Between 1996 and 2008, bean varieties with resistance to rust made the threat of a bean rust epidemic in North Dakota very low. However, in 2008 a new race of the pathogen was identified in North Dakota. The new race has the ability to cause disease on the only commonly used effective resistance gene in common varieties. In 2010, the new race spread throughout North Dakota and into northwestern Minnesota. With the spread of the new race, the region is at risk again for the multimillion dollar yield losses caused by bean rust decades ago.

 Cause
Bean rust is caused by the fungal pathogen *Uromyces appendiculatus*. Numerous races of the pathogen exist and change through time. In 2008, a race that can cause disease on the resistance gene *Ur*-3 was discovered in Traill County, North Dakota (race 20-3). Prior to this, *Ur*-3 was effective against all known races in North Dakota, and the widespread use of this gene in varieties was very effective in managing bean rust in our region. At the time of the printing of this publication, no commonly grown variety is known to be resistant to the new race. Because most of the varieties are resistant to the “old” races of bean rust, producers should assume that any rust on dry beans is the new race or a variant of it.

 Signs and Symptoms
Bean rust usually is observed first as discrete pustules (called uredinia) about 1/16 inch diameter. Pustules are filled with cinnamon-brown spores, which leave a dusty brown streak when rubbed (Figure 1). On the upper surface of the leaf, pustules are relatively flat and often surrounded by a yellow halo (Figure 2a). On the under surface of the leaf, pustules are distinctly raised and have a dusty appearance (Figure 2b).
Bean rust usually is observed first in a field in distinct “hotspots,” or localized areas with severe infection ranging from a few feet to several dozen feet in diameter. Hot spots are difficult to see from a distance; leaves on top of the canopy may have very few pustules, while leaves in the middle of the plant canopy may have numerous pustules (Figures 3a-c). As the disease progresses, plants throughout the field will become infected. Note that once a urediniospore infects a leaf, a week or more may pass before any symptom is observed, even under ideal conditions. Thus, a field always has more infection than what is observed.

Figure 3a. A bean rust hot spot at approximately 10 feet. (Photo by Sam Markell)

Figure 3b. A bean rust hot spot at approximately 5 feet. (Photo by Sam Markell)

Figure 3c. A bean rust hot spot at approximately 2 feet. (Photo by Sam Markell)

Figure 2. Pustules on the a) upper leaf surface and b) underside of the leaf. (Photos by Sam Markell)
When beans mature, the pustules will turn black (telia) and begin producing black spores (teliospores) (Figure 4). These pustules may appear slightly larger than the original uredia, and the spores do not rub off. Several additional spore stages, which rarely are observed, occur in the spring, including 1) basidiospores, which can be observed only microscopically, 2) pycnia, which appear as a small white blister on the upper leaf surface and 3) aecia, which can be found on the lower side of the leaf, immediately opposite the pycnia, appearing as a discrete cluster of small white cups (Figure 5).

**Disease Cycle**

Unlike the cereal rusts (wheat leaf rust, wheat stripe rust, barley leaf rust, others), the bean rust pathogen survives the winters in North Dakota. The pathogen will survive primarily as teliospores (black phase) embedded in telia on crop residue, but survival of urediniospores (brown phase) has been documented. In the spring, teliospores will undergo sexual division and produce basidiospores (Figure 5). Basidiospores will infect bean plants and produce pycnia, where receptive hyphae (female) and spermogonia (male) sexually recombine and produce aecia. Aeciospores, which are produced in the aecia, are aerially dispersed and will infect bean leaves and produce the uredinia. Uredinia produce abundant urediniospores, which produce more uredinia and urediniospores. This commonly is called the “repeating cycle.” When plants mature, uredinia will change to telia, and the pathogen overwinters.

Completion of all spore stages is relatively rare, but its occurrence generally will result in hot spots. Once hot spots form, urediniospores are produced rapidly and dispersed aerially, and can travel long distances before causing new infections. These subsequent infections can result in the formation of additional hot spots or fieldwide epidemics.
Free moisture on leaves is necessary for infection of any spore stage to occur. As a result, development of rust early in the season and epidemic progression of the disease throughout the season is favored by heavy and prolonged dews, fog and rain. Epidemics progress fastest at moderate to warm temperatures (65 to 85°F), and under ideal conditions, the “repeating cycle” will occur in 10 to 14 days and quickly result in epidemics.

Management

Resistance – Selection of a rust-resistant variety is a very effective and economical management tool. However, researchers believe that all bean varieties available in our region are susceptible to the new race. Resistance to the old races, which are found periodically, still is widely available (Ur-3 gene). Breeders and pathologists continually strive to incorporate additional resistance genes into varieties. Through time, rust resistance to the new race will be available.

Crop Rotation – Crop rotation is important for numerous dry bean diseases, particularly root rots, bacterial blights and white mold. For rust, crop rotation will limit the ability of the pathogen to overwinter and successfully undergo sexual recombination. Crop rotation also may help delay the onset of infection, but because rust spores can travel great distances, rotation will not prevent an epidemic from occurring in your field.

Control Volunteer Beans – Overwintering of rust is most likely to occur near the previous year’s infested residue. As a result, overwintered spores are most likely to infect volunteer beans.

Foliar Fungicides

A fungicide application can be a very effective tool for rust management. Triazole (DMI, FRAC 3) fungicides, including Proline, Folicur and generics, are among the most effective rust products available. Strobilurin fungicides (Qol, FRAC 11), including Headline and Quadris, are also very effective. In rust trials conducted between 2009 and 2011, all fungicides tested, including Tipsin, Endura and Omega, reduced rust severity (although generally less than triazoles or strobilurins). Because of this, a secondary benefit to a fungicide application for white mold (which occurs at early bloom, R1-R2) is that the application may offer some measure of rust protection.

A fungicide application is most effective soon after disease is found, making scouting for the disease critical. Rust can occur at any time or place in a field, but scouting likely areas will help maximize the effort. Rust is most likely to occur first near the previous rust-infected bean fields or in an area where microclimates will provide longer dews (tree rows). During epidemics of the past, rust first was observed in the late vegetative or early reproductive stages.

If rust is found in a field that is at least four weeks from maturity (when pintos begin to stripe), a fungicide application may be necessary. If infection occurs in the late vegetative or early reproductive stages, multiple applications may be needed. Because no symptoms occur between the time of infection and pustule formation (seven to 10 days) more rust always is present in a field than you see. Similarly, rust may appear to increase immediately after a fungicide application. This is due to infection that occurred several days before application.

Preventative fungicide applications were recommended decades ago; however, with the availability of Triazole and Strobilurin fungicides, widespread preventative applications generally are not recommended.