Crop Rotation, Prosaro Fungicide, Seed Treatment and Cultivar as Management Tools to Control Disease on 2-Row Barley, Langdon, 2009

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Efforts have been initiated and funded by the U.S. Wheat and Barley Scab Initiative to communicate some of the research progress made in developing and identifying strategies that will reduce or minimize the effect on small grains from the disease Fusarium head blight (FHB) or scab. Seed treatment was added to this study with support from the North Dakota Barley Council. One of these efforts is reported here that compares using crop rotation, a foliar fungicide treatment, a seed treatment and cultivars with different levels of resistance or tolerance to FHB. The study utilized a common regional crop rotation, 2-row barley after canola, as a comparison to a small grain rotation, 2-row barley after hard red spring wheat. The theory behind this is that the quantity of inoculum would be reduced when the previous crop was not susceptible to FHB. The second strategy researched was an application of Prosaro fungicide to minimize the effects of FHB. The third strategy researched would be the selection of a cultivar with less susceptibility to FHB. An additional strategy was also tested comparing a broad spectrum seed treatment with untreated seed.

MATERIALS AND METHODS

These studies were initiated in 2008 by planting six randomized replicated strips of hard red spring wheat and canola on the North Dakota State University Langdon Research Extension Center. The study plan was a randomized complete block design with a split split plot arrangement. Whole plot factor was previous crop, split plot factor was Prosaro fungicide and split split plot factor was cultivar. An additional factor was added by reducing the 6 replicates to three and adding a broad spectrum seed treatment to three of the six replicates and leaving the other three replicates untreated. In 2009 six 2-row barley cultivars, AC-Metcalfe, Conlon, Merit, Pinnacle, Rawson and Scarlet were treated with seed treatment. The cultivar Conlon would have slightly greater tolerance to FHB than the other cultivars. The cultivars were selected because they were planted on significant acreages of growers in North Dakota or fit a range of susceptibility to FHB. The seed treatments included BASF fungicides Charter F2 (triticonazole/metalaxyl) applied at rate of 5.4 fl oz/cwt, Stamina (pyraclostrobin) applied at rate of 0.4 fl oz/cwt and the BASF insecticide Axcess (imidicloprid) applied at a rate of 0.2 fl oz/cwt. The seed treatments were individually applied with a syringe to 2 lb lots of 2-row barley with a Hege Model 11 liquid seed treater (Wintersteiger Inc, Salt Lake City, Utah). Seed was planted at 1.25 million pure live seed per acre, determined by blotter paper germination in vitro.

The plots were seven rows wide six-inch row spacing and measured 20 feet long. An Almaco double disk drill was used to seed the plots on 19 May. Nitrogen liquid fertilizer was spring applied by broadcast method to achieve a target yield goal of 100 bushel /acre. A solution of Prosaro fungicide and Induce adjuvant (Helena Chemical Co.) was applied at 6.5 fl oz /acre and 0.125%v/v at head extended growth stage on 2-row barley. Prosaro fungicide (421 SC 3.57 lb/gal. formulation of prothioconazole/tebuconazole, 19% +19% w/w, manufactured by Bayer CropScience), applied at Feekes growth stage 10.5, is recommended to reduce the effects of FHB in small grains. Fungicide treatments were applied with a CO_2-pressurzed backpack sprayer. The boom was equipped with two Spraying Systems Co. XR8001 nozzles mounted on a double swivel. The swivels were spaced on 20-inch centers and oriented to spray 30 degrees downward from horizontal and forward and backward. The spray volume was 18.4 GPA obtained by pressurizing the boom at 40 psi. Twenty days after the fungicide application (soft dough growth stage, Feekes 11.2) 20 heads were removed and evaluated to determine FHB incidence (number of spikes infected) and severity of the infected heads(number of FHB infected kernels per head divided by total kernels). FHB index is the summation of the incidence times the severity. The plots were harvested with a Hege plot combine and the sample processed to determine yield, test weight and plump on the barley. Immediately after harvest the remaining plant including roots was removed with a spade from approximately six feet of row, bagged, dried and stored. The sub crown internode was removed from each of the roots. Fifteen roots were scored using a scale of 1-4, one (0-25%), two (26-50%), three (51-75%) and four (76-100%) severity. Some samples did not have an intact sub crown internode. An assumption was made that the sub crown internode was severely infected and assessed a score of four. An index was calculated by summing the number of samples times the score for each category and dividing by the total root sample number of 15. A sub sample of the grain was ground and sent to North Dakota State University Barley Quality Lab to determine the presence of the toxin deoxynivalenol (DON). North Dakota State University Extension recommended production practices for barley for Northeast North Dakota were followed. Data was analyzed with the general linear model (GLM) in SAS. Fischer's protected least significant differences (LSD) were used to compare means at the 5% probability level (Table 1).

