University of Idaho
College of Agriculture

Cooperative Extension Service
Agricultural Experiment Station

Current Information Series No. 737

Foot Rot Control in Winter Wheat Using Tillage, Rotation, Variety, Fungicide and Nitrogen Variables

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Yield losses in winter wheat caused by foot rot may reach 50 percent in the Palouse region of eastern Washington and northern Idaho. Management practices such as late fall seeding and spring application of fungicide (e.g. Benlate or Mertect) partially control this disease. Late seeding increases the risk of soil erosion, and the cost of applying a fungicide in the spring is undesirable. Understanding what influences other practices such as crop rotation, tillage, variety selection and nitrogen fertilization have on foot rot and wheat yield could be useful to improve existing disease control practices and spur new management alternatives that more economically reduce foot rot and promote yield.

The fungus *Pseudocercosporella herpotrichoides* is the cause of foot rot. It is found in Palouse soils and in most areas where winter wheat is produced. Winter wheat seedlings are infected initially by spores (conidia) residing in soil or wheat stubble. The leaf sheaths and the stem near the base of wheat seedlings are typical sites of infection.

Infection occurs in winter or early spring when the fungus comes in contact with wheat seedlings. Driving rain or other mechanisms that move soil or debris about the plant base assist in this regard. New conidia or mycelium produced on infected stems can cause additional infections. This secondary infection normally does little damage to the current crop but promotes survival of the fungus and increases the chance of infection of subsequent wheat crops.

The foot rot fungus penetrates the young plant especially during tillering when conditions are cool and moist. The time necessary to penetrate successive layers of leaves and eventually reach the stem is directly related to stem rigidity and width and to the duration of cool, moist environmental conditions.

Initial symptoms of foot rot occur at or just above the soil line. An eliptical or "eyespot" lesion, with a pale center surrounded by a brown margin, is diagnostic (Fig. 1). In many cases, the gray-black fungus may darken the center of the lesion. Later symptoms

Fig. 1. Eyespot lesion of foot rot at the base of a wheat stem.

of foot rot include lodging of diseased plants, incomplete grain fill and/or premature white heads.

Foot rot causes yield losses by reducing tillers and limiting grain filling. Tissues damaged by the fungus impede the movement of nutrients to the roots and discourage grain filling. Indirect yield losses occur when lodging further reduces seed weight and quality. Lodging also makes harvest mechanically difficult and inefficient.

From 1981 to 1983, foot rot was studied in Whitman County, Washington, and in Latah and Nez Perce counties in Idaho. Each year foot rot occurred naturally (no artificial inoculation) and was measured by examining a minimum of 50 wheat tillers within each test plot during early and late spring. The percentage of tillers with foot rot lesions was used as a measure of disease incidence.

Tillage

Preplant tillage operations had a significant and consistent affect on disease incidence. Conventional tillage (moldboard plow, disk, harrow) supported the highest level of foot rot. Reduced and no-till treatments decreased disease incidence (Fig. 2).

The reduction in foot rot by reduced tillage and no-till operations may be related to increased amounts of straw and other residues at the soil line separating the plant's lower stem from the foot rot fungus in the soil below. Also possible is that organisms that decay straw compete with the foot rot fungus for food and space. Perhaps the growth and/or germination of the fungus is inhibited by such microbial activity.

Variety

The variety of winter wheat influenced the amount of foot rot infection. This study, like previous reports, found 'Stephens' to support less foot rot than other popular varieties (Fig. 3). Stephens — relative to 'Daws,' 'Nugaines' and 'Luke' — has a thicker stem which may resist or better tolerate foot rot infection.

Crop Rotation

Rotations in which wheat crops occur every 1 or 2 years tended to support more foot rot than 3-year rotations that included a green manure crop and/or spring peas. Although not statistically significant because of a lack of repetition, wheat/pea/wheat rotations supported lower levels of foot rot than wheat/lentil/wheat rotations. This phenomenon was expressed in both 1982 and 1983 in adjacent fields and in fields with similar soil texture, rainfall and aspect. Wheat/wheat and wheat/summer fallow rotations supported the highest level of foot rot.

Fungicides (Registered Product)

Under low disease pressure, as in 1982, thiabendazole (Mertect) increased yield 4.7 bushels per acre and lowered foot rot incidence by about 8 percent. In 1983, disease incidence was higher because of a particularly mild winter. Under these conditions, infection levels ranged to 50 percent, and the most effective foliar spray applications of Mertect (20 oz/acre) increased yield by 5.4 bushels per acre and reduced foot rot by 16 percent (Table 1).

