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CIMMYT
International Maize and Wheat Improvement Center

A PICTORIAL GUIDE FOR
Field Identification of Wheat Diseases-Version II

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Foreword

This pictorial guide on wheat diseases is a crucial resource for agricultural professionals and enthusiasts alike, and it is my privilege to write the foreword for it. Wheat, as one of the most significant cereal crops globally, plays a vital role in food security, particularly in regions like Bhutan, where it is second only to paddy and maize.

The introduction of durum wheat by the National Wheat Program marks a significant advancement in Bhutan's agricultural practices, especially for pasta production. However, with the anticipated increase in wheat demand by 50% by 2050 (CIMMYT), the challenges posed by emerging pests and diseases cannot be overlooked. This guide aims to address these challenges by enhancing the diagnostic capabilities of our field colleagues, enabling them to effectively monitor and manage wheat diseases.

Through comprehensive visual aids and detailed descriptions, this guide serves as a vital reference for identifying various wheat diseases. It is designed to support proactive measures in disease surveillance and management, ultimately safeguarding our wheat production against potential outbreaks.

As we face an evolving landscape of agricultural challenges, this guide is not just a tool but a call to action for preparedness and vigilance. I commend the authors for their dedication to improving our understanding of wheat diseases and their impact on our agricultural systems. May this guide empower all who engage with it to contribute to the resilience and sustainability of wheat farming in Bhutan and beyond.

Trashidelek!

Yeshey Dema
(Program Director)

Content

1. Stripe rust/ Yellow rust

Causal agent: *Puccina striformis* f. sp. *tritici*

Conditions: Previously thought to be prevalent in cool climate & moist regions; now found in warm places as well. The disease may develop rapidly when free moisture (rain or dew) occurs and temperatures range between 10-20°C.

Symptoms: Yellow masses of spores from pustules (uredia) arranged in long stripes on leaves (Figure 1) but at early growth stages, often no stripes (Figure 2). It can also infect spikes under severe condition (Figure 3). Late in the season, black telia forms on the leaves (Figure 4).

Plant parts infected: Leaf blades & sheaths; stems; glumes and awns under severe condititon

Host range: Wheat (bread & durum); barley; rye, emmer wheat; triticale; some grass species.

Alternate host: *Mahonia* sp. (Figure 5) & *Barberry* sp. (Figure 6)

Importance: Severe infections can cause yield losses of >40% (100% loss is possible), mainly by reducing the number of kernels per spike, test weights, and kernel quality.

Figure 1: Yellow rust symptoms on older wheat leaves

Figure 2: Yellow rust symptoms on younger wheat leaves

Figure 3: Yellow rust symptoms on spikes

Figure 4: Teliospores on leaves

Figure 5: *Mahonia* sp.

Figure 6: *Barberry* sp.

Management practices:

- Use resistant cultivars
- Remove volunteer wheat plants (green bridge) to avoid early infection
- Use fungicides: Propiconazole @1ml per liter of water and carry out second spray within 10-14 days after first spray if necessary. Apply early in epidemic. If stripe rust appears after ear emergence only highly susceptible cultivars may need spraying. Fungicide seed treatment during the time of sowing can suppress early stripe rust.

2. Leaf rust/Brown rust

Causal agent: *Puccina triticina*

Conditions: The disease can develop rapidly when free moisture is available and temperatures are 15 -20°C.

Symptoms: Round to oval pustules with orange to light brown spores, found mainly on the upper surface of leaves and sheaths (Figure 7). Pustules seldom penetrate the leaf. **Late in the season,** it develops black teliospores, usually on the under surface of the leaf or on the leaf sheath.

Plant parts infected: Leaves, sheaths, glumes and awn

Host range: Wheat; Tricale; emmer wheat; some wild grass species

Alternate hosts: *Thalictrum* sp.; *Anchusa* sp.; *Isopyrum*; *Clematis*

Importance: Severe early infections can cause significant yield losses, mainly by reducing the number of kernels per spike, test weights, and kernel quality. Losses over large areas are generally light to moderate 1- 20%.

Figure 7: Various symptoms of leaf rust on the wheat leaves

Management Practices:

- Use resistant cultivars
- Remove volunteer wheat plants
- Use fungicides: Propiconazole @1ml per liter of water and carry out second spray within 10-14 days interval if necessary.

3. Stem rust/Black rust

Causal agent: *Puccina graminis* f. sp. *tritici*

Conditions: Hot days 25-30°C, mild nights 15-20°C with adequate moisture for night time dews.

