Imazalil Seed Treatment Reduces Common Root Rot and Increases Yield of Barley Under Commercial Conditions

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ABSTRACT

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The efficacy of imazalil (Nuzone 10EC) seed treatment for controlling common root rot caused by *Bipolaris sorokiniana* in barley (*Hordeum vulgare*) was evaluated in large-scale field trials in Fremont County, Idaho, at six sites in 1985 and three sites in 1986. The control seeds of barley cultivars Steptoe and Klages were treated with carboxin and thiram (Vitavax 200 at 2.6 ml/kg) to control loose smut. The imazalil treatment was the Vitavax 200 treatment at the same rate plus Nuzone 10EC at 1.0 ml/kg. Isolations from 173 diseased subcrown internodes of plants in the control and imazalil treatments in 1986 yielded 106 isolates (61%) of *Bipolaris* but no *Fusarium* spp. Seed treatment with imazalil significantly ($P = 0.05$) lowered disease severity in the subcrown internode, increased grain yield 6%, and increased test weight compared to the control treatment.

Additional keywords: chemical control

Common root rot is one of the most widespread diseases in barley (*Hordeum vulgare* L.), occurring in all production areas (10). *Bipolaris sorokiniana* (Sacc.) Shoem. (syn. *Helminthosporium sativum* Pammel, King, & Bakke; teleomorph *Cochliobolus sativus* (Ito & Kurib.) Drechs. ex Dast.) is the pathogen most frequently isolated from diseased plants in the intermountain West and Great Plains of the United States, the Canadian Prairie Provinces, and the Soviet Union (3,5,10,13). *Fusarium* spp. may also cause common root rot and are the principal pathogens in parts of the Pacific Northwest and the Mediterranean area of the Middle East (10).

Yield losses are reported to range from 6 to 20%, depending on cultivar and location (7,9–13). Common root rot reduces the size of internodes in wheat (*Triticum aestivum* L.) (2) and affects yield by reducing the number of heads per plant, the number of seeds per head, and kernel weight (3,4,6,9,10,13). *B. sorokiniana* can also cause seedling blight and spot blotch on leaves as well as root disease.

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Disease control recommendations have focused on cultural practices such as planting date, soil fertility, crop rotation, and clean cultivation (1,5,10–12,14). In 1984, imazalil became the first seed treatment chemical registered by the U.S. Environmental Protection Agency for the control of common root rot of barley and wheat. Although imazalil has been shown to be effective experimentally in suppressing the disease (2,7,15), no data on its efficacy in large-scale, commercial use were available. The objective of this research, therefore, was to evaluate common root rot control with imazalil seed treatment and to determine seed yield and test weight response of barley under commercial production conditions in southeast Idaho.

MATERIALS AND METHODS

Large-scale field trials were established in Fremont County, Idaho, at six sites in 1985 and three sites in 1986. The experimental units varied in size, but all were larger than 0.4 ha. For the control treatment, seed of barley cultivars Steptoe and Klages was treated with carboxin plus thiram (Vitavax 200) at 2.6 ml/kg to control loose smut. For the imazalil treatment, seed was treated with imazalil (Nuzone 10EC) at 1.0 ml/kg in addition to the carboxin-thiram treatment.

In 1985, the control and imazalil seed treatments were replicated once at each of five sites and were planted in three blocks of a randomized block design at a sixth site. In 1986, the two treatments were arranged in a randomized block design with four replications at each of three sites. All plots were seeded at about 112 kg/ha between 10 April and 5 May by cooperating growers. All sites except site F (Table 1) in 1985 received supplemental irrigation. The previous crop grown at each site is shown in Table 1.

Disease was rated between 3 and 15 July when the barley was heading (Feekes growth stage 10.1 [8]). About 50 plants were pulled from the ground in each experimental unit, and their root systems were classified into one of three infection groups based on the extent of discoloration of the subcrown internode (SCI): none, slight (less than 20% of the SCI discolored), or severe (20% or more of the SCI discolored). A root rot severity index (RRSI) was then calculated by the following formula: RRSI $= (1A + 2B + 3C) / 3(A + B + C) \times 100$, where A, B, and C are the numbers of plants in the first, second, and third infection groups, respectively.

In 1986, after SCIs were rated for disease severity, isolations were made from the same tissues to identify the organism(s) associated with the symptomatic tissue. Ten discolored SCIs per experimental unit were washed in running water, disinfested for 2 min in 0.5% sodium hypochlorite, and plated onto acidified potato-dextrose agar. Plates were incubated at room temperature (about 25 C) and examined after 21 days.

