts. During favourable weather conditions, it becomes active and produces conidia.

These conidia act as the primary inoculum and initiate disease in new crops.

Spore Dissemination: The conidia spread through wind currents, Rain splash, Irrigation water, Human activities and farm machinery. Wind dissemination is the most important mode of spread.

Spore Germination

When spores land on susceptible plant surfaces under favourable conditions, they germinate rapidly. Relative humidity above 85%. Presence of free moisture or dew. Temperature between 25–30°C. Germination may occur within a few hours under ideal conditions.

Formation of Appressorium: After germination, the fungus develops a specialized infection structure called an appressorium. The appressorium is adheres strongly to the plant surface. Generates high pressure. Penetrates plant tissues. This structure enables successful infection even through intact plant surfaces.

Penetration and Colonization: The fungus enters epidermal cells. Hyphae spread within plant tissues. Nutrients are absorbed from host cells. Internal colonization progresses rapidly.
Lesion Development: Visible symptoms appear within a few days after infection. Spindle-shaped. Greyish-white in the centre. Dark brown around the margins. These lesions serve as sites for new spore production

Secondary Infection

Large numbers of conidia are produced on infected lesions. These spores are dispersed repeatedly and continuous spread disease. Rapid increase in disease severity. Development of epidemics during favourable weather. Several infection cycles may occur during a single crop season.

Favourable Conditions for Disease Development

Blast disease becomes severe under the following conditions: Humidity above 85 percent promotes spore germination and infection. Intermittent rains provide moisture required for disease development. Temperatures between 25 and 30°C favour fungal growth and sporulation. Cloudy conditions prolong leaf wetness and increase infection. Heavy nitrogen application produces succulent growth that is highly susceptible to blast. Dense plant populations increase humidity and facilitate disease spread.
Epidemiology in Western Rajasthan: Traditionally, the hot and dry climate of Western Rajasthan limited blast development. However, changing climatic conditions and occasional periods of high humidity have increased disease incidence.
Severe outbreaks are generally associated with:

- Good monsoon rainfall.
- Continuous cloudy weather.
- Prolonged humidity.
- High-yielding susceptible hybrids. During favorable years, blast disease can spread rapidly and cause significant economic losses

Integrated Disease Management

Effective blast management requires an integrated approach.
1. Use Healthy Seed: Use certified and disease-free seed. Avoid seed from infected fields.
2. Resistant Varieties: Cultivation of resistant or tolerant varieties remains the most economical and effective strategy. Farmers should adopt varieties recommended by agricultural universities and state agricultural departments.
3. Crop Rotation: Avoid continuous cultivation of pearl millet. Crop rotation reduces pathogen survival.
4. Field Sanitation: Remove infected crop residues. Destroy volunteer plants.Control grassy weeds. These measures reduce carry-over inoculum.
5. Balanced Fertilization: Apply fertilizers according to soil test recommendations. Avoid excessive nitrogen application and maintain balanced nutrition through phosphorus and potassium.
6. Proper Plant Spacing: Recommended spacing improves air circulation and reduces humidity within the crop canopy.
7. Timely Sowing: Follow recommended sowing windows to avoid highly favorable disease conditions during critical growth stages.
Chemical Management: At the first appearance of disease symptoms, apply fungicides as recommended. A broad-spectrum systemic fungicide containing Tebuconazole (50%) and Trifloxystrobin (25%) WG @0.5 g per litre of water, Tricyclazole 75 WP @0.6 g per litre of water and Propiconazole 25 EC @ 1.0 ml per litre of water.

Spray Schedule

- First spray at disease initiation.
- Second spray after 10–15 days if disease persists.

Conclusion

Blast disease, caused by *Magnaporthe grisea* (*Pyricularia grisea*), has emerged as an important disease of pearl millet in Western Rajasthan. The pathogen survives on crop residues, alternate hosts and volunteer plants and spreads through wind-borne conidia under favourable environmental conditions. High humidity, intermittent rainfall and moderate temperatures promote rapid disease development. The disease affects leaves, nodes, necks and ear heads, resulting in significant reductions in grain and fodder yield. Adoption of integrated disease management practices including resistant varieties, healthy seed, crop rotation, field sanitation, balanced fertilization and timely fungicidal sprays can effectively reduce disease incidence and improve productivity. Continuous farmer awareness and regular field monitoring are essential for sustainable pearl millet production in the arid and semi-arid regions of Rajasthan.