Symptoms: Oval pustules with brick red spores and the pustules rupture the epidermis (Figure 8a & 8b),pustules break through leaf – visible on upper and lower surface of leaf (Figure 10). In late season these pustules will turn into black teliospores (Figure 11).

Plant parts infected: All above ground plant parts (Leaves, sheaths, stems and spikes (Figure 9).

Host range: Wheat (bread & durum), barley and triticale

Alternate host: *Barberry* sp. *& Mahonia* sp.

Importance: If infection happens during the early stages of the crop, the consequences can be severe, including reduced tillering and a decline in grain weight and quality. When conditions favor the disease, total crop loss may occur.

Figure 8a: Stem rust symptoms on young plants

Figure 8b: Stem rust symptoms on wheat stems

Figure 9: Symptoms on spike

Figure 10: Symptoms on leaves

Figure 11: Stem rust teliospores on stem

Management Practices:

- Use resistant cultivars
- Control of volunteer wheat plants
- Use fungicides: Propiconazole @1ml per liter of water and carry out second spray within 10-14 days interval if necessary.
- If stem rust appears before heading and >5% of stems infected, spray is recommended on moderately susceptible – susceptible cultivars.

4. Fusarium Head Blight

Causal agent: *Fusarium graminearium*

Conditions: Infection is favored by warm and humid weather during and after heading. Temperatures between 10-28°C are required for infection.

Symptoms: Bleached heads /spikelet (Figure 12), pink to salmon

colour (Figure 13), Awns extended outwards (Figure 14). Shape of the spores under microscopic observation: **"banana"** shaped (Figure 15)

Plant Parts infected: Spikes and leaves

Importance: Severe levels of infection can cause yield losses of more than 50 percent and significant reductions in grain quality. Kernels from diseased spikes are often shriveled. Harvested grain containing more than five percent infected kernels can contain enough mycotoxin to be harmful to humans and animals.

Figure 12: FHB symptoms on spikes/heads

Figure 13: Pinkish colour symptoms

Figure 14: Awns extended outward

Figure 15: FHB spores

Management Practices:

- Use resistant cultivars
- Residue management-managing the crop residue of maize, wheat and barleys to reduce the disease inoculum by burning.
- Crop rotation- Avoid growing maize, wheat and barleys in same field every year, instead rotate those crops with some other crops like canola, mustard, pulses, forage legumes, soya to reduce the disease pressure.
- Vary planting time. Asynchronous flowering can reduce risk
- Use of fungicides. Timing is critical. If weather conditions are suitable apply at early flowering stage. Triazoles are the most effective, do not use strobilurins (these can increase mycotoxin levels). Spraying after disease symptoms are visible is not effective.
- Remove infected lightweight kernels (chalky kernels) after harvest. This will reduce mycotoxin levels (the infected kernels should not be fed to any livestock animals and it should be destroyed by burning)

5. Wheat blast

Causal agent: *Magnaporthe Oryzae Pathotype triticum* (MoT)

Conditions: The epidemiology of wheat blast is still largely unknown. Moderate to warm temperatures 18-25°C and continuous rainfall during flowering seem to be important factors favoring epidemics.

Symptoms: Highly bleached heads (Figure 16), dark gray / charcoal sporulation on rachis (Figure 17), Eye shaped lesions on leaves with gray or whitish centers surrounded by dark brown margins (Figure 18), Shape of the spores under microscopic observation: **"pear"** shaped (Figure 19).

Plant part infected: Spikes and leaves

Importance: Wheat blast is prevalent in Bangladesh and there is a high chance of disease spreading to neighbouring countries. Accidental spread on infected grain or seed is a risk. Under favorable conditions rapid and complete crop loss is possible.

Figure 16: Completely bleached spikes

Figure 17: Charcoal sporulation on rachis

Figure 18: Blast symptoms on leaves

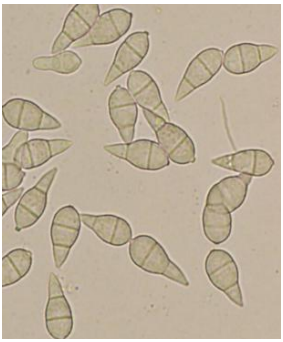

Figure 19: Wheat blast spores

Management Practices:

- Use resistant cultivars. Currently, cultivars with the 2NS translocation are exhibiting resistance.
- Management of volunteers and grassy hosts around wheat crops.
- Timely planting to avoid heading coinciding with warm + humid conditions.
- Crop rotations with non hosts – oilseeds and pulses.
- Seed treatment with fungicides
- Fungicide application (triazoles) at heading / early flowering. Spraying after disease symptoms are visible is not effective

6. Septoria blotch

Causal agent: *Zymoseptoria tritici*

Conditions: Initial infections tend to be on the lower leaves, progressing to the upper leaves and spikes if environmental conditions remain favorable. Cool temperatures (10-15°C) and prolonged wet, cloudy weather favors the development of these diseases.

