Influence of Tillage and Nitrogen Fertilizer on Rhizoctonia Root Rot (Bare Patch) of Winter Wheat

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ABSTRACT

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Discovery of Rhizoctonia root rot (*Rhizoctonia solani*) in northeastern Oregon during 1984 led to studies of the impact of seedbed tillage and nitrogen fertilization on occurrence of the disease and a comparison of growth and yield of bare patch-affected and unaffected winter wheat plants. Seedbed preparation of moldboard plowing, subsurface tillage, paraplowing, and nontillage were applied to wheat following alfalfa and wheat following wheat rotations. Nitrogen fertilizer treatments of 1) no fertilizer, 2) 56 kg/ha at planting plus 168 kg/ha at late tillering, 3) 56 kg/ha at planting plus 224 kg/ha at late tillering, and 4) 168 kg/ha at late tillering were applied over the tillage treatments. Frequency of bare patch occurrence was inversely related to amount of soil disturbance in seedbed tillage. Level and timing of nitrogen fertilization had no impact on frequency of occurrence of patches. Grain and straw yields of visually affected plants were reduced by more than 50%, primarily by reduction in the number of heads. Growers practicing conservation tillage must remain alert to the potential for development of Rhizoctonia root rot; however, severity of this disease can be greatly reduced in infected fields by increased soil disturbance during tillage for seedbed preparation.

Rhizoctonia root rot of cereals caused by *Rhizoctonia solani* Kühn (*Thanatephorus cucumeris* (Frank) Donk) (1) is well known in Australia (2,7,12,14). This disease has also been reported in Scotland (10), Canada (16), and the Pacific Northwest region of the United States (17).

Infections of roots of young plants result in a characteristic dark-colored, sharp-pointed tip on the remaining live tissue (2,10,14,16). Severely affected plants are stunted, often in patches (bare patch), and this stunting persists throughout the growing season even though isolation of *R. solani* from roots of older plants is difficult if not impossible (4,9,10,15). Roots of young cereal plants are predisposed to invasion by a complex of root-rot organisms that may have a more adverse effect on yield than the initial *R. solani* infection. This association of *R. solani* with a complex of root diseases has been noted in several other crops (4,15).

Bare patch occurred in three conservation tillage winter wheat (*Triticum aestivum* L.) experiments conducted at the Hermiston Agricultural Research and Extension Center. This paper reports the effects of seedbed tillage and nitrogen fertilization on the incidence of bare patch and compares characteristics of plants affected and not affected by this disease. A description of bare patch in the initial experiment has been reported (17).

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MATERIALS AND METHODS

A field experiment (experiment 1) was initiated in August 1983 to compare conservation seedbed tillage with conventional seedbed tillage for soft white winter wheat (cultivar Stephens) following 3 yr of alfalfa (*Medicago sativa* L.). Alfalfa and grassy weeds were killed with an application of glyphosate (2.1 L/ha) and 2,4-D (1.6 L/ha) 4 wk before wheat planting. Conservation tillage treatments consisted of 1) no seedbed tillage and planting the wheat with shovel-type no-till drills and 2) subsurface tillage consisting of sweeping 15 cm deep before planting. These conservation tillage treatments were compared with conventional seedbed preparation consisting of moldboard plowing and packing. A disc drill was used to plant the sweep and plow seedbed treatments.

Each tillage main plot was divided into four fertilizer subplots. Nitrogen fertilizer treatments were 1) no fertilizer, 2) 56 kg/ha at planting (PT) plus 158 kg/ha at late tillering (LT) (6) in the spring, 3) 56 kg/ha PT plus 224 kg/ha LT, and 4) 168 kg/ha LT. Sources of nitrogen were ammonium sulfate at PT and ammonium nitrate at LT.

Soil where the experiments were located was classified as Adkins loamy sand (mixed, mesic Xerollic Camorthids). Irrigation water was applied via sprinklers to provide adequate soil moisture for seed germination, seedling establishment, and optimum development of the growing crop (3).

Areas of wheat affected by Rhizoctonia root rot were identified by visual root examination during early spring tillering, late tillering, and jointing growth stages (Feekes scale 3, 5, and 8, respectively) (6). Areas for harvesting were visually designated as either affected or not affected by the bare patch phase of this disease. Measurements of grain and straw yields (kg/ha), number of heads per square meter, and plant height (mm) were made at harvest; only patches larger than 0.6 m were sampled. Treatment means were determined separately for measurements inside and adjacent to patches. Areas observed before harvest to be affected by take-all (*Gaeumannomyces graminis* (Sacc.) von Arx & Olivier var. *tritici* (Walker) were discarded from the measurements of plant characteristics and yields. Data on the effect of tillage and nitrogen fertilizer on incidence of bare patch were analyzed by Fisher's exact test (5), and plant characteristics and yield data of plots affected and not affected by bare patch were analyzed by pairwise contrasts.

A second experiment was initiated in the summer of 1984. A wheat after wheat cropping sequence was established on the site where bare patch was first identified. Tillage and fertilizer treatments were the same as in experiment 1; straw and chaff from the previous wheat crop was removed by burning to facilitate wheat planting.

Also in 1984, a third experiment was established on a site about 400 m from that of experiments 1 and 2. A 3-year-old alfalfa field was prepared for planting to wheat by the same procedures as in experiment 1. Additionally, a fourth tillage treatment was initiated in experiment 3; paraplowing was used as a third conservation tillage variable.

Table 1. Effect of tillage on incidence of bare patches in winter wheat

Seedbed preparation	Number of plots infected/number of plots observed		
	Exp. 1	**Exp. 2**	**Exp. 3**
Plow	0/16 a[z]	0/16 a	0/16 a
Sweep	0/16 a	2/16 a	2/16 ab
Paraplow	...	...	4/16 bc
No tillage	24/48 b	15/48 b	14/32 c

[z] Numbers within a column followed by the same letter are not significantly different ($P = 0.05$) according to Fisher's exact test (5).

Table 2. Effect of nitrogen fertilizer on incidence of bare patches in winter wheat

Nitrogen fertilizer applied (kg/ha)	Number of plots infected per 16 plots observed		
	Exp. 1	**Exp. 2**	**Exp. 3**
No nitrogen	7 a[y]	3 a	5 a
56 PT + 168 LT[z]	8 a	4 a	5 a
56 PT + 224 LT	3 a	4 a	4 a
0 PT + 168 LT	8 a	5 a	6 a

[y] Numbers within a column followed by the same letter are not significantly different ($P = 0.05$) according to Fisher's exact test (5).
[z] PT = planting time, LT = late tillering in the spring; ammonium sulfate applied at PT, ammonium nitrate applied at LT.

Table 3. Characteristics of bare patch-affected and unaffected winter wheat plants

Experiment	Plant character	Bare patch	No bare patch	Contrast
1	Grain (kg/ha)	3,280	7,690	**[a]
	Straw (kg/ha)	4,600	12,120	**
	Straw/grain ratio	1.43	1.57	**
	Heads/m^2	221	531	**
	Plant height (mm)	689	903	**
2	Grain (kg/ha)	3,140	6,750	**
	Straw (kg/ha)	3,955	8,830	**
	Straw/grain ratio	1.30	1.31	**
	Heads/m^2	197	440	*
	1,000-kernel wt (g)	45.8	48.0	**
	Plant height (mm)	604	781	**
3	Grain (kg/ha)	3,540	7,450	**
	Straw (kg/ha)	4,375	10,105	**
	Straw/grain ratio	1.23	1.35	**
	Heads/m^2	257	605	**
	1,000-kernel wt (g)	47.0	48.6	*
	Plant height (mm)	596	852	**

[a] Pairwise contrasts of bare patch-affected plants versus unaffected plants. * = Significant ($P < 0.05$); ** = significant ($P < 0.01$).

RESULTS AND DISCUSSION

Incidence of bare patches in wheat planted no-till after alfalfa was the same in each location (experiments 1 and 3, Table 1). The previous crop did not influence the incidence of bare patch because there was the same amount of the disease in no-till-planted wheat following wheat as in wheat following alfalfa. A review of the literature indicates that the previous crop has minor influence on the occurrence of this disease (12,13).

Disturbing the soil in seedbed preparation by either plowing or subsurface sweeping significantly reduced the incidence of bare patch compared with no-till seedbed preparation (Table 1). This reduction in bare patch with seedbed tillage was very consistent among the three experiments. No statistical difference ($P = 0.05$) in the incidence of bare patch (Table 1) or yield of patch-affected or unaffected plants was measured among tillage treatments; however, a trend existed for fewer bare patch areas as surface soil disturbance increased. The paraplow fractured the soil along natural planes of weakness with no soil inversion and very little mixing. The amount of mixing and disturbance in the top 10 cm of soil by sweep tillage was more than that created by paraplowing but less than that created by moldboard plowing plus secondary tillage. The type of no-till drill used did not have a significant ($P > 0.20$) effect on the occurrence of bare patch. These data support published results that soil disturbance during seedbed preparation reduced the occurrence of bare patch of cereals (7,12,13).

Patch areas at harvest were obvious because of shorter plants and fewer heads. All plants within a patch were affected; and the line between affected and unaffected plants was very distinct. The area occupied by each patch ranged from less than 0.5 to several square meters; the larger areas may have been composed of coalescing patches. Nearly 5% of the area of the no-till-planted wheat was affected by bare patch, which was significantly greater ($P = 0.005$) than the 1 and 2% area of bare patch found in the sweep and moldboard plow seedbeds, respectively.

Neither time nor rate of nitrogen application had a significant effect on the occurrence of bare patch (Table 2). These results do not agree with those of MacNish (7), who reported a reduction in the incidence of the disease from nitrogen application. Ammonium sulfate applied at PT (Table 2) did not reduce bare patch; this does not agree with Noble et al (11), who reported that "ammonium sulfate at planting or during the winter months is satisfactory control." No reduction in the incidence or severity of the disease by nitrogen fertilization could be detected in these experiments.

Plants within patch-affected areas produced 3,600–4,400 kg/ha less grain than plants adjacent to the visibly affected areas (Table 3), which is a grain yield reduction of 52% attributable to primary and secondary effects of bare patch. On a field basis, the yield reduction was 3%. MacNish and Lewis (8) reported yield within patch was 8% of yield outside of patch. Yield increase on a field basis from seedbed disturbance was about 10% (7).

Straw production and heads per square meter were reduced similarly to grain yield (Table 3). Kernel weight was slightly reduced by bare patch. These data indicate that most of the grain yield reduction was associated with the decrease in heads produced. Plant height was reduced by about 200 mm.

Although the area occupied by bare patches was relatively small, the dramatic yield reduction associated with this disease cannot be ignored. The occurrence of Rhizoctonia root rot in cereals grown with little or no soil disturbance raises concern as to how extensive this disease may become with continued use of these conservation tillage practices.

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