# COMMON ROOT ROT OF SPRING CEREALS
# Differential Susceptibility of Durum Wheats

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**From 1976 through 1978 a total of 12 durum wheat cultivars were evaluated for susceptibility to the common root and crown rot caused by *Helminthosporium sativum*. Two cultivars, "Edmore" and "Wakooma," showed outstanding levels of resistance to the root rot. One other cultivar "Coulter" also was less susceptible in most trials. The cultivars "Rolette" and "Calvin" had more root rot than the other durums. The potential exists for selection of root-rot resistant durum wheats.**

One of the most widespread diseases of spring wheat and barley in North Dakota is the "common root rot" caused by the soil-inhabiting fungus *Helminthosporium sativum*. This fungus was present in the native prairie grassland and has persisted with the cultivation of wheat and barley (8). Early researchers recognized that the problems caused by common root rot were widespread in North Dakota (1, 12). In fact, H. L. Bolley's early description of this disease as "wheat-sick soil" roused the ire of the St. Paul bankers and almost led to his own removal as state seed commissioner.

Although this disease is called common root rot, the crowns and lower stems are attacked as well as the roots. Observations of and isolation from diseased plants in these studies confirms the findings of previous workers that *Helminthosporium sativum* is the principal root and crown pathogen affecting adult plants of spring wheat in North Dakota (1, 8), just as it is in the adjacent prairie provinces of Canada (3, 4, 5).

The impact of common root rot upon 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. In the early 1940's, Greaney calculated wheat root rot losses of 5% for Manitoba and 9% for Saskatchewan (4); Machacek, during the same period placed the figure at 12% for wheat in Manitoba (4). More recent reports place the annual losses at 5.7% for wheat and 10.3% for barley in the prairie provinces of Canada (3, 5). Our own findings show that losses of similar magnitude occur in North Dakota (R. W. Stack, unpublished).

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Varieties (cultivars) of wheat show differential responses to common root rot (6, 11), and these differential responses hold up year after year (7). Most studies on resistance have concentrated on other wheats, although the potential for selection of resistant lines in durum would appear to be almost as great as in other wheats (2). In a limited study at NDSU several years ago, Statler and Darlington (10) showed differences in susceptibility to root rot among the durum cultivars Wells, Rolette, and Leeds.

We here report our findings from studies conducted during 1976 through 1978 on differential susceptibility of durum cultivars to common root rot caused by *H. sativum*. Other studies on the manner of disease development, the inheritance of susceptibility, and determination of losses are in progress.

## METHODS

**Field Experiments.**

Eight separate field trials were done to test root rot susceptibility in durum wheat cultivars. All soils were naturally infested with *H. sativum*, and no inoculum was added. Each trial contained 7 to 12 durum wheat cultivars; some also contained hard red spring wheat or barley, but those results are not presented here (except that Thatcher HRS is included for comparison). Trials were done at Langdon in 1976 and 1978, at two Fargo fields, each in 1977 and 1978, at Williston, and at Erie (western Cass County) in 1978.

**Fargo-1 1977.** This experiment was a randomized complete block design with twelve replicates per cultivar. The experimental units were plots eight rows wide by 15 ft (4.57 m) long, planted with a four-row plot seeder; rows were 12 in (30 cm) apart. A sample of 36 plants was rated from the center rows of each plot. Ratings of all cultivars within a replicate were taken at the

same time. This experiment was planted on land sown to wheat in the previous year.

**Fargo-1 1978.** This experiment was planted in an incompletely randomized design of land which had been in wheat for the two previous years. Drill strips 6 ft (1.83 m) by 350 ft (106.7 m) were planted across a previously determined gradient of root rot severity. Samples of 24 plants per cv each were taken along four transects across the plot at 3 dates.

**Langdon 1976, 1978; Williston 1978; Fargo-2 1977, 1978.** These disease ratings were based on samples of at least 36 plants taken from several spots within single, non-replicated drill strips 6 ft wide (1.83 m) by 100 ft long (30.5 m). Different cvs were in adjacent drill strips. The Langdon and Williston plots were on land which had not been in small grains during the previous year; Fargo-2 1977 was on an area which had been planted continuously to wheat for many years; Fargo-2 1978 was on land which had been sown to barley for the previous two seasons.

**Erie 1978.** This experiment was planted as a randomized complete block design with four replications. Each experimental unit was a drill strip 6 ft (1.83 m) by 100 ft (30.5 m). Samples of 50 to 100 plants were collected for disease evaluation from several spots within each drill strip. This experiment was planted on land which had been in wheat or barley for several years prior to this experiment and which had shown a high level of root rot in the previous year (1977).

**Disease Ratings.**

As explained in the introduction, common root rot affects the crown, roots, and lower stem of the plant. The sub-crown internode (the part of the stem between the seed and the crown) is a convenient area for assessing the extent of disease. The amount of *H. sativum* lesioning of the sub-crown internode (sci) is a good indicator of the amount of disease on the entire crown and root system (3) and thus can be used as an index of disease for the whole plant. In these studies we determined the amount of disease using the sci-indicator method.

Ratings were made when plants were between anthesis and soft dough stage. Plants were removed from the soil and the sci freed of soil by shaking or rubbing. The plant was classified by the amount of lesioning on the sci as clean (1), slight (2), moderate (3), or severe (4) in disease level. These categories represent 0.1%, 20%, 50%, 99% disease, respectively. Little or no difference in results was found whether disease categories were coded as 1, 2, 3, 4; or as per cent disease.

All ratings were expressed and analyzed as sample means. We previously had determined that a sample of 24 to 36 plants was adequate to determine the extent of root rot in any particular field location or in an experimental unit of moderate size (9). All field plots were evaluated using samples of this size range.

## RESULTS

The results of the field trials are given in Table 1 and 2. The amount of root rot differed among locations and years, but a consistent response among durums can be noted. The four cultivars Crosby, Rugby, Ward, and Botno tended to give similar ratings in these experiments and generally did not differ significantly from each other in individual experiments. These four cultivars accounted for about 75% of the durum grown in North Dakota in 1978 and may thus be considered representative of durums. We have considered that any cultivar showing significantly less root rot than these four has resistance, while one with more disease is highly susceptible. Each experiment was analyzed statistically and cultivar ratings which differed significantly from these representative four are underlined in the tables.

**TABLE 1. Durum Root Rot 1976-77 Field Results**

| | Per Cent Disease[1] | | |
|---|---|---|---|
| | Fargo 1977 | | 1976 |
| Cultivar | Exp. 1 | Exp. 2 | Langdon |
| Edmore | 25[3] | 25 | |
| Wakooma | 31 | 34 | |
| Coulter | 34 | 28 | |
| Cando | 45 | 45 | |
| Crosby | 45 | 34 | 13 |
| Rugby | 48 | 48 | 12 |
| Ward | 45 | 56 | 14 |
| Botno | 37 | 37 | 14 |
| Wells | | | 22 |
| Calvin | 61 | 56 | |
| Rolette | 52 | 61 | 31 |
| Thatcher (HRS)[2] | 31 | | 17 |
| lsd .05 | 8.1% | 11% | 15% |

[1]*Per cent disease = proportion of subcrown internode tissue covered by lesions. Plants rated for disease at anthesis-to-mid-dough stage.*

[2]*Thatcher hard red spring wheat (HRS) included for comparison.*

[3]*Underlined values are significantly (P = .05) different from the average of Crosby, Rugby, Ward, Botno.*

Two cultivars, Edmore, a 1978 North Dakota release, and Wakooma, a widely grown Canadian durum, showed consistently less disease than the others (Tables 1 & 2). A third cultivar, Coulter, a newer Canadian durum, was often better than the representative four. In one experiment Mindum was significantly more susceptible than average. One cultivar, Rolette, consistently showed levels of disease significantly greater than all others. This response may be due in part to the earliness of Rolette. Rolette's susceptibility is not entirely due to earliness, however, because when the disease ratings were adjusted for plant stage of development, Rolette still showed more than average disease.

Comparison of three durums, Edmore, Coulter, and Rolette, at five locations in 1978 (Table 3) reveals that while the amount of disease differs somewhat among locations, the cultivar ratings are consistently and significantly different. The differentiation between resistant

**TABLE 2. Durum Root Rot — 1978 Field Results**

| Cultivar | Per Cent Disease[1] Fargo 1 | Fargo 2 | Erie | Williston | Langdon | Mean[2] |
|---|---|---|---|---|---|---|
| Edmore | 21[4] | 11 | 26 | 6 | 10 | 14 |
| Wakooma | 18 | 11 | 21 | 13 | | 16 |
| Coulter | | 21 | 26 | 23 | 16 | 21 |
| Crosby | 45 | 25 | | 27 | 18 | 28 |
| Rugby | 45 | 18 | 51 | 21 | 19 | 30 |
| Ward | 46 | 17 | 58 | 24 | 24 | 32 |
| Botno | 46 | 21 | 43 | 28 | 26 | 32 |
| Rolette | 53 | 36 | 70 | 66 | 30 | 49 |
| Cando | | 17 | | 17 | 17 | —[3] |
| Wells | | | | 29 | | —[3] |
| Calvin | | 31 | | 26 | 19 | —[3] |
| Mindum | | | | 36 | | —[3] |
| Thatcher | 34 | 16 | 33 | | 8 | 22 |
| lsd .05 | 11. | 9. | 8. | 11. | 12. | |

[1]*Per cent disease = proportion of subcrown internode tissue covered by lesions. Plants rated for disease at anthesis-to-mid-dough stage.*

[2]*Means of cultivars for all experiments in 1978. Each experiment given equal weight.*

[3]*These cultivars were not adequately represented in all trials for means to be calculated.*

[4]*Underlined values are significantly (P = .05) different from the average of Crosby, Rugby, Ward, Botno.*

**TABLE 3. Comparison of root rot disease percentages at five locations in North Dakota in 1978**

| Cultivar | Per Cent Disease[1] Fargo[3] | Carrington | Langdon | Minot | Williston | cv Average[2] |
|---|---|---|---|---|---|---|
| Edmore | 11 | 10 | 10 | 3 | 6 | 8. x |
| Coulter | 21 | 20 | 16 | 3 | 23 | 16. y |
| Rolette | 36 | 54 | 30 | 32 | 66 | 42. z |
| Location Average[2] | 22 y | 26 y | 18 xy | 10 x | 27 y | |

[1]*Per cent disease = proportion of subcrown internode tissue covered by lesions. Plants rated at anthesis-to-mid-dough stage.*

[2]*Means of cultivars or locations differ significantly (P = .05) when not followed by the same letter.*

[3]*Fargo here is same as Fargo 1 in Table 2.*

(Edmore), intermediate (Coulter), and highly susceptible (Rolette) cultivars was best at the locations having the most disease (Carrington, Williston). The location with the least disease (Minot) gave the poorest differential for root rot disease evaluation.

## DISCUSSION

These results show that the range of response to common root rot is as great for durum as has been reported for hexaploid wheats (2). Sources of resistance to root rot are thus available for incorporation into modern durum cultivars.

Studies of resistance to root rot in hexaploid wheats have shown that resistance can be incorporated through breeding but that the inheritance is complex (6, 7). Comparing our results of different locations and years for cultivars in the middle range of response (Crosby, Rugby, Ward, Botno, etc.), one sees variation in relative rank. This suggests that identification of, or selection for small increases in resistance might be very difficult. At the same time, one notes that the more resistant cultivars such as Edmore or Wakooma show consistent responses in different seasons and locations, which suggests that selection for lines with substantial levels of

resistance should be relatively independent of location and year.

Helminthosporium root rot is more severe in dry years and on droughty sites; under these conditions Helminthosporium root rot can cause serious losses (3, R. W. Stack, unpublished data). Since the pathogen survives well in dry soil, planting of wheat after wheat or barley during a series of dry seasons will especially favor build-up of the disease and potential serious loss. The best way to minimize loss is through rotation of small grains with other crops.

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

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civil engineering, food and nutrition including the dietetics option, medical technology, nursing and pharmacy regularly take one or more bacteriology courses. Others may take a bacteriology course to better understand the role of microorganisms in our individual and community life. Perhaps the more general awareness, in recent years, of the importance of protecting the environment, providing safer food and better health care has increased student interest in microbiology. Students working toward an M.S. degree in bacteriology have increased from six in 1967-68 to an average of 16 per year for the period 1971 through 1978.

Increased research effort has been directed during the past couple of years toward investigation of agricultural problems that have been identified by well-recognized scientists as those most deserving of special effort. Present department research projects within the Agricultural Experiment Station have as objectives the improvement of biological nitrogen fixation, development of more effective methods for waste disposal, development of better diagnostic and control methods for certain animal diseases and achievement of greater photosynthetic efficiency.

Research completed recently has dealt with the etiology of poultry necroses, Japanese beetle control with *Bacillus popilliae*, effects of insecticides on agriculturally important microbiological activities, effect of 1-amino-D-proline on enzyme systems and bacterial viruses in farm animal waste lagoons. Completed multidisciplinary research has involved studies on water quality and land use in the Sheyenne River basin, evaluation of the utilization and management of water resources in the Lake Metigoshe watershed and assessment of environmental effects of a coal gasification plant in Dunn County, North Dakota. Results of research completed recently have been published in Applied Microbiology, the Canadian Journal of Microbiology, Plant and Soil, Poultry Science, Soil Biology and Biochemistry and North Dakota Research Reports.

The tradition of providing service for those in need established by Dr. Nelson has been continued in recent years. Dr. Mary Bromel frequently responds to the request that she determine the quality of drinking water. On several occasions she has met with citizen groups who were concerned about the quality of particular recreational lakes. Other members of the department may be called upon when contamination of food is suspected, when questions arise about inoculation of seed with nitrogen-fixing bacteria or even when someone wonders if microorganisms could be responsible for paint peeling from walls.

As we look to the future, we are committed, as are those in other disciplines at the University, to provide educational opportunities for students, to offer needed services when possible and to conduct research related to the needs of the state and region.