Symptoms: Initially small yellowish spots on seedlings, black fruiting bodies visible to the naked eye on brownish tan spots, on mature leaves, lesions are long elliptical or shapeless; parallel to veins; **prominent fruiting bodies –pycnidia,** lesions may have yellow border (Figure 20).

Plant parts infected: Leaves

Importance: If these diseases reach severe levels prior to harvest, major losses can occur due to seed shriveling.

Figure 20: Septoria blotch symptoms on wheat leaves

Management Practices:

- Use resistant cultivars
- Crop rotation
- Stubble / Residue management. Avoid leaving lots of wheat stubble on the soil surface this can be a reservoir of disease.
- Use of fungicides (if disease pressure is high and susceptible cultivars grown). Foliar sprays are most effective when applied at flag leaf stage.

7. Septoria nodurium blotch/Septoria glume blotch

Causal agent: *Parastagnospora nodorum,* previously known as *Septoria nodorum*

Symptoms: Oval/lens shaped dark brown lesion with yellow border (halo), older lesions have grey centers, lesion coalesce and can cover whole leaf, pin-head size black structures (pycnidia) visible on mature lesions- not so prominent in Septoria blotch

Plant parts infected: Leaves, glumes, stems & nodes

Importance: If infection occurs early in the crop cycle and conditions remain favorable for development, complete defoliation is possible. Major reductions in yield and severely shriveled kernels will occur.

Figure 21: Glume blotch symptoms on leaves

Figure 22: Symptoms on spikes/heads

Management Practices:

- Use resistant cultivars
- Crop rotation
- Management of crop residues, complete burial of residues.
- Removal of wild grasses that can act as alternative host
- Fungicide seed treatment
- Use of fungicides (triazoles). The goal is to protect the flag leaf.

8. Spot Blotch (Bipolaris)

Causal agent: *Bipolaris sorokiniana*

Symptoms: Elongated to oval lesions, generally dark brown color, as lesions mature, the centers often turn a light brown to tan color, surrounded by an irregular dark brown ring (Figure 23). Primary infections tend to be on the lower leaves, beginning as chlorotic flecks or spots. These infection sites enlarge, turn dark brown, and often coalesce. When the disease is severe, affected leaves or leaf sheaths may die prematurely.

Plant parts infected: Leaves, stems and spikes

Importance: If infection occurs early in the crop cycle and conditions remain favorable for development, complete defoliation is possible. Which results in major reductions in yield and severely shriveled kernels. Under favourable conditions yield loss of >50% is possible. Average yield losses in South Asia are 15-20%

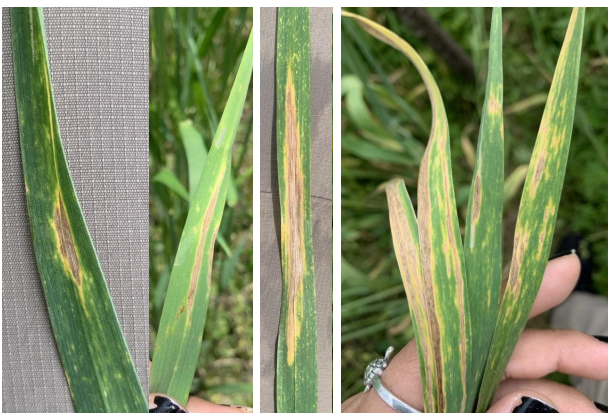

Figure 23: Spot blotch symptoms on wheat leaves

Management Practices:

- Use clean seed
- Seed treatment with fungicides
- Early sowing like 2-3 weeks earlier than the normal sowing time
- Good crop nutrient management (balanced application of nitrogen, phosphorous and potassium)
- Crop rotation with rice, oat, sunflower, soybean
- Management of crop residues, complete burial of residues.
- Use of fungicides (triazoles)

9. Loose smuts

Causal agent: *Ustilago tritici*

Conditions: Infection and disease development are favored by cool, humid conditions, which prolong the flowering period of the host plant.

Symptoms: Black, powdery fungal spores replace normal head tissues and infected heads produce no grain (Figure 24).

Plant part infected: Spikes

Importance: Yield losses depend on the number of spikes affected by the disease.

Figure 24: Loose smut symptoms on wheat

Management Practices:

- Use disease-free seeds
- Fungicide seed treatment

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