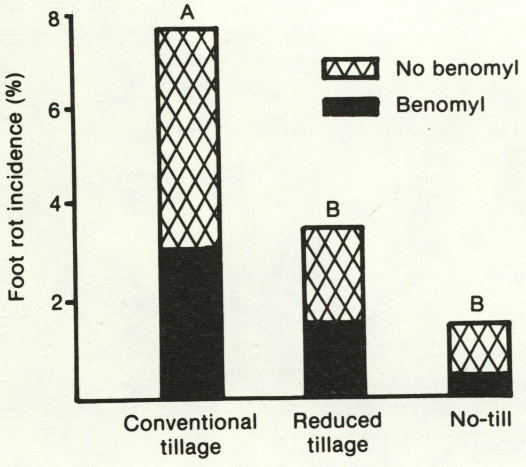

Fig. 2. Foot rot incidence as influenced by tillage and benomyl (Benlate) treatments, May 1982. Different letters indicate significant differences. Disease levels in benomyl and no-benomyl treatments were significantly different within all tillage treatments.

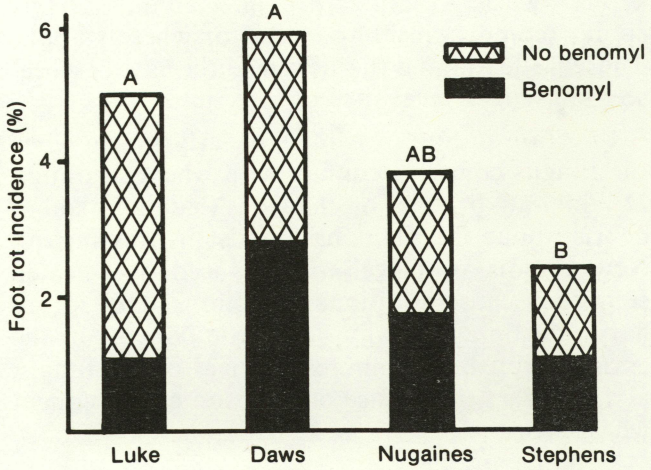

Fig. 3. Foot rot incidence as influenced by variety and benomyl (Benlate) spray, May 1982. Different letters indicate significant differences between varieties. Disease levels between benomyl and no-benomyl treatments were significantly different within all varieties.

Table 1. Effects of fungicide on foot rot incidence and yield at three sites in the Palouse region in 1983.

Treatment chemical	Rate	Chemical status	Foot rot at heading	Yield
	(product/acre lb/acre)		(%)	(bu/acre)
Control	unsprayed		43	91.1
Mertect	20 oz	registered	27*	96.5
Benlate	1 lb	unregistered emergency use permit	12*	97.5*
Topsin M wettable powder	1 lb	unregistered	20*	97.5*
Topsin M liquid fluid	23 fl oz	unregistered	18*	96.7*
DuPont H6573	.5 lb	unregistered	15*	99.0*

*Differs significantly from control at P = 0.05.

Fungicides (Unregistered Products)

Benlate, wettable powder formulation of benomyl, has been available under emergency exemption. In 1982, Benlate increased yield 3.9 bushels per acre and lowered disease incidence by about 8 percent. Under heavy disease pressure in 1983, Benlate increased yield by 6.4 bushels per acre and reduced disease by 31 percent (Table 1).

Topsin® M, a member of the same chemical family as benomyl and presently available only for experimental use on winter wheat, was comparable to benomyl in reducing foot rot and increasing yield (Table 1). Another experimental fungicide, DuPont H6573-30,* supported a 7.9 bushels per acre yield increase and reduced disease incidence by 28 percent (Table 1).

Nitrogen

Nitrogen fertilizer applied as 27-12-0-4 at rates of 100 to 135 pounds per acre did not significantly affect foot rot incidence. Because fertilization practices are relatively uniform across the Palouse, the effect of ammonium-based fertilizers vs. green manure without supplemental nitrogen could not be examined. Studies in other areas, however, indicate that green manure as a nitrogen source coupled with longer rotations could reduce foot rot levels in winter wheat.

Conclusions

Efforts to control foot rot and soil erosion are sometimes counterproductive. For example, late fall seeding reduces foot rot but contributes to soil erosion. On the other hand, reducing tillage simultaneously limits foot rot and soil erosion. Reduced tillage resolves, at least in part, two of the most critical problems in Palouse wheat production.

This study and previous data suggest that foot rot may be reduced by half, and a threefold decrease in erosion may result from reduced vs. conventional tillage. Although no-till wheat crops support less disease and erosion compared to reduced tillage, yields sometimes are unacceptably low.

Reduction of foot rot by reducing tillage is a relatively unique phenomenon. Most soilborne and foliar diseases of wheat are intensified when tillage is reduced. Growers are advised, therefore, to weigh the benefits of reduced foot rot against increased pressure from diseases such as Cephlasporium stripe and Fusarium root rot.

High levels of foot rot in recent years have been associated with heavy fertilization, early seeding, mild winters and susceptible varieties. Also, in recent years, green manure crops are rare while continuous wheat crops are commonplace. Until varieties truly resistant to foot rot are available, a combination of reduced tillage, late seeding, longer rotations, green manure and, if necessary, application of fungicide can limit foot rot, conserve soil and maintain high yields.

*NOTE: Nonregistered products may not be used commercially until registered or until given emergency exemption.

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The authors wish to acknowledge the assistance and cooperation of Roger H. Harder, professor emeritus in soil science, UI.

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