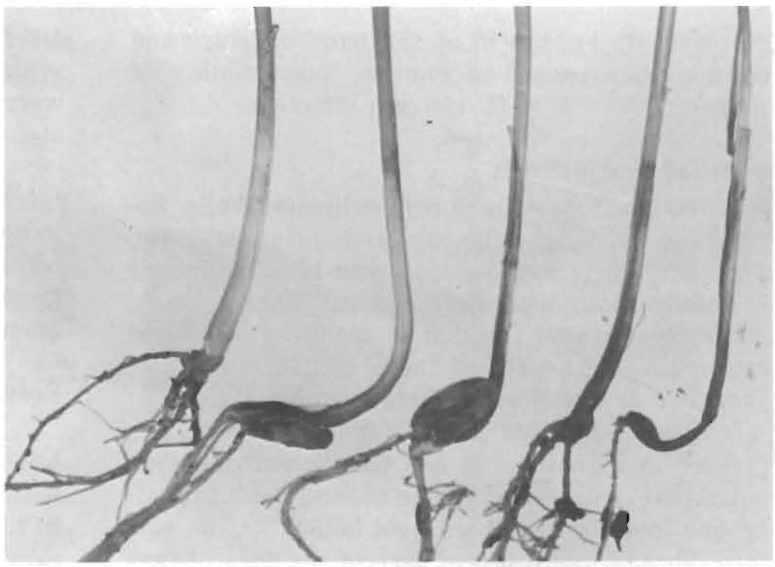

Fig. 1. Wheat seedlings infected with Fusarium roseum. Left, healthy; right, severely diseased.

Seedling Blight and Crown Rot Resistance Of Durum and Hard Red Spring Wheat

Glen D. Statler and Lee C. Darlington

Helminthosporium sativum Pamm., King & Bakke (**Cochliobolus sativus**), is a widely distributed cereal pathogen in North Dakota. This fungus causes seedling blight, crown rot and root rot as well as kernel black point and foliar spotting. **Fusarium roseum** Lk. (emend. Snyd. & Hans.) f. sp. **cerealis** (Che.) Snyd. & Hans. 'Culmorum' has been associated with root and crown rot (4, 6), but **H. sativum** has been cited as the main cause of root rot in Canada (8) and appears to be the most important fungus causing root and crown rot in North Dakota. Typical symptoms of root and crown rot include reduced stands, poor growth, general loss of vigor and dead tillers which significantly reduce yields. Pulling plants to evaluate any discoloration or decay of the root and crown areas is the only satisfactory method of assessing disease severity (Fig. 1).

Losses caused by these soil borne pathogens are difficult to assess and often overlooked. Cook (4) reported that losses due to Fusarium root and foot rot in individual winter wheat fields in the Pacific Northwest ranged up to 50 per cent. He found Fusarium root and foot rot common throughout the cereal acreages examined, but in most cases only trace amounts of infection were detected. Organisms causing root and crown rot are also found throughout North Dakota and, in certain years when weather conditions are unfavorable for plant growth or favor a rapid buildup of inoculum, severe losses may be suffered by cereal growers in North Dakota.

The damage from soil borne pathogens varies from year to year and from field to field depending upon the amount of inoculum present and the prevailing climate (1,4). Colhoun et al. (3) found that **F. culmorum** required high temperatures and low soil moisture for optimum development. Other investigators cited by Butler (1) found more root rot in wet seasons and especially in wet areas, but generally agreed that the highest incidence occurred when climatic conditions were least favorable for

Dr. Statler is assistant professor and Darlington is a graduate student, Department of Plant Pathology.

crop growth. Fenster et al. (5) found moisture and temperature stresses to increase susceptibility of roots and crowns to **H. sativum** infection.

Materials and Methods

We inoculated the durum cultivars, Wells, Rolette and Leeds, and the hard red spring cultivars, Thatcher, Chris and Waldron with **H. sativum** and **F. roseum** both separately and in combination to determine varietal reaction to seedling blight and crown rot. Crown rot of these cultivars was also evaluated at five North Dakota locations.

Black point-free seed of each cultivar was planted in a greenhouse bed partitioned into four equal parts with polyethylene sheets which extended one foot above and one foot below the soil surface. Three replications of each of the six cultivars were randomized within each of the four sections. Thirty seeds of each cultivar were planted in each replication for seedling evaluations. Six plants of each cultivar were evaluated for adult evaluations.

Inoculum of **H. sativum** and **F. roseum** was grown for three weeks on vermiculite moistened with potato nutrient broth (1,000 grams vermiculite : 300 milliliters broth). One thousand grams of the vermiculite **H. sativum** inoculum were applied to one 12 sq. ft. section of the greenhouse bed and 1,000 grams of vermiculite - **F. roseum** inoculum were applied to another section. The third section received a mixture of 500 grams of inoculum of each fungus. The fourth section was not inoculated. Seedlings were inoculated by placing the inoculum directly on the seeds prior to covering the rows. Adult plants were inoculated by placing inoculum near the crowns when the plants were tillering.

Seedlings were evaluated for seedling blight three weeks after planting. Evaluation was on a 1-5 scale (1 represented no infection and 5 represented a severely decayed seedling). Adult plants were in the late dough stage when they were evaluated for crown rot.

Ten plants of each of the six cultivars grown in the leaf rust nurseries at five North Dakota field locations during the summer of 1971 were rated for crown rot. Isolations were made from field grown seedlings and adults to determine the frequency of each organism.

Results and Discussion

Differences in varietal response to seedling blight and crown rot and differences in virulence between **F. roseum** and **H. sativum** were established in these studies. Inoculations with **F. roseum** or **H. sativum** significantly increased the intensity of seedling blight (Table 1). Chris was less severely infected than the other varieties, while Wells and Rolette were the most susceptible.

Adult plants were damaged more by **F. roseum** or combinations of both organisms than by **H. sativum** alone (Table 1). However, the mean crown rot ratings of plants inoculated with **H. sativum** were significantly greater than the controls. This is important because **H. sativum** was isolated more frequently than **Fusarium** from crown rot infected plants in North Dakota in 1971. The hard red spring varieties were less severely infected than the durum wheats. The test using adult plants was repeated and results were similar to the first trial except that Leeds was more severely damaged by **H. sativum.**

The average crown rot ratings from five North Dakota locations in 1971 are presented in Table 2. The average crown rot ratings of the hard red spring wheats were lower than the durum wheats.

Table 1. Average seedling blight and crown rot of six wheat cultivars inoculated with Helminthosporium sativum, Fusarium roseum or combinations of the two fungi.

Treatment	Variety						Total means
	Wells	Rolette	Leeds	Thatcher	Chris	Waldron	
Seedlings							
Control	1.30[1]	1.12[2]	1.06	1.10	1.05	1.04	1.11
H. sativum	1.10	1.11	1.18	1.28	1.07	1.33	1.18
F. roseum	2.92*+	2.06*+	1.57+	1.35	1.14	1.28	1.72+
Both fungi	2.85*+	2.30*+	1.69*+	1.75*+	1.23	1.88*+	1.95+
Total mean	2.04*	1.65*	1.38*	1.37*	1.12	1.38*	
Adult plants							
Control	1.16	1.22	1.22	1.11	1.00	1.22	1.27
H. sativum	2.83*+	2.92*+	2.55	2.27	2.49+	2.72*+	2.63+
F. roseum	3.41*+	3.99*+	3.41*+	2.89+	3.20+	2.89+	3.30+
Both fungi	3.23*+	3.28*+	3.21*+	3.10+	2.87+	2.89+	3.10+
Total mean	2.66*	2.85*	2.60	2.34	2.39	2.43	

+Significantly greater (.05) than control.
*Significantly greater (.05) than Chris.
[1]Means of 3 replications.
[2]Crowns rated on a scale of 1-5; 1 = healthy, 5 = crowns destroyed.

Table 2. Average crown rot ratings of adult wheat plants at five North Dakota locations in 1971.

	Dickinson	Minot	Carrington	Fargo	Langdon	Varietal means
Wells	1.87[1,2]	3.40	3.00	3.30	2.90	2.89
Rolette	1.80	3.50	3.70	4.00	2.80	3.16
Leeds	2.37	3.60	2.90	3.90	3.30	3.21
Thatcher	1.50	2.30	2.20	2.20	1.70	1.98
Chris	2.00	3.10	2.60	3.10	2.50	2.66
Waldron	1.70	3.50	2.70	3.30	2.50	2.75
Location means	1.87	3.57	2.85	3.30	2.62	

[1]Means of 10 plants.
[2]Crowns rated on a scale of 1-5; 1 equals healthy, 5 equals crowns destroyed.

Leeds and Rolette were more severely damaged than Wells. Highest average crown rot ratings were recorded at Minot and Fargo, while the lowest was at Dickinson. Sampling was, however, insufficient for a definitive estimation of crown rot throughout the state and the data should be used only to compare the six varieties.

Differences in varietal response to seedling blight and crown rot and differences in virulence between the **F. roseum** and **H. sativum** tested were established in these tests. However, since disease development is so closely related to climatic conditions, varietal resistance is very complex. We are, in fact, dealing with intermediate levels of resistance and susceptibility (7). Yet varietal resistance has been established (5, 6, 7). Research conducted by Greaney et al. (6) indicated that varieties which were consistently resistant to **F. culmorum** were consistently resistant to **H. sativum** and susceptibility to one was associated with susceptibility to another. The hard red spring wheats tested in this study were more resistant than the durum wheats to **F. roseum** and **H. sativum** or combinations of both organisms. The production of varieties containing genes for resistance to both phases of this disease should reduce root and crown rot in our state.

In addition to varietal response and soil or climatic factors, the amount of inoculum present also contributes to disease development (1, 4). Much higher spore concentrations of **H. sativum** have been noted in fields seeded to wheat when compared to summer fallow (2). The practice of monoculturing wheat or barley-wheat rotation increases the inoculum level of **H. sativum** because barley is also parasitized. A study conducted in Michigan associated sporulation on barley straw with severity of **H. sativum** infection (9). A three-year rotation with summer fallow in fields having a history of root and crown rot problems has been suggested in North Dakota to reduce the inoculum level (E. H. Lloyd, personal communication). Potatoes, corn, flax, oats and forage legumes can be grown to reduce the level of **H. sativum** in the soil, but growing oats may increase levels of **F. roseum.** Spurr and Kiesling (9) found that beans, tomatoes and certain other dicotyledonous plants were parasitized by **H. sativum.** Their work demonstrated the pathogen's wide host range and emphasized the importance of testing crops used in rotation so as not to increase the inoculum level in the soil or crop refuse.

Wheat plants were evaluated for damage from crown rot and root rot. Dr. Statler (left) and Robert MacArthur, plant pathology technician, look at diseased specimens.

Summary

Both **F. roseum** and **H. sativum,** alone or in combination, cause seedling blight and crown rot of cereals in North Dakota. Although **F. roseum** caused more severe symptoms in this study, **H. sativum** was more prevalent and probably causes more damage in North Dakota. The durum varieties were usually more severely damaged by seedling blight and crown rot than the hard red spring wheats tested. Hard red spring wheats could be planted in place of durum if a severe root rot problem exists.

The disease can also be reduced by lowering the inoculum in the soil by crop rotation or summer fallow. These farming practices combined with the resistance displayed by the hard red spring wheats should reduce the seedling blight, root and crown rot disease complex in North Dakota.

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FROM THE DIRECTOR —

(Continued from page 2)

Emerald winter squash is the third such release from NDSU, started by Yeager's release of Buttercup, still a standard for quality. Emerald is a bush type with a fruit that stores well and has an ideal size for family use.

Three NDSU potato varieties—Norchip, Norgold Russet and Norland—make up over 50 per cent of the potato acreage grown in the Red River Valley. A red potato line undergoing consumer reaction, ND6634-2R, appears to be nearing the end of its testing period. It suberizes better than existing red varieties, is uniform and has a bright red skin which means high consumer eye appeal. Dr. Bob Johansen, NDSU's internationally-known potato breeder, has several promising russets under observation in his breeding program.

Since 1960, additional agronomic releases from NDSU include Wells, Lakota and Leeds durums; Trophy, Larker and Dickson barleys; Carman, Norkota and Mindak sorghums; Justin, Fortuna and Waldron hard red spring wheats; Dawn and Wyndmere oats; Foster flax; Lodorm green needlegrass; and 72 inbred corn lines released to commercial corn breeders.