RESULTS

Data was initially analyzed as a four factor experiment. The significant effects that included the seed treatment factor are reported in Tables 1, 2 and 3. The seed treatment factor was removed and the trial was re-analyzed as a three factor experiment with split split plot arrangement and six replicates. The data is partitioned into three data pools to increase the degrees of freedom and the likelihood of measuring statistical differences between the three remaining treatments. These results are reported in Tables 1, 2, 4 and 5. The statistics and data for the roots are presented in Tables 6, 7, 8, 9 and 10. Data for the individual sub crown internode disease scores are provided. Interpretation of the differences in the scores needs to be kept in context with the 2009 environment.

Seed Treatment. Applying seed treatment averaged across both previous crop rotations, both foliar fungicide treatments and all cultivars reduced the deoxynivalenol accumulation in the harvested seed, Table 2. Deoxynivalenol accumulation levels were small and below levels that would receive price discounts at local elevators, 0.5 PPM. The application of seed treatment increased yield by 8.3 bushel/ acre, test weight by 0.6 pound/ bushel, plump by 1.2% and stand by 163,148 plants/ acre. When seed treatment was used with Prosaro fungicide yield, test weight and stand increased, Table 3. Yield and test weight were increased over all other treatments. When seed treatment was not used with Prosaro fungicide yield decreased compared to a) no seed treatment b) seed treatment and c) seed treatment and no Prosaro fungicide. No differences in the other treatments were measured for test weight. Stand was increased significantly when Prosaro fungicide and seed treatment were applied. The seed treatments with no Prosaro fungicide had the same stands but much greater than the Prosaro and no seed treatment. Seed treatment averaged across both foliar fungicide treatments and all cultivars reduced root disease index, Table 8.

Previous Crop Residue. Yield, when previous crop residue was canola when averaged over foliar fungicide treatments and cultivars, was increased by 14.7 bushel/ acre, Table 2. Planting into canola residue showed advantage in sub crown internode (root) disease scores over HRSW residue and both disease severity and index, Table 8. A previous crop residue by cultivar interaction was measured for three and four root scores, Table 9 and a previous crop residue by foliar fungicide treatment by cultivar for three, Table 10. Cultivars Conlon, Merit, Rawson and especially Scarlet had much lower four root disease levels on previous crop canola residue.

Prosaro Fungicide. Visual disease symptoms, FHB severity, incidence, and index, and deoxynivalenol accumulation in the seed were reduced and 1000 seed weight was increased by 2.1 grams when Prosaro foliar fungicide was applied when averaged across previous crop residues and cultivars, Table 2. An interaction was measured for foliar fungicide treatment by cultivar averaged across all previous crop residues. Fusarium head blight severity was lowest on Scarlet and greatest on Pinnacle and Rawson when no fungicide was applied, Table 5. When Prosaro fungicide was applied FHB severity was lowest on Merit, and equal on Conlon, AC-Metcalfe and Scarlet and greatest on Pinnacle. Fusarium head blight incidence was lowest on Conlon and greatest on Pinnacle when no Prosaro fungicide was applied. Pinnacle and Merit were the only two cultivars that had reduced incidence as a result of Prosaro fungicide application. Fusarium head blight disease index was lowest on Scarlet and Conlon and greatest on Pinnacle when no fungicide was applied. When Prosaro fungicide was applied FHB disease index reductions were measured for Pinnacle and Merit but not the other cultivars. Foliar fungicide treatment averaged across previous crop residues and cultivars had no measured affects on root disease, Table 7. A three-way interaction was measured for parameter three for root disease, Table 10. Disease levels were much greater for cultivar Rawson and Scarlet for the untreated on HRSW residue. Disease levels were much greater for Merit and Scarlet when Prosaro fungicide was applied on HRSW residue.

