Reduction of Rhizoctonia Bare Patch in Wheat with Barley Rotations

William F. Schillinger and Timothy C. Paulitz
Washington State University and USDA-ARS

1 Abstract
Rhizoctonia bare patch caused by Rhizoctonia solani AG-8 is a major fungal root disease in no-till cropping systems. In an 8-year experiment comparing various dryland no-till cropping systems near Ritzville, Washington, Rhizoctonia bare patch first appeared in year 3 and continued unabated through year 8. Crop rotation had no effect on bare patch during the first 5 years. But from years 6 to 8, both soft white spring wheat (SWS) and hard white spring wheat (HWS) (Triticum aestivum L.) had an average of only 6.6% of total land area with bare patches compared to 15% in continuous annual SWS or HWS (i.e., monoculture wheat). In years 6 to 8, average grain yield of both SWS and HWS were greater (P<0.001) when grown in rotation with SB than in monoculture. Although both classes of wheat had less bare patch area and greater grain yield when grown in rotation with SB, monoculture HWS was more severely affected by Rhizoctonia than SWS. This is the first documentation of suppression of Rhizoctonia bare patch disease in low-disturbance no-till systems with rotation of cereal crops.

Abbreviations: HWS, hard white spring wheat; SB, spring barley; SWS, soft white spring wheat.

2 Introduction
Rhizoctonia bare patch and root rot is a major disease in no-till cereals in Australia and the U.S. Pacific Northwest. Rhizoctonia solani AG-8, the causal agent, attacks seminal and crown roots (Photo 1), resulting in patches of dead or stunted plants up to several meters in diameter in the field (Photo 2). Rhizoctonia bare patch increases when tillage is eliminated, and the disease has become a major limiting factor to the adoption of no-till technology. Other than tillage, there are few management options for control of Rhizoctonia. In addition to cereals, R. solani AG-8 attacks and causes bare patch in pulse and cropping systems near Ritzville, Washington, Rhizoctonia bare patch first appeared in 1997 during year 3 of the experiment and continued through year 8. The percentage area of Rhizoctonia bare patch was not affected by crop or crop rotation in 1999 and 2000 but, beginning in 2002 and continuing in 2003 and 2004, significantly less Rhizoctonia bare patch area was measured in SWS and HWS grown in rotation with SB compared to continuous annual monoculture of SWS and HWS (Fig. 1). Averaged over the 3 years, bare patch comprised 15% of total plot area for continuous annual SWS and HWS, compared to less than 7% for SWS and HWS grown in rotation with SB (Fig 1). Rhizoctonia bare patch also occurred in SB every year but bare patch area in barley was not affected by rotation to SWS and HWS. From 2002 to 2004, grain yield of SWS after SB was greater than monoculture SWS in 2 of 3 years as well as the 3-yr average (Fig. 2). There were no differences in grain yield between SB grown in rotation with HWS compared to monoculture HWS in 2002 and 2003, but in 2004 (and in the 3-yr average), monoculture HWS had the lowest grain yield of all treatments (Fig. 2). There were no differences in SB grain yield between treatments in any year or when averaged over the 3 years (data not shown).

This study provides the first documentation that barley provides a positive long-term rotation effect on wheat compared to monoculture wheat. This is surprising, since R. solani AG-8, often showing greater stunting than wheat (Photo 2). The beneficial effect of the barley rotation was not seen during the early transition to no-till. What are some possible explanations for this rotation effect? One possible explanation is a suppressive microbial effect. Another possibility is that barley roots may decompose faster than wheat roots, leaving less inoculum for the following year. Further research will focus on elucidating the mechanism behind this rotation phenomenon by measuring changes in microbial communities among the rotations.

3 Methods
An 8-year field study of no-till annual cropping systems was conducted from 1997 to 2004 near Ritzville, WA. Average annual precipitation for the site is 301 mm. Although numerous crop rotations were evaluated, this poster reports findings from only four crop-rotation treatments. These treatments are: (i) continuous annual SWS, (ii) a 2-year SWS – SB rotation, (iii) continuous annual HWS, and (iv) a 2-year SWS – SB rotation. Experimental design was a randomized complete block with four replications. Glyphosate herbicide was applied 2 to 4 weeks before planting to control weeds. All plots were planted and fertilized in one pass directly into the undisturbed soil and residue left by the previous crop in late March or early April using a custom-built no-till drill equipped with Cross-slot® notched-coulter openers on 20-cm row spacing (Photo 3). Seeding rate and fertilizer rate was held constant among treatments in all years.

The location, size and area of patches were determined with a global positioning system every year (Photo 4). Grain yield was determined in late July or early August by harvesting the grain from plants in a swath through each 150-m-long plot with a commercial combine. Treatment means for Rhizoctonia bare patch area and grain yield were considered significantly different at P<0.05. The Bonferroni method was used to control the experimentwise error rate for multiple comparisons.

4 Results and Discussion
Less than average (i.e., < 301 mm) precipitation occurred in 7 of 8 crop years. Rhizoctonia bare patch first appeared in 1999 during year 3 of the experiment and continued through year 8. The percentage area of Rhizoctonia bare patch was not affected by crop or crop rotation in 1999 and 2000 but, beginning in 2002 and continuing in 2003 and 2004, significantly less Rhizoctonia bare patch area was measured in SWS and HWS grown in rotation with SB compared to continuous annual monoculture of SWS and HWS (Fig. 1). Averaged over the 3 years, bare patch comprised 15% of total plot area for continuous annual SWS and HWS, compared to less than 7% for SWS and HWS grown in rotation with SB (Fig 1). Rhizoctonia bare patch also occurred in SB every year but bare patch area in barley was not affected by rotation to SWS and HWS. From 2002 to 2004, grain yield of SWS after SB was greater than monoculture SWS in 2 of 3 years as well as the 3-yr average (Fig. 2). There were no significant differences in grain yield between HWS after SB compared to monoculture HWS in 2002 and 2003, but in 2004 (and in the 3-yr average), monoculture HWS had the lowest grain yield of all treatments (Fig. 2). There were no differences in SB grain yield between treatments in any year or when averaged over the 3 years (data not shown).

This study provides the first documentation that barley provides a positive long-term rotation effect on wheat compared to monoculture wheat. This is surprising, since barley is very susceptible to R. solani AG-8, often showing greater stunting than wheat (Photo 2). The beneficial effect of the barley rotation was not seen during the early transition to no-till. What are some possible explanations for this rotation effect? One possible explanation is a suppressive microbial effect. Another possibility is that barley roots may decompose faster than wheat roots, leaving less inoculum for the following year. Further research will focus on elucidating the mechanism behind this rotation phenomenon by measuring changes in microbial communities among the rotations.

![Fig. 1. Rhizoctonia bare patch area as a percentage of total plot area in continuous annual soft white wheat and continuous annual hard white wheat compared to soft white wheat and hard white wheat grown in a 2-yr rotation with spring barley. Within-yr and 3-yr average means followed by the same letter are not significantly different at P<0.05.](image1)

![Fig. 2. Grain yield of continuous annual soft white wheat and continuous annual hard white wheat compared to soft white wheat and hard white wheat grown in a 2-yr rotation with spring barley. Within-yr and 3-yr average means followed by the same letter are not significantly different at P<0.05.](image2)