Common Root Rot of Spring Barley: Relative Susceptibility of Six-Rowed Cultivars

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Introduction

North Dakota is the principal producer of barley in the United States, with production amounting to nearly one-fourth of the nation's total. Over the last several years, the area planted to barley in North Dakota has ranged from 1.7 to 3.6 million acres with average yields of 45 bushels per acre (1).

One of the most widespread disease problems in barley in North Dakota is the common root and crown rot caused primarily by *Helminthosporium sativum* P.K.&B., a parasitic fungus which survives in the soil (5). This same fungus also causes root rot in wheat and durum. Common root rot of barley is a longstanding problem for North Dakota's grain farmers, but it frequently goes unrecognized except when it is most severe (5,7,8).

The impact of common root rot on yield is highly variable because the disease interacts strongly with environmental factors. This variation has plagued researchers attempting to determine the real damage done by root rot. Although conspicuous symptoms may be absent from the above-ground parts of the plant, root rot may still cause serious reduction in yields. A survey of barley root rot in the three prairie provinces of Canada during the 1970's placed long-term average losses at 10.3 percent annually (7). A similar survey in North Dakota, made by the author from 1980 through 1982, indicated that yield reduction in barley, attributable to root rot for that period, was 9.7 percent (9 and R.W. Stack, unpublished).

Barley cultivars (varieties) show different degrees of susceptibility to infection by the common root rot fungus (6). The disease reactions of barley lines have been found to be consistent and stable when tested under field conditions for several years and at different locations (3,11). Although a seedling test for root rot reaction would speed up introduction of resistant lines, no reliable testing method has yet been developed (2,10). Research currently being done at North Dakota State University may eventually lead to such a method.

Recently, reports have been published describing relative susceptibility of Canadian barley cultivars (3) and two-rowed spring barleys (5) to common root rot. There is no similar comprehensive information on six-rowed spring barleys now grown in the main barley producing areas in North Dakota. This report provides that information for barley growers in North Dakota and nearby areas.

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Methods

Locations. Barley root rot comparisons were made at five locations in North Dakota during the years 1980 through 1983. The author's previous work at these sites had demonstrated that *H. sativum* was the principal root rot pathogen of barley present. Plots were located on North Dakota Agricultural Experiment Branch Stations at Williston, Minot, Carrington, and Langdon, and in farmer-cooperator fields near Erie (Cass County).

Barley culture. Nine spring barley cultivars were tested for reaction to common root rot over 8 locations/years (loc/yr). Each cultivar was present in at least 6 of the 8 loc/yr. Seven additional cultivars were also present in some tests. Barley was planted in April or May in side-by-side drill strips (14 cm row spacing) which varied from 1.5 m to 2m wide and 15 m to 30 m long, depending on location. Crops were managed following normal spring grain production methods. Except at one location (Erie), drill strips at individual loc/yr were not replicated and no statistical anaylsis was made for them separately.

At Erie in 1980, 31 barley cultivars were planted in a field experiment in a randomized complete block design. There were six replicate plots of each cultivar; each plot was a 1.5 m × 10 m drill strip with rows 14 cm apart. Plots were planted on April 16, and disease ratings were made when plants were in milk to soft dough stage.

Disease reactions. Disease ratings were made by collecting plants along transects across the drill strips. Common root rot was assessed using the subcrown internode index system of Ledingham, Sallans and Tinline, based on the extent of lesion development on the sub-crown internode where 1 = clean, 2 = slight, 3 = moderate, and 4 = severe (12). This scale is illustrated in Figure 1. The basis of this system is that the extent of *H. sativum* infection on the subcrown internode is highly correlated with the extent of similar infections on the whole root system, provided that adequate numbers of plants are used for each comparison (11,12). At least 70 plants per drill strip were individually scored at milk to soft dough stage. The rating for each loc/yr is an average of the individual plant scores. The disease ratings for the 8 loc/yr were treated as replicates in the analysis of variance.

Results

Severity of common root rot varied among loc/yr, being least at Williston and Carrington in 1980 and greatest at Langdon in 1980 and Williston in 1983 (Table 1). Differences among cultivars in root rot reaction were signficant and relatively consistent as shown by the loc/yr means (Table 1). Among 9 barley cultivars, Larker, Beacon and

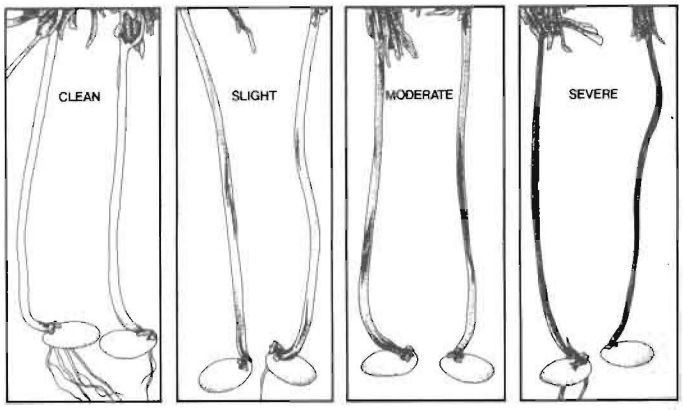

Figure 1. Common root rot disease rating scale. Sub-crown internodes of barley from left to right illustrating the clean (1), slight (2), moderate (3), and severe (4) disease categories, respectively. The dark elongate lesions are typical of those caused by *Helminthosporium sativum*.

Morex were most susceptible to common root rot, while Bumper, Park and Azure were least susceptible. Dickson, Glenn and Bedford showed intermediate root rot reaction among this group of 9 cultivars. Other cultivars were present in too few tests for proper statistical comparison. Among these cultivars, Robust (3 loc/yr) and Valley (4 loc/yr) were similar to Dickson; Klondike (4 loc/yr) was similar to Glenn; and Nordic (2 loc/yr) and Hazen (3 loc/yr) were similar to Park. One two-rowed barley cultivar, Hector, was present in all 8 loc/yr tests and would be considered moderately susceptible because it was intermediate in reaction between Glenn and Morex.

In the replicated experiment done at Erie in 1980, 31 barley lines and cultivars were tested for common root rot reaction. There were highly significant differences between the barleys, as shown in Table 2.

Discussion

Barley cultivars have been tested for susceptibility to spot blotch, a leaf disease also caused by *H. sativum* (V.D. Pederson, unpublished, pers. comm.). When the spot blotch disease reaction of barley cultivars was compared to the root rot reaction as given in Table 1, the relationship was poor (r = 0.50). This indicates that selection for spot blotch resistance in breeding will not automatically carry along resistance to root rot. Despite this, there has been improvement in root rot resistance in barley cultivars released in North Dakota over the years. Figure 2 shows the relative root rot reaction of the N.D. cultivars listed in Table 1 when plotted against their year of introduction. There was a steady improvement in resistance to root rot. Perhaps selection for spot blotch resistance carried along some root rot resistance as well. A trend toward resistance to root rot is not evident when barley cultivars from other improvement programs are analyzed in a similar manner.

Studies of resistance to root rot have shown that resistance can be incorporated through breeding but that inheritance is complex (2). Comparing our results of different locations and years for cultivars in the middle range of response (such as Dickson and Glenn), variation in relative rank is evident for different locations and years. This suggests that identification of, or selection for, small increases in resistance might be very difficult. At the same time, the more resistant cultivars (such as Azure or Park) show consistent responses in different seasons and locations, which sug-

Table 1. Root Rot Susceptibility of Six-Row Barleys in North Dakota, 1980-83.

	Common Root Rot Rating[1]								
	Location and Year[2]								
Cultivar[3]	E80[5]	W80	L80	C80	M81	W82	E83	W83	Mean
Larker	3.2	2.3	3.0	2.4	2.7	2.4	2.6	3.1	2.71
Beacon	3.2	2.2	2.6	2.5	2.6		2.5		2.60
Morex	3.1	1.8	2.9	2.4	2.7	2.4	2.6	2.9	2.60
Dickson	2.6	2.4	2.0	2.2	2.7		2.5		2.40
Glenn	2.8	2.0	2.2	1.9	1.8	2.4	2.4	2.8	2.30
Bedford		2.0	2.3	2.5	2.0	2.8	2.2		2.28
Bumper		1.9	2.4	2.1	2.1	2.3	2.4	2.4	2.23
Park	2.6	1.6	2.1	1.9	2.2	2.3	2.6	2.5	2.22
Azure		1.8	2.3	2.0	2.3	2.1	2.2	2.3	2.14
Flsd (.05)									0.20
Conquest[4]	3.2						2.6		
Robust[4]						2.7	2.5	2.8	
Bonanza[4]		2.1	2.5	2.1					
Valley[4]		2.1	2.0	2.0	2.6				
Klondike[4]	2.7	1.7	2.8	1.9					
Nordic[4]	2.4						2.3		
Hazen[4]						2.2	2.1	2.5	

[1]Disease rating based on average of individual plant scorings as 1 = clean, 2 = slight, 3 = moderate, 4 = severe (See Figure 1).

[2]Locations, C = Carrington, E = Erie, L = Langdon, M = Minot, W = Williston. Year - 80 = 1980 etc.

[3]Cultivars, Larker - Azure, are listed in order of decreasing root rot rating.

[4]These cultivars should be compared to other cultivars within location/years only.

[5]This test (E80) is the same one presented in Table 2.

Table 2. Reaction of 31 Barley Cultivars to Common Root Rot.

Rank	Cultivar[1]	Rating[2]	Rank	Cultivar	Rating
1	Elrose	2.40	17	Glenn	2.82
2	Nordic	2.43	18	Vangard	2.82
3	Betzes	2.45	19	Trophy	2.84
4	Hennchen	2.60	20	Norbert	2.88
5	Park	2.63	21	Fairfield	2.89
6	Hector	2.64	22	Piroline	2.92
7	Dickson	2.64	23	Primus II	2.95
8	Steptoe	2.64	24	Manker	3.02
9	Compana	2.65	25	Traill	3.02
10	Firlbecks III	2.66	26	Unitan	3.10
11	Klages	2.67	27	Morex	3.12
12	Shabet	2.69	28	Beacon	3.15
13	Kimberly	2.70	29	Conquest	3.15
14	Klondyke	2.71	30	Larker	3.17
15	Moraviar III	2.71	31	Karl	3.27
16	Blazer	2.72			

p .001, Flsd .01 = 0.32

[1]Cultivars listed in order of increasing susceptibility to root rot.

[2]Disease rating on a scale of 1 = clean, 2 = slight, 3 = moderate, 4 = severe infection by *Helminthosporium sativum* on the sub-crown internode (See Figure 1).

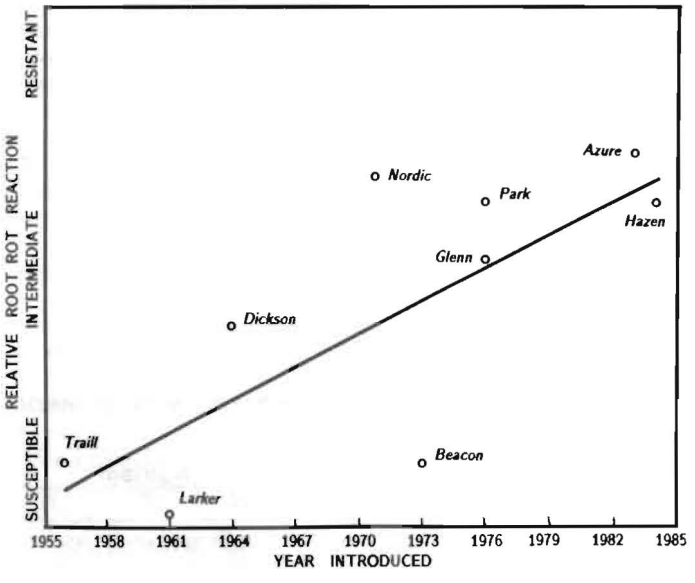

Figure 2. Relative root rot susceptibility of barley released by North Dakota in the past 30 years. The line shown is the fitted regression line (R^2 = .624, P .01) and illustrates the trend toward increased resistance to common root rot.

gests that selection for lines with substantial levels of resistance should be relatively independent of location and year.

Common root rot causes greater damage in dry years and on droughty sites; under these conditions common root rot can cause serious losses. Since the pathogen survives well in dry soil, planting of barley after barley favors build-up of the disease and potential serious loss. The best way to minimize loss is through rotation of small grains with other crops.

The information on the differential response of barley to root rot will be of more immediate use to farmers who grow barley year after year and to those who have had problems with root rot in the past. Farmers may want to consider the differential susceptibility of barley cultivars to root rot as one factor in selecting which cultivars to plant.

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