Cultivar. Differences for all parameters were measured for cultivar when averaged over both previous crop residues and foliar fungicide treatments, Table 2. Fusarium head blight severity was lowest on Scarlet, Merit, Conlon and AC-Metcalfe. Fusarium head blight incidence was lowest on Conlon and highest on Pinnacle, Merit, and AC-Metcalfe. Fusarium head blight index was lowest on Conlon and Scarlet and greatest on Pinnacle and Rawson. Deoxynivalenol accumulation was 0.5 PPM or greater on Pinnacle and Rawson and lowest on AC-Metcalfe and Conlon. Yield ranged from a low of 78 bushels/ acre on AC-Metcalfe to the greatest yield of 111.3 bushels/ acre on Scarlet. Test weights were greatest on Scarlet and Conlon and lowest on Rawson and AC-Metcalfe. Plumps ranged from 91.5% on Merit to 97.3% on Rawson. Established stands were equal on Conlon, Pinnacle, Rawson, and Scarlet and lower on Merit. The stand of AC-Metcalfe was much lower at 335,775 plants/ acre. A wide range of 1000 seed weight was measured (47.8 - 60.3 grams). Differences in root disease severity were measured in all categories for cultivars averaged over both previous crop residues and foliar fungicide treatments, Table 7. The lowest root disease index was measured on Merit. The greatest root disease index was on AC-Metcalfe. Rawson was statistically equal to AC-Metcalfe, Conlon, Pinnacle and Scarlet. Similar pattern was measured for severity, three and four. A previous crop residue by cultivar interaction was measured for three and four, Table 9. When planted on previous crop canola residue, Conlon, Merit, Rawson and Scarlet all had less root disease than on HRSW residue. On Scarlet, the largest differences were measured between previous crop residues, 11.8 vs 6.1 for sub crown internode samples scoring four. Only AC-Metcalfe had the same disease scores on both previous crop residues. A three-way interaction was measured for sub crown internodes that received three scores, previous crop residue*foliar fungicide treatment*cultivar, Table 10. The effect of the Prosaro fungicide treatment was much greater on Merit planted into canola residue. The cultivars Rawson and Scarlet had much lower numbers of three on HRSW residue that was did not receive a Prosaro fungicide treatment, 9 and 7 vs 2 and 2.5.

Discussion. The season was cool and the planting date later than previous years at Langdon. The yield increase as a result of seed treatment was likely related to an increase in established stand. Test weight was also greater after seed treatment indicating an improved plant health. The substantially increased yield on canola residue has been identified in previous crop rotation studies at Langdon. Crop rotation is a low cost input to producers and will not produce large effects in every environment, but produces enough additional revenue in environments like 2009 to warrant consideration as management strategy often. The application of Prosaro fungicide reduced effects of FHB on 2-row barley. An increase in yield due to FHB reduction is not common on barley. Deoxynivalenol accumulation in the seed was below price reduction levels and may not have warranted the cost of the fungicide treatment. However, a fairly large increase in 1000 seed weight was measured and foliar fungicide application may have been warranted for seed producers and seed production fields. Differences in cultivars for all parameters were measured. Caution has to be taken in interpreting the FHB disease differences because this study was conducted in the absence of added Fusarium inoculum and supplemental water. The 2-row barley cultivars emerge from the boot over an extended period of time, different dates of exposure to inoculum load, and differences among cultivars are likely affected by escapes in the infective environment and not necessarily differences in resistance. Other data sets should be evaluated to compare genetic resistance to FHB. Several cultivars warrant consideration for environments like 2009 because the cultivar's deoxynivalenol accumulation in the seed was below levels where price discounts would apply. A range in yield (78-111.3bushel/acre) was measured offering substantial income potential increase related to cultivar selection. All test weights were excellent with a range of 2.5 pounds/ bushel. The cool season was quite favorable for growing barley. All plumps were excellent. Established stand of AC-Metcalfe was low and likely affected yield. Merit had lower established stand but still yielded well. The 1000 seed weight data suggests a large difference in the genetics of the cultivars and their effects in this environment.

