Rust Diseases of Several Legumes and Corn in Florida

Ken Pernezny and Tom Kucharek, Professor of Plant Pathology, Everglades Research and Education Center, Belle Glade; and Professor and Extension Plant Pathologist, Department of Plant Pathology, University of Florida, Gainesville.1987; Revised 1999.

Florida Cooperative Extension Service/ Institute of Food and Agricultural Sciences/ University of Florida/ Christine Waddill, Dean

A number of related pathogens known as the rust fungi cause diseases of several important vegetable crops in Florida. These pathogens, unlike the majority of plant pathogenic fungi, are characterized by an absolute requirement for a compatible host for growth and reproduction. These fungi require living host tissue for production of spores and all other aspects of their life cycles, except for spore germination. Growth of most of these rust fungi in artificial culture in laboratories has not yet been accomplished.

Rust fungi are also characterized by having complex life cycles, especially in temperate regions of the world (Fig. 1). Three or four distinctly different stages of development (with equally distinct spores) may occur during the completion of a rust cycle. Some rust fungi require nonrelated host plants for completion of the life cycle. Two of the rust fungus stages, the spermatial and aecial, are associated with the portion of the fungus life cycle in which mating types merge and reassociate genetic material. The spermagonia are the structures where mating actually occurs. Aecia are a direct result of the growth of the fungus after mating; they are typified by the formation of orange blisters on the host plant filled with aeciospores that mature when the fungus ruptures the epidermis of the host. Aeciospores are readily transmitted by wind currents. The spermagonia and aecia usually are formed on a non-crop plant, commonly referred to as an “alternate host”. The alternate host can serve as a reservoir of the pathogen in the absence of the crop plant.

On crop plants in Florida and in other tropical and subtropical areas, however, the rust fungi often are found almost exclusively in one part of the life cycle known as the “repeating stage” or uredial stage. In this stage masses of spores called urediospores are produced by simple asexual reproduction. The time between generations of these urediospores can be as short as five days, and the spores are easily transmitted by wind currents.

As the crop matures and tissue naturally senesces, the fungus may form another type of spore, called a teliospore. Teliospores give rise to basidiospores which are capable of infecting the alternate host. One is most likely to find basidiospores in the fall in North Florida-grown crops. Those parts of the life cycle other than the urediospore stage are seen less commonly in Florida. Another source of the rust fungi may be rust urediospores borne on air currents from distant sites in the Caribbean and South America where the spores develop on infected crop plants.

Due to frequent changes in use restrictions for pesticides, consult the University of Florida Cooperative Extension Service for current fungicide recommendations.

Bean Rust

Rust, caused by the fungus *Uromyces phaseoli* var *typica*, has been observed on most types of snap beans and dry beans grown in the state. Historically, this disease has been particularly severe on pole beans. A closely related fungus, *Uromyces phaseoli* var *vignae*, causes a destructive disease of southern pea. Rust does not seem to be a major problem in lima bean production in Florida, although the disease does occur.

The rust pustules characteristic of this disease are usually evident on the bean leaves. Occasionally, rust will appear on pods in a given production area. Observations of rust on bean stems are rare. Rust symptoms begin as whitish, minute, slightly raised pustules. Later, these pustules become the distinct, circular, reddish-brown spots on the underside of leaves that readily identify the disease (Fig. 2). The characteristic color of the pustules is due to the production of great masses of urediospores of the fungus. If not properly controlled, pustules may accumulate over much of the leaf surface (Fig. 3) with subsequent premature leaf drop. Similar symptoms appear somewhat later and more sparingly on the upper surface of leaves (Fig. 4). In very susceptible varieties, pustules are often surrounded by striking, yellow haloes (Fig. 5). In resistant reactions symptoms may consist only of small necrotic flecks.

If a compound microscope is available, the presence of rust can be definitely confirmed. Urediospores taken from the pustules will appear round, brown, with distinct, short spines on the surface (Fig. 6). *U. phaseoli*, unlike most rust fungi, does not require an alternate host for completion of its life cycle. All developmental stages occur on beans. In northern latitudes, basidiospores are known to infect beans.

Bean rust is primarily found during the cooler production months when heavy dews, rather than actual driving rain, provide moisture for spore germination and penetration of host plants. In Dade County, rust usually first appears in early January and becomes progressively more severe through the end of the commercial crop in April.

The optimum temperature for urediospore germination is from 17.5 to 22.5°C (63.5-72.5° F). Germination still occurs as low as 10°C (50°F) and as high as 25°C (77°F). No germination occurs at 4°C (39°F) or at 27.5°C (81.5°F). After infection, symptoms may be seen in about five days and spores produced in another five to ten days.

Variation in pustule size, prominence of haloes, and other symptom patterns are due, in part, to the many races of the bean rust fungus - 57 at last count. Each race is pathogenic on a specific combination of bean varieties. If varieties resistant to those specific races in a given locale are planted, control of rust can be very good. However, new races of the pathogen seem to appear almost as fast as new varieties are released. As a result, most of the commonly grown bean and southern pea cultivars are susceptible to one or more races of the rust fungus.

Prompt crop destruction after harvest is very important in the control of rust. If fields are abandoned after picking and not destroyed, rust can continue to develop and serve as a major source of inoculum for fields in full production. Brown clouds made of literally millions of rust spores have been observed above abandoned fields on gusts of wind. Such inoculum loads can make it difficult to control rust even with the most intensive spray schedule.

Currently, the most important method for rust control is periodic application of protectant fungicides. Aircraft or ground equipment may be used, but the latter is much preferred because of superior coverage of the underside of leaves and better penetration of the spray into the plant canopy. Initiate the spray program prior to the first sign of rust if rust is an annual problem. Where rust is sporadic in occurrence, begin the spray program at first sign of the disease. Subsequent sprays may have to be at 5 to 7 day intervals.

Sweet Corn Rust

Two rust diseases of sweet corn occur. in Florida: common rust, caused by *Puccinia sorghi*, and southern (polysora) rust, caused by *Puccinia polysora*. The symptomology of these diseases is similar but differences do occur. Laboratory assistance is often needed to differentiate these two rust diseases.

Symptoms vary on corn varieties due to the large number of reaction types depending on the specific strain of the rust fungus present. Symptoms also vary with temperature and light regimes. Common rust pustules may occur on all above-ground plant parts but are especially numerous on leaves. Pustules occur simultaneously and in about equal numbers on both leaf surfaces. Individual pustules are circular to elongate and golden brown to cinnamon brown and become raised early in development. The fungus membrane enclosing the common rust spores also ruptures early in development, exposing the large masses of cinnamon-brown urediospores (Fig. 7). As disease severity increases, pustules become more numerous (Fig. 8) and result in yellowing and death of leaves.

Common rust is a cool weather disease. Urediospores of *P. sorghi* germinate from 4 to 30°C (39-86°F), but the optimum is from 15 to 17°C (59-63°F). Optimum temperature for formation of infection structures is also near 15° C. Penetration into the host is via stomates (air pores) on either leaf surface. Germination of urediospores occurs within 1 to 6 hr, with infection structures forming in 3 to 4 hr. In 24 to 48 hr light green to yellow flecks may be visible on foliage.

Generation time can be as short as five days at temperatures from 25 to 30°C (77-86°F), and as long as 16 days at 10°C (50°F). Pustule formation is most rapid at 15 to 20°C (59-68°F).

If a microscope is available, one can distinguish the common rust from southern rust by examination of the urediospores. Common rust urediospores appear spherical to slightly ovoid and are reddish brown.

Oxalis spp. serve as the alternate host for *P. sorghi*. Although these weeds are important in the common corn rust life cycle in Mexico, their role in Florida is undefined. Spermagonia and aecia occur on Oxalis, and the urediospores and basidia (when produced) are found on all types of corn. Other grass hosts for the urediospore stage include teosinte.

Southern rust can be a serious and destructive disease of sweet corn. Many hybrids have no resistance. Yield losses of 45 percent have been recorded, with up to 65 percent lodging of field plants. This disease is more likely to be a problem on corn grown during warm weather, such as late planted corn within a double cropping system in north Florida.

Southern rust is characterized by light, cinnamon-brown pustules confined for the most part to the upper leaf surfaces. The fungus membrane enclosing the southern rust urediospores usually, but not always, remains intact longer (Fig. 9) than in common rust. Heavily infected leaves become generally yellow and dry.

Under the microscope the urediospores of *P. polysora* appear distinctly different from those of *P. sorghi*. The *P. polysora* urediospores are definitely ovoid and are golden in color. They also have fewer spines on the urediospore surface than those of the common rust fungus.

Teliospores of *P. polysora* have been germinated but no alternate host is known. Other grass hosts include teosinte, plumegrass and *Tripsicum* spp.

Urediospores of southern rust germinate well at 27 to 28°C (81-82°F), and stomates are readily penetrated at these temperatures. Six or seven days after the fungus spores alight on corn leaves, yellow spots can be seen. Pustules can form in nine days at 27 to 28°C but require about 14 days at 24°C (75°F). Pustule development ceases at 32°C (90°F). When dew periods are about 16 hr, optimal infection has been recorded at 26°C (79°F), with some infection found from 16 to 32°C (61-90°F). If the dew period is reduced to 8 hr, infection may occur only in the range of 24 to 28°C (75-82°F). By the ninth day, the host epidermis may rupture.

Another corn rust, caused by *Physopella zeae*, occurs in Mexico, Central America, South America, and the Caribbean islands. In 1969 and 1970 it was found in the United States at Fairchild Tropical Gardens in Miami on *Euchlaena perrennis* (a wild corn relative) and possibly *Tripsicum* spp. brought into the country for possible sources of resistance to corn Helminthosporium leaf spots. The disease was completely eradicated and has not been identified in the United States since that time.

Urediospore germination of *P. zeae* can occur in 1 to 2 hr at 22 °C (72 °F). Infection structures can form within 5 hr of spore germination, followed by fungus penetration of the host within 12 hr.

Sweet corn rusts can be controlled by fungicide applications. However, in south Florida, fungicide applications are dictated, for the most part, by the potential severity of leaf blights caused by *Helminthosporium* spp. These sprays often also provide good control of the rusts, accounting for the low incidence of observations of severe rust infections in commercial fields. Different degrees of resistance to rusts probably exist in commercially available sweet corn varieties.

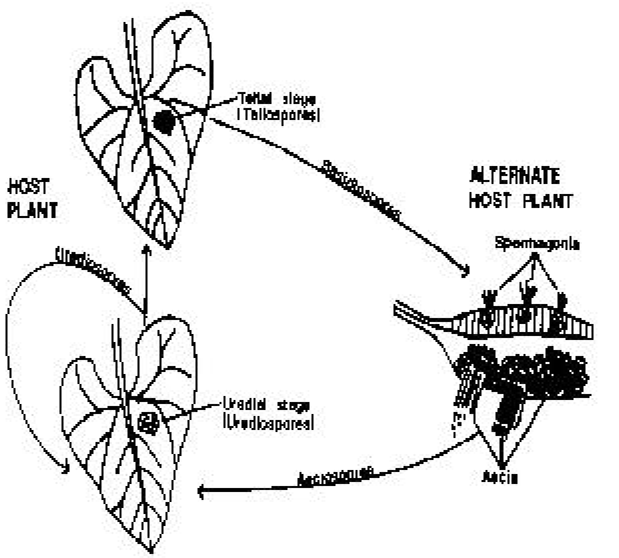

Figure 1. Schematic diagram of a "typical" rust fungus life cycle.

Figure 2. Circular, reddish-brown pustules characteristic of rust on underside of snap bean leaf.

Figure 3. Heavy accumulation of rust pustules on underside of sanp bean leaf from field with inadequate spray program.

Figure 4. Beginning rust pustule development on upper leaf-sruface of pole bean.

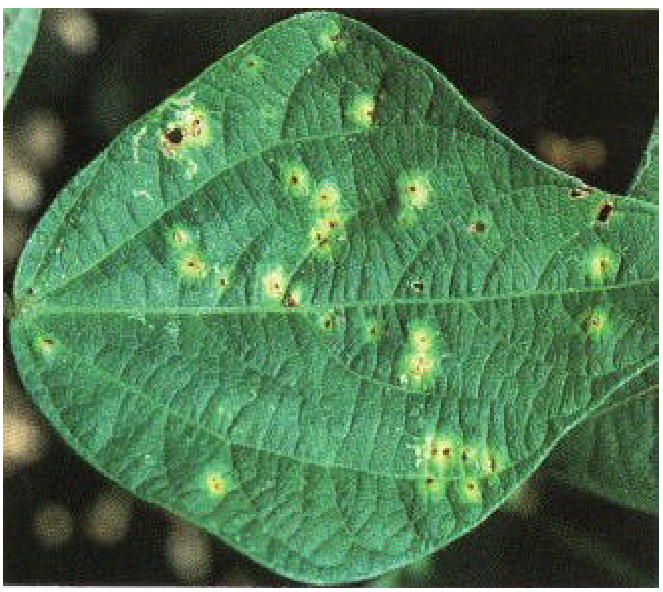

Figure 5. Large, bright haloes surround rust pustules on very susceptible bean variety.

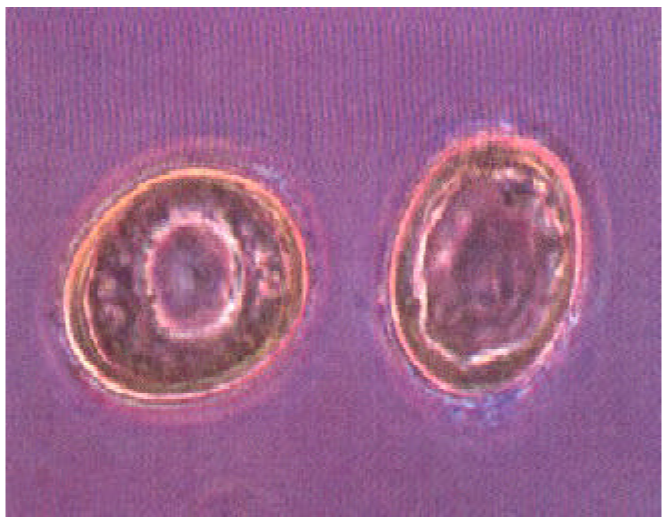

Figure 6. Bean rust urediospores as seen through a microscope at 400X magnification.

Figure 7. Common rust pustules on underside of sweet corn leaf. The fungus membrane has ruptured relatively early revealing the masses of cinnamom-brown urediospores.

Figure 8. Extensive common rust damage on corn.

Figure 9. Southern (polysora) rust on corn. The fungus membrane enclosing the urediospores is still fairly intact.