Plots were harvested by commercial combines between 1 August and 17 September 1985 and between 20 August and 23 October 1986. Grain yield and test weight were determined for each plot. The severity index, grain yield, and test weight for the control and imazalil treatments were compared using a paired t test for each year separately and then using data from both years.

RESULTS AND DISCUSSION

Seed treatment with imazalil suppressed but did not completely control common root rot; it reduced the root rot severity index from 76 to 66 when data were averaged over both years (Table 1). These results are consistent with those reported for common root rot control in wheat (2). In addition, grain yield of barley given the imazalil seed treatment was 6% greater than that of the control plots (Table 1). The reduction in RRSI

Table 1. The effect of imazalil seed treatment on common root rot severity, grain yield, and test weight of barley in Fremont County, ID, in 1985 and 1986 trials

Location	Previous crop	Cultivar	Replications (no.)	Severity[a] Imazalil[b]	Severity[a] Control[c]	Grain yield (kg/ha) Imazalil[b]	Grain yield (kg/ha) Control[c]	Test weight (kg/hl) Imazalil[b]	Test weight (kg/hl) Control[c]
				1985					
A	Barley	Steptoe	3	64	71	NA[d]	NA	NA	NA
B	Potato	Steptoe	1	82	87	NA	NA	57.9	56.6
C	Barley	Steptoe	1	57	61	4,830	4,416	59.2	56.6
D	Alfalfa	Steptoe	1	58	60	6,456	6,164	62.4	61.8
E	Barley	Klages	1	46	54	4,618	4,517	64.4	63.1
F	Potato	Klages	1	53	59	4,337	3,956	62.4	61.8
1985 mean				61	66	5,060	4,763	61.3	60.0
Difference[e]				−5**		297**		1.3*	
				1986					
G	Barley	Steptoe	4	60	79	5,820	5,302	61.4	61.0
H	Barley	Klages	4	76	86	4,465	4,475	62.2[f]	61.8[f]
I	Barley	Klages	4	72	82	5,574	5,218	—[f]	—[f]
1986 mean				69	82	5,286	4,998	61.9	61.5
Difference[e]				−13**		288*		0.41*	
Overall mean				66	76	5,230	4,940	61.7	61.0
Difference[e]				−10**		290**		0.68**	

[a]Common root rot severity is a weighted mean ranging from 0 (healthy) to 100 (all plants severely diseased).
[b]Nuzone 10EC (1 ml/kg) in addition to carboxin-thiram treatment.
[c]Carboxin plus thiram (Vitavax 200) at 2.6 ml/kg.
[d]NA = not available.
[e]Differences are significantly different from zero at the 5% (*) and 1% (**) levels.
[f]Test weight data from locations H and I are combined.

and the increase in yield of the imazalil treatment compared with the control treatment were consistent and statistically significant at the 1% level in both years (except for the 1986 yield comparison, which was significant at the 5% level). Test weight in the imazalil treatment was significantly greater ($P < 0.05$) than that in the control treatment for both years of the study (Table 1). (Data for grain yield and test weight for locations A and B are missing in Table 1 because of misunderstandings with the growers and failure to keep the treatments separate.)

Bipolaris was isolated from 61% (106 of 173) of the SCIs tested. The remainder of the SCIs yielded nonsporulating fungal colonies, bacterial isolates, or no microbial growth. No *Fusarium* or *Fusarium*-like colonies were observed.

Although disease pressure varied by year, location, and crop rotation (Table 1), the increment in disease suppression associated with the imazalil seed treatment (RRSI of the control minus that of the imazalil treatment) was surprisingly similar across all locations in the study. The disease was more severe in 1986, perhaps partly because barley was recropped at all three sites.

Spot blotch, another manifestation of infection by *B. sorokiniana,* occurs sporadically in Idaho. Imazalil seed treatment may also suppress spot blotch, especially if the incidence of the pathogen on the seed is high and no barley residue from a previous crop is nearby. Weather conditions in 1985 and 1986 were not favorable for the development of spot blotch, and the data collected in this study were insufficient to assess the effect of imazalil seed treatment on spot blotch. Similarly, seedling blight was not evident in either year.

Our data indicate that the use of imazalil as a seed treatment for common root rot control in barley is effective under commercial conditions in Fremont County and may be beneficial in other parts of Idaho and the intermountain West. Because the additional cost of the material relative to the benefits derived therefrom would clearly vary with cultural practices and the price of barley, growers need to evaluate this equation on their individual farms.

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