Scoring one and two for disease measurement of the sub crown internode had very low sample numbers and do not merit discussion. Seed treatment slightly reduced root disease index. This is somewhat surprising as the benefit of a fungicide applied to the seed would not be expected to have a major impact on the disease on the sub crown internode when measured at harvest. Generally the effect of a fungicide applied to the seed would be effective for less than a month. Root disease was much less on canola residue by all measured categories. The most interesting finding is that the severity of the disease increased when seed treatment was not applied and Prosaro foliar fungicide was applied on previous crop canola. My theory is that the increased vigor and growth of the plants grown on canola residue and receiving foliar fungicide treatment put extra stress on the root system and the soil environment creating increase in disease. Further research in this area is warranted.

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Table 1. Source of variation for seed treatment, previous crop residue, fungicide and cultivar and confidence intervals for Fusarium head blight disease severity, incidence and index, deoxynivalenol concentration (DON), yield, test weight, plump, stand and 1000 seed weight on 2-row barley, Langdon 2009.

Source of Variation	Severity	Incidence	Index	DON	Yield	Test Weight	Plump	Stand	1000 Seed weight
Replicate (3) [z]	0.0243	0.0380	0.0125	0.2357	<0.0001	<0.0001	0.0121	<0.0001	0.1148
Seed treatment	0.3199	0.1165	0.0832	0.0400	0.0001	0.0059	0.0137	0.0001	0.6845
Res.*Seedtrt	0.1391	0.9103	0.2393	0.0733	0.4978	0.6640	0.3767	0.6586	0.4499
Fung*Seedtrt	0.4615	0.9187	0.4861	0.4145	0.0002	0.0244	0.0790	0.0019	0.8742
Cultivar*Seedtrt	0.8390	0.2483	0.5570	0.3288	0.4040	0.5564	0.1295	0.6337	0.3876
Res*Fung*Seedtrt	0.7323	0.6452	0.9645	0.4613	0.9885	0.9554	0.3375	0.5885	0.5664
Replicate (6) [z]	0.0057	0.1050	0.0042	0.0594	<0.0001	<0.0001	0.0028	<0.0001	0.0140
Residue	0.1138	0.6750	0.3061	0.1293	0.0104	0.1963	0.3965	0.5384	0.8385
Rep*Res	0.9487	0.4522	0.6012	0.2602	<0.0001	0.0749	0.1280	0.0009	0.4050
Fungicide	0.0014	0.0127	0.0087	0.0258	0.7930	0.3609	0.9976	0.3912	0.0027
Res*Fung	0.6476	0.1451	0.4654	0.0028	0.4957	0.4557	0.6960	0.5554	0.0703
Rep*Fung(Res)	0.2301	0.6015	0.0966	0.0011	<0.0001	<0.0001	0.0386	<0.0001	0.0693
Cultivar	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Res*Cult	0.9251	0.4001	0.4829	0.0073	0.9568	0.9019	0.1205	0.8005	0.1439
Fung*Cult	0.0046	0.0292	<0.0001	0.3412	0.1479	0.0912	0.3474	0.5494	0.5749
Res* Fung*Cult	0.1055	0.8719	0.1250	0.0792	0.4640	0.9539	0.7150	0.5129	0.1310
% C.V.	28.5	24.6	63.9	51.7	8.7	2.0	2.8	18.4	4.6

[z] Seed treatment was analyzed with ANOVA in a factorial arrangement with three replicates due to limited degrees of freedom. Seed treatment was dropped for second ANOVA analysis in split split plot arrangement with six replicates to increase the degrees of freedom for the analysis.

Table 2. Fusarium head blight severity, incidence and index, DON, yield, test weight, plump, stand and 1000 seed weight for seed treatment averaged across previous crop residues, fungicide treatments and cultivars; residue average across fungicide treatments and cultivars; fungicide averaged across previous crop residues and cultivars; and cultivar averaged across residues and fungicide treatments on 2-row barley, Langdon 2009.

	Fusarium Head Blight								1000
Main Effects	Severity	Incidence	Index	DON	Yield	Test Weight	Plump	Stand	Seed weight
Seed Treatment	(%)	(%)		(ppm)	(bu/a)	(lb/bu)	(%)	(plt/a)	(g)
Untreated	8.8	62.6	4.1	0.44	92.8	49.2	94.7	738,302	52.4
Treated	9.3	66.8	5.0	0.37	101.1	49.8	95.9	901,450	52.6
LSD $_{(P=0.05)}$	NS	NS	NS	0.07	4.2	0.4	0.9	80,396	NS
Residue									
Canola	9.3	64.1	4.8	0.37	104.3	49.7	95.6	802,230	52.6
HRSW	8.9	65.3	4.3	0.44	89.6	49.3	95.0	837,522	52.5
LSD $_{(P=0.05)}$	NS	NS	NS	NS	9.5	NS	NS	NS	NS
Fungicide									
Untreated	10.1	68.4	5.6	0.49	97.5	49.3	95.3	850,832	51.5
Prosaro	8.0	61.1	3.6	0.32	96.4	49.7	95.3	788,920	53.6
LSD $_{(P=0.05)}$	1.1	5.4	1.4	0.14	NS	NS	NS	NS	1.2
Cultivar									
AC-Metcalfe	8.0	69.9	4.1	0.27	78.0	48.5	93.7	335,775	51.1
Conlon	7.8	46.2	2.0	0.30	95.5	50.7	96.7	987,965	54.5
Merit	7.6	71.5	4.1	0.42	100.6	49.1	91.5	799,205	47.8
Pinnacle	12.1	74.5	8.0	0.50	103.0	49.5	96.0	918,390	53.6
Rawson	12.0	66.6	6.2	0.59	93.2	48.2	97.3	950,455	60.3
Scarlet	6.9	59.6	3.0	0.36	111.3	51.0	96.8	927,465	47.9
LSD $_{(P=0.05)}$	1.5	9.1	1.7	0.12	4.8	0.6	1.5	86,403	1.4

Table 3. Yield, test weight and stand by fungicide treatment and seed treatment averaged across previous crop residues and cultivars in 2-row barley, Langdon 2009.

Fungicide	Seed treatment	Yield (bu/a)	Test Weight (lb/bu)	Stand (plants)
Prosaro	None	88.1	49.1	642,510
	Treated	104.6	50.3	935,330
None	None	97.4	49.3	834,093
	Treated	97.6	49.4	867,570
LSD $_{(P=0.05)}$		5.9	0.6	36,035

Table 5. Deoxynivalenol concentration by previous crop residue and cultivars averaged across fungicide treatments in 2-row barley, Langdon 2009

Residue	Cultivar	DON (ppm)
Canola	AC-Metcalfe	0.35
	Conlon	0.30
	Merit	0.33
	Pinnacle	0.37
	Rawson	0.60
	Scarlet	0.28
HRSW	AC-Metcalfe	0.19
	Conlon	0.30
	Merit	0.52
	Pinnacle	0.63
	Rawson	0.58
	Scarlet	0.45

DON LSD= 0.14 for a_0c_0 vs. a_0c_1 and LSD= 0.14 for a_0c_0 vs. a_1c_0 and a_0c_0 vs. a_1c_1.

Table 6. Fusarium head blight severity, incidence and index by previous fungicide treatment and cultivars averaged across previous crop residues on 2-row barley, Langdon 2009

		Fusarium Head Blight		
Fungicide	Cultivar	Severity (%)	Incidence (%)	Index
Prosaro	AC-Metcalfe	7.0	65.4	3.0
	Conlon	7.0	48.4	1.9
	Merit	6.7	64.0	2.8
	Pinnacle	9.2	64.2	4.1
	Rawson	11.0	69.4	6.3
	Scarlet	7.1	55.0	3.2
Untreated	AC-Metcalfe	9.0	74.5	5.3
	Conlon	8.6	43.9	2.1
	Merit	8.5	79.1	5.4
	Pinnacle	15.0	84.8	11.8
	Rawson	13.0	63.8	6.0
	Scarlet	6.8	64.2	2.9

Severity LSD= 2.1 for b_0c_0 vs. b_0c_1 and LSD= 1.6 for b_0c_0 vs. b_1c_0 and b_0c_0 vs. b_1c_1. Incidence LSD= 12.9 for b_0c_0 vs. b_0c_1 and LSD= 13.0 for b_0c_0 vs. b_1c_0 and b_0c_0 vs. b_1c_1. Index LSD= 2.4 for b_0c_0 vs. b_0c_1 and LSD= 2.6 for b_0c_0 vs. b_1c_0 and b_0c_0 vs. b_1c_1.

Table 7. Source of variation and confidence intervals for disease from assessment of the sub crown internode (1-4) for roots scoring one, two, three, four, severity and index on 2-row barley, Langdon 2009.

Source of Variation	One	Two	Three	Four	Severity	Index
Replicate (3) [z]	1.0000	0.1025	0.1297	0.0871	0.0794	0.0687
Seed treatment	0.5692	0.0025	0.9055	0.1970	0.0580	0.0393
Res.*Seedtrt	0.5692	0.3033	0.7219	0.4454	0.2921	0.3704
Fung*Seedtrt	0.5692	0.0576	0.2529	0.9206	0.5305	0.5790
Cultivar*Seedtrt	0.3606	0.5708	0.6154	0.3697	0.2484	0.3537
Res*Fung*Seedtrt	0.5692	0.0576	0.0459	0.0119	0.0093	0.0095
Replicate (6) [z]	0.7118	0.0240	0.4357	0.1796	0.0810	0.0661
Residue	0.6109	0.1537	0.0132	0.0149	0.0191	0.0185
Rep*Res	0.3632	0.1472	0.0145	0.0089	0.0184	0.0143
Fungicide	0.5490	0.3061	0.3563	0.9772	0.6601	0.5646
Res*Fung	0.0924	0.8609	0.1438	0.2363	0.4414	0.4138
Rep*Fung(Res)	0.5876	0.0024	0.3768	0.1994	0.0578	0.0603
Cultivar	0.7118	0.1825	0.0104	0.0020	0.0027	0.0021
Res*Cult	0.3632	0.5577	0.0156	0.0323	0.0759	0.0809
Fung*Cult	0.3632	0.7154	0.6934	0.7611	0.7530	0.7955
Res* Fung*Cult	0.7118	0.2642	0.0281	0.1266	0.3547	0.2296
% C.V.	702.0	154.4	41.9	25.8	6.8	5.9

[z] Seed treatment was analyzed with ANOVA in a factorial arrangement with three replicates. Seed treatment was dropped for second ANOVA analysis in split split plot arrangement with six replicates to increase the degrees of freedom for the parameter pools for the analysis.

Table 8. Disease from assessment of the sub crown internode (1-4) for roots scoring one, two, three, four, severity and index for seed treatment averaged across previous crop residues, fungicide treatments and cultivars; residue averaged across fungicide treatments and cultivars; fungicide averaged across previous crop residues and cultivars; and cultivar averaged across residues and fungicide treatments on 2-row barley, Langdon 2009.

	Sub Crown Internode Scores					
Main Effects	One	Two	Three	Four	Severity	Index
Seed Treatment	(Count)	(Count)	(Count)	(Count)	(%)	
Untreated	0.03	0.4	4.9	9.6	77.9	3.61
Treated	0.01	1.0	4.9	9.1	76.1	3.54
LSD $_{(P=0.05)}$	NS	0.4	NS	NS	NS	0.07
Residue						
Canola	0.03	0.9	6.0	8.0	74.5	3.47
HRSW	0.01	0.5	3.8	10.7	79.6	3.68
LSD $_{(P=0.05)}$	NS	NS	1.5	1.9	3.8	0.16
Fungicide						
Untreated	0.01	0.5	5.1	9.4	77.7	3.59
Prosaro	0.03	0.9	4.8	9.4	76.8	3.56
LSD $_{(P=0.05)}$	NS	NS	NS	NS	NS	NS
Cultivar						
AC-Metcalfe	0.00	0.4	3.7	10.9	80.1	3.70
Conlon	0.00	0.6	5.0	9.4	77.2	3.58
Merit	0.04	1.2	5.8	8.0	73.8	3.45
Pinnacle	0.00	0.7	5.3	9.0	76.5	3.55
Rawson	0.04	0.5	4.5	10.0	78.3	3.63
Scarlet	0.04	0.7	5.4	8.9	76.3	3.54
LSD $_{(P=0.05)}$	NS	NS	1.2	1.4	3.0	0.12

Table 8. Disease from assessment of the sub crown internode (1-4) for roots scoring three, four, severity and index, by previous crop residues, fungicide treatment and seed treatment averaged across cultivars in 2-row barley, Langdon 2009.

Fungicide	Seed treatment	Three (count)	Four (count)	Severity (%)	Index
Canola Residue					
Prosaro	None	5.4	9.3	77.6	3.59
	Treated	5.8	7.4	72.9	3.37
Untreated	None	6.6	7.7	74.2	3.46
	Treated	6.4	7.8	74.4	3.47
HRSW Residue					
Prosaro	None	4.6	9.9	78.3	3.63
	Treated	3.3	10.8	79.3	3.66
Untreated	None	3.2	11.7	81.6	3.78
	Treated	4.2	10.3	79.0	3.66
LSD $_{(P=0.05)}$		1.4	1.7	3.6	0.14

Table 9. Disease from assessment of the sub crown internode (1-4) for roots scoring three and four by previous crop residues and cultivars averaged across foliar fungicide treatment and seed treatment in 2-row barley, Langdon 2009.

Previous Crop Residue	Cultivar	Three (count)	Four (count)
Canola	AC-Metcalfe	4.1	10.4
	Conlon	6.1	8.3
	Merit	6.5	6.8
	Pinnacle	6.0	8.0
	Rawson	5.8	8.8
	Scarlet	7.8	6.1
HRSW	AC-Metcalfe	3.3	11.4
	Conlon	3.9	10.5
	Merit	5.0	9.3
	Pinnacle	4.6	10.0
	Rawson	3.2	11.3
	Scarlet	2.9	11.8

Three LSD= 1.7 for a_0c_0 vs. a_0c_1 and LSD= 2.2 for a_0c_0 vs. a_1c_0 and a_0c_0 vs. a_1c_1. Four LSD= 2.0 for a_0c_0 vs. a_0c_1 and LSD= 2.6 for a_0c_0 vs. a_1c_0 and a_0c_0 vs. a_1c_1.

Table 10. Disease from assessment of the sub crown internode (1-4) for roots scoring three by previous crop residues, fungicide treatment and cultivars averaged across seed treatments in 2-row barley, Langdon 2009.

Fungicide	Cultivar	Three (count)
Canola Residue		
Prosaro	AC-Metcalfe	3.8
	Conlon	6.2
	Merit	7.2
	Pinnacle	5.7
	Rawson	4.5
	Scarlet	6.2
Untreated	AC-Metcalfe	4.3
	Conlon	6.0
	Merit	5.8
	Pinnacle	6.3
	Rