Rust Diseases of Wheat in North Dakota

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Three rust fungi have the potential to infect wheat and cause economic damage in North Dakota. Wheat leaf rust is the most common rust disease observed. Stem rust historically caused severe losses, but resistant varieties have made this disease rare in recent decades. Stripe rust was observed in the relatively cool summers of 2004 and 2005, but the disease was not widespread or at economic levels.

stem rust

Figure 2. Stem rust.

leaf rust

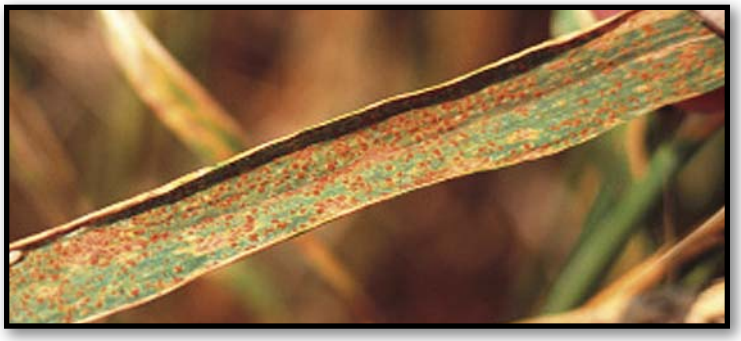

Figure 1. Leaf rust.

stripe rust & leaf rust

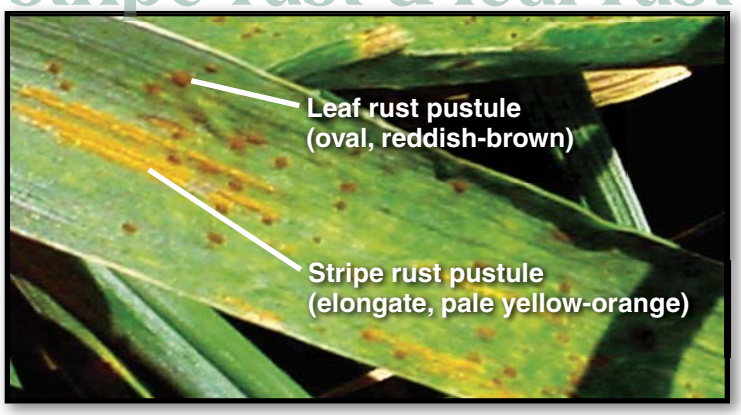

Figure 3. Stripe rust and leaf rust on wheat leaf.

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Wheat Leaf Rust

Cause and signs of disease: Wheat leaf rust, caused by the fungus *Puccinia triticina* (formerly *recondita* f. sp. *tritici*), reduces wheat yields in susceptible varieties when weather conditions favor rust development and spread. The most characteristic signs of leaf rust infection are the rusty-red spores in round to oval pustules breaking through the leaf surface (Figure 1). These spore masses are detected first on wheat in North Dakota in late May or early June, generally in the southern-most counties, and on lower leaves where higher humidity occurs.

Disease cycle: Leaf rust develops early in the spring on wheat grown in states farther south. The leaf rust spores are carried by wind currents, and the disease advances progressively northward across the Great Plains as the wheat crops develop (Figure 4). Leaf rust infections can lead to epidemics when environmental conditions are favorable. The following factors must be present for wheat leaf rust infection to occur: viable spores, susceptible or moderately susceptible wheat plants, moisture on the leaves (six to eight hours of dew) and favorable temperatures (60 to 80 degrees Fahrenheit). Relatively cool nights combined with warm days are optimum conditions for leaf rust development. Under favorable environmental conditions, rust spores germinate and penetrate into the leaf. The fungus obtains nutrients from the leaf and, within a week to 10 days, the fungus produces more spores, which erupt through pustules in the leaf surface. These newly produced spores are wind-blown to other wheat leaves or fields. By the end of the season, severe infection may result in reduced yields and lower test weights.

Yield loss and reduction of test weight are related to disease severity and time of infection. Yield losses of 30 percent to 40 percent have been recorded when severe infection occurred before flowering and damage on the flag leaf was high (> 60 percent to 100 percent, see Figure 5). However, if severe leaf rust does not occur until dough stages of kernel development or beyond, yield losses may be in the range of 5 percent to 15 percent.

Control

Resistance

Genetically inherited resistance is an excellent means of controlling leaf rust. Resistance limits infection and retards fungus growth and spore formation. Resistance levels vary among varieties and are classified according to the degree of resistance: R = Resistant, MR = Moderately Resistant, MS = Moderately Susceptible and S = Susceptible. Resistant and susceptible wheat cultivars react differently to infection. If a variety is resistant, the leaf retards or kills the fungus, and the infection is slowed or stopped. Resistant varieties may develop yellowish-white “flecks” at the site of spore penetration, while moderately resistant varieties develop yellowish-

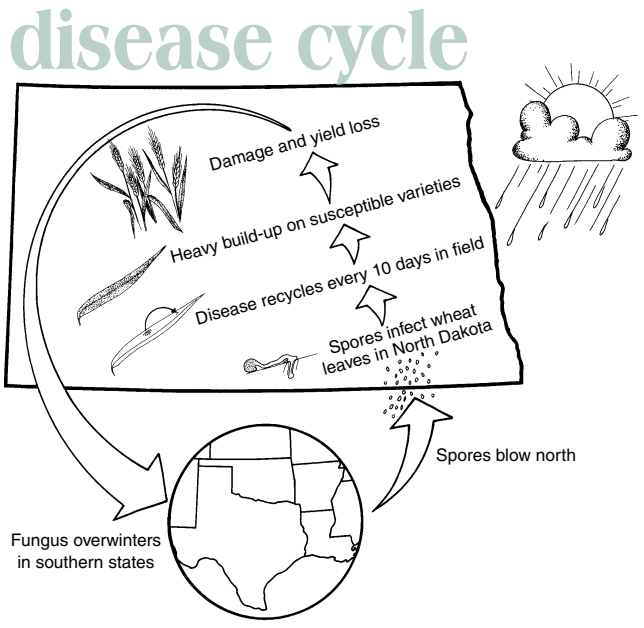

Figure 4. Leaf rust disease cycle.

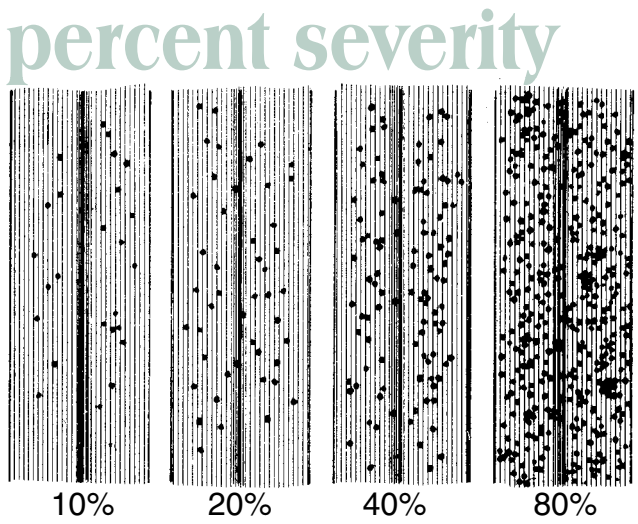

Figure 5. Percent severity.

white spots with a small amount of spore production in the center (Figure 6). Moderately susceptible varieties develop small reddish-orange pustules surrounded by a yellow-white halo (Figure 6). Susceptible varieties do not have the ability to retard fungal growth; the fungus grows extensively and produces relatively large pustules that may produce about 1,000 spores daily, each one of which is capable of re-infecting wheat (Figure 6). Therefore, this disease can increase rapidly and epidemics may occur whenever susceptible varieties are grown and weather conditions are favorable for rust development.

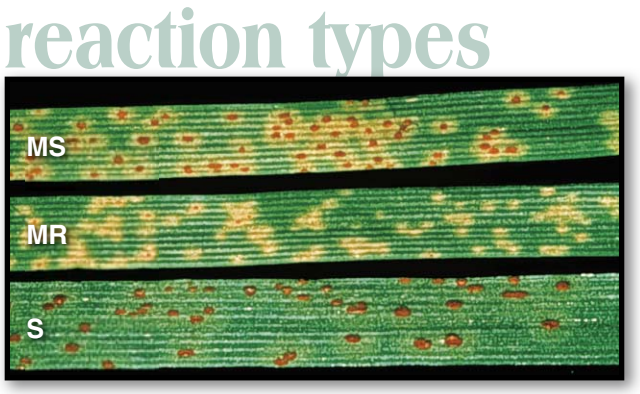

Figure 6. Wheat leaf rust reaction types.

The population of the leaf rust fungus is genetically diverse and made up of many races. Different races have the ability to cause infection on varieties with different resistance genes. The leaf rust pathogen is dynamic, and races are constantly changing. Varieties formerly considered resistant can become susceptible if new rust races develop. Resistant levels are updated each year for varieties. Consult the NDSU Extension Service publications A-574, "North Dakota Hard Red Spring Wheat Variety Performance Descriptions," and A-1196, "North Dakota Hard Red Winter Wheat Variety Performance Descriptions," for current rust resistance ratings of public and private varieties. Generally, durum varieties are considered resistant because of their "slow rusting" reaction; consult NDSU Extension publication A-1067, "North Dakota Durum Wheat Variety Performance Descriptions," for specific durum variety responses to leaf rust.

Fungicides

Fungicides are very effective in controlling wheat leaf rust when applied prior to infection. Fungicides specifically registered (in 2008) for wheat leaf rust control include mancozebs (Dithane, Manzate and Penncozeb), metconazole (Caramba), propiconazole (Tilt, Bumper and Propimax), propiconazole + trifloxystrobin (Stratego), azoxystrobin (Quadris), azoxystrobin + propiconazole (Quilt), pyraclostrobin (Headline), prothioconazole (Proline), and tebuconazole (Folicur, Orius). Fungicides often are re-evaluated for registered uses, and some new fungicides may become available. Consult the fungicide recommendations given in the most current NDSU Extension publication PP-622, "North Dakota Field Crop Fungicide Guide."

Fungicide application for leaf rust control is targeted to reach and protect the flag leaf. In North Dakota, the greatest response to leaf rust control in spring wheat generally has been when fungicides are applied to the flag leaf at full head emergence or early flowering (Feekes 10.5-10.51) growth stages, when the flag leaf is fully extended and grain heads are above the canopy. Typically, systemic fungicides are effective in the plant for about three weeks, and application at flag leaf emergence or early boot (Feekes 10) often results in the fungicide being dissipated in the leaf before the very high populations of rust spores develop in North Dakota. Application to the flag leaves prior to head emergence generally is recommended in North Dakota only if leaf rust infections become visible on the flag leaf prior to heading. No matter what growth stage of application, if more than 5 percent of the flag leaf is covered with leaf rust, you probably are too late to spray because many spores already may have penetrated the leaf, producing infections that will not be visible for seven to 10 days.

Good coverage is essential for control; 10 to 15 gallons of water per acre are recommended for ground application, while 5 gallons of water per acre are recommended for aerial application. Individual labels may have slightly different requirements, so consult the label of the individual fungicide product for appropriate timing of application, registered rates, preharvest intervals and restrictions against grazing or using straw for bedding.

Information on the risk of leaf rust infection may be found at the following disease forecasting Web site: **www.ndsu.edu/scabforecast**. Disease risk information is provided based on weather data from 69 North Dakota Agricultural Weather Network (NDAWN) locations.

Stem Rust

Cause and signs of disease: Stem rust is caused by the fungus *Puccinia graminis* f. sp. *tritici.* The most characteristic signs of stem rust are the irregular-shaped pustules filled with dark red-brown spores erupting through the plant tissue. Although pustules are found primarily on stems and leaf sheaths, the leaves, glumes and awns also may be infected. Pustules are generally elongated and have jagged edges on the wheat stem (Figure 2). When stem rust infection occurs, it may cause severe lodging and reduced yields and test weights.

Disease cycle: The alternate host of stem rust is the common barberry, a plant in which the fungus may overwinter and go through sexual recombination. Common barberry plants were eradicated in the spring wheat region in the 1950s to reduce the chance of this fungus overwintering and undergoing rapid genetic changes. Consequently, infection in North Dakota usually is caused by spores blown into our region from states to our south, similar to leaf rust as seen in Figure 4.

The stem rust fungus infects at warmer temperatures than leaf rust, with an optimum temperature for development near 80 F, and development stopping at temperatures above 100 F. These temperatures often coincide with the later stages of maturity of wheat in North Dakota, resulting in a late-season appearance.

All spring wheat and durum wheat varieties currently grown in North Dakota are resistant to the races of stem rust prevalent in the U.S. A few winter wheat cultivars are susceptible to prevalent races. A new race of stem rust has been identified in Africa (TTKS; originally referred to as race UG99), and most spring wheat varieties are susceptible to this new race, which will pose a threat to our wheat crops if it arrives in the U.S. The U.S. Department of Agriculture's Cereal Disease Laboratory in St. Paul, Minn., and other agencies are monitoring movement of this new race and screening wheat varieties and new germplasm for resistance. Resistance is the primary means of control of stem rust.

Stripe rust

Cause and signs of disease: This disease is caused by the fungus *Puccinia striiformis* f. sp. *tritici.* The infection is characterized by a yellow-orange spore that forms in parallel lines on the leaf surface (Figure 3). The oval, darker-colored pustules of leaf rust are easily distinguished from the infections of stripe rust on a single leaf (Figure 3).

Disease cycle: Stripe rust has been rare in North Dakota, but was observed in 2004 and 2005. The stripe rust spores were carried into North Dakota on winds from states such as Kansas and South Dakota, which had some severe stripe rust epidemics those years. The stripe rust fungus has the lowest optimal temperature for growth (50 to 60 F) of the three rust fungi. Cool, wet conditions favor this rust, and temperatures in North Dakota usually become too warm in July for any rapid development of this disease. North Dakota wheat varieties are not screened for resistance to stripe rust because of its rare occurrence. Fungicides effective for wheat leaf rust should be effective for stripe rust control.

For more information on this and other topics, see: www.ag.ndsu.edu

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