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Biological control of common root rot in barley by *Idriella bolleyi*

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Seed treatment of spring barley in field tests with an isolate of the fungus *Idriella bolleyi* collected in Saskatchewan significantly reduced disease symptoms of common root rot by 16% over a 6-year period compared to untreated seed, and increased grain yield by 4%. There was no effect of the treatment on emergence.

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Lors d'essais au champ, le traitement de semences de l'orge de printemps avec un isolat du champignon *Idriella bolleyi* provenant de la Saskatchewan a significativement réduit de 16 %, sur une période de 6 ans, les symptômes de la pourriture sèche par rapport à des semences non traitées et a augmenté le rendement en grains de 4 %. Le traitement n'a pas eu d'effet sur la levée des semis.

In the Canadian prairies, common root rot, caused mainly by *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem. [teleomorph, *Cochliobolus sativus* (Ito & Kurib.) Drechsl. ex Dastur], reduces the yield of spring wheat and spring barley by 6–10% annually (Ledingham et al. 1973, Piening et al. 1976). Bacteria and/or fungi have been reported to be antagonistic to *B. sorokiniana* in the laboratory, but these were not evaluated in the field (Campbell 1956, Henry 1931, Ledingham et al. 1949, Old 1965, Porter 1924, Sanford & Cormack 1940). *Idriella bolleyi* (R. Sprague)Arx [=*Microdochium bolleyi* (R. Sprague) de Hoog & Herm-Nijh] has been reported to be associated with common root rot infected wheat plants, and in greenhouse tests, *I. bolleyi* reduced the severity of damage caused by *B. sorokiniana* for up to 63 days (Vanstone 1989, Vanstone et al. 1991). However, in the field, disease control was not affected. No zones of inhibition were observed between *I. bolleyi* and *B. sorokiniana* when they were grown together in culture. *Idriella bolleyi* has also been investigated as a biological control agent for other diseases of wheat, namely eyespot (Hinton & Parry 1993) and take-all (Kirk & Deacon 1987a). Knudsen et al. (1995) found *I. bolleyi* reduced the severity of *B. sorokiniana* on barley in greenhouse tests, where the disease originated from seedborne inoculum, but in the field, there was no significant improvement in disease control or yield, although yield was increased by 10%.

A program was initiated several years ago at the Saskatoon Research Centre to isolate organisms which might reduce the damaging effects of common root rot (Duczek 1994). In the Canadian prairies, this disease originates from soilborne inoculum. The assessment did not focus on potential agents described in the literature, but was based on the random isolation of indigenous organisms, which were then assessed for control of common root rot in wheat and barley. Candidate organisms were isolated from the coleoptiles of young plants and then applied on seed with the intention of protecting the coleoptile. This tissue is important as an entry point for the pathogen to become established in plants and it is an area from which the fungus could invade the underlying tissues of the subcrown internode and crown. Many organisms were assessed, and it was only after some potential activity was demonstrated that organisms were identified. This report describes one isolate which showed the best activity for both disease reduction and yield increase in barley.

Idriella bolleyi (isolate 371) was isolated on potato dextrose agar (PDA, Difco Laboratories) from a wheat coleoptile collected on 8 June 1989 near Kenaston, Saskatchewan. An initial screening trial was done in the field in 1990 to determine effectiveness for control of common root rot. For inoculum production, two petri dishes (100 × 15 mm) of PDA were inoculated with 4 mm diameter plugs of isolate 371 and grown at 20°C in the dark for 3 weeks. *Idriella bolleyi* produces numerous small conidia in culture, and one petri dish will yield about 4×10^9 colony forming units. Three millilitres of 2% methocel (Dow Chemical Co, Midland, MI) and 250 seeds of the spring barley (*Hordeum vulgare L.*) cv. Melvin were added to each petri dish, and the surface growth of the fungus, which consisted mainly of conidia, was scraped and mixed with the seed. Seed was air dried overnight and packaged into four lots of 125

seeds each. One package was used to plant one row. The experimental design was a randomized complete block with four replicates of single 2-m row plots spaced 23 cm apart. Seeding was done on 30 May 1990. Control plots of nontreated and methocel treated seed were included. Common root rot was rated by determining the percentage of 40 plants in a plot with lesions covering greater than 50% of the subcrown internode (Duczek 1994).

Trials measuring emergence, disease severity, and yield were conducted from 1991 to 1996 at the Agriculture and Agri-Food Canada, Saskatoon Research Centre farm site. Experiments were made up of four-row plots, each row 6 m in length and 23 cm apart, with four to six replicates. The spring barley cvs. used were Melvin in 1991–92 and Brier in 1993–96. Inoculum of *I. bolleyi* consisting mainly of conidia was prepared by scraping 16 petri dishes of isolate 371 in 10 mL of 2% methocel. The methocel-conidia mixture was transferred to a 100 mL beaker and made up to 70 mL with methocel. The mixture was blended using a hand-held Omni homogenizer for 10 to 15 sec. Inoculum was added to 350 g of seed in a plastic bag and mixed until all seeds were coated. Seed was air dried overnight, packaged into lots of 350 seeds, and each lot was then used to seed one 6 m row. Seed was treated as close as possible to the date of planting. After seeding, excess seed was placed on PDA where isolate 371 was only recovered from 100% of seeds treated with the fungus. Nontreated and methocel treated control plots were included in all trials and seeding occurred between 11–27 May for all years.

Emergence was measured by counting seedlings in 2 m of row 2 or row 3 of each 4-row plot at the two-leaf stage between 31 May and 11 June. Values were converted to plants/m^2. Common root rot was rated between 13 and 27 August at the dough stage using the method described above. A disease rating was not done in 1996. One outside row of each plot was used for rating, and all the plants in that outside row were removed prior to harvest. Trials were harvested by combining three rows trimmed to 5 m long between 23 August and 14 September. Yield was recorded as grams of dry grain per plot and converted to kg/ha. To confirm the causal organism of common root rot, isolations were made from diseased subcrown internodes collected from control plots. *B. sorokiniana* was isolated from 80–100% of diseased internodes and red *Fusarium* spp. from 5–20%.

Univariate analysis (SAS Statistics, Version 6, SAS Institute, Box 8000, Cary N.C.) showed that the data from all years were normally distributed, therefore, no transformations were done before the data were analyzed using an analysis of variance procedure. Because of the similar disease reaction of Melvin and Brier, data were analyzed by combining all years as well as for each year.

Table 1. Effect of *Idriella bolleyi* on emergence, common root rot, and yield of barley cvs. Melvin and Brier[a]

	Year							
Treatment	1990	1991	1992	1993	1994	1995	1996	Mean
Emergence (plants/m^2)								
Isolate 371		225	192	236	178	222	232	212
Nontreated control		223	202	227	198	213	272	219
Methocel control		222	211	223	188	197	215	208
LSD 0.05		65	37	39	26	39	49	17
Pr > F Treatment								0.292
Year								0.001
Year × Treatment								0.568
Common Root Rot (%)								
Isolate 371	42	58	71	27	43	33		46
Nontreated control	64	82	78	35	54	38		56
Methocel control	68	76	77	33	49	39		54
LSD 0.05	59	29	13	12	12	11		7
Pr > F Treatment								0.0001
Year								0.0001
Year × Treatment								0.816
Yield (kg/ha)								
Isolate 371		5152	5463	6587	5562	6036	6597	5943
Nontreated control		4936	5389	6151	5378	6224	6363	5788
Methocel control		4483	5643	5907	5355	5901	6385	5679
LSD 0.05		841	393	266	275	478	475	194
Pr > F Treatment								0.018
Year								0.0001
Year × Treatment								0.273

[a] Melvin was grown in 1990–92 and Brier in 1993–96.

There was a significant average yield increase of 4% over the mean of nontreated and methocel-treated control plots over six years (Table 1). Yield ranged from an increase of 9% in 1991 to a decrease of 1% in 1992. Common root rot severity was significantly reduced by an average of 16% over six years compared to nontreated and methocel-treated controls. Common root rot ratings were consistently lower after treatment with isolate 371 compared to the controls and ranged from 36% lower in 1990 to 8% lower in 1992. Emergence was not significantly different as a result of seed treatment with isolate 371. Emergence, common root rot, and yield varied from year to year which is indicated by a significant F-value for year, but the year by treatment interaction was not significant which indicates that treatment with isolate 371 had a similar effect each year.

Idriella bolleyi is common in agricultural soils worldwide and it is usually associated with crowns and roots of graminaceous species including wheat and barley (Hannukkala & Koponen 1988, Murray & Gadd 1981, Sturz & Bernier 1987, Vanstone 1989). *Idriella bolleyi* is considered to be nonpathogenic or a weak parasite (Kane et al. 1987). Murray and Gadd (1981) found *I. bolleyi* caused some discoloration on the coleoptiles of barley but not on roots even though roots were heavily colonized. Hemens et al. (1992) found that *I. bolleyi* spread within the cortex only and did not attack the endodermal cells or the vascular tissue of roots and coleoptiles of barley, while Kirk and Deacon (1987b) found that *I. bolleyi* behaved as a weak parasite by only damaging roots in a few instances but mainly invaded naturally senesing cortices of cereal and grass roots. *Idriella bolleyi* has unique properties that make it a suitable candidate for biological control. It grows readily on solid media (Hannukkala & Koponen 1988) and in liquid culture (Jadubansa et al. 1994, Lascaris & Deacon 1994), where it produces conidia as well as chlamydospores. In addition, when *I. bolleyi* was applied as a seed treatment in alginate gel to wheat grown in perlite in the greenhouse, it readily colonized the seed and roots (Lascaris & Deacon 1991). There could, however, be variability in *I. bolleyi* and there also may be a plant-*I. bolleyi* interaction. For instance, Liljeroth and Baath (1989) found cultivar differences in barley in the colonization of *I. bolleyi* on roots. In the present study, isolate 371 reduced common root rot and increased yield in barley in field trials but it did not perform similarly on wheat (Duczek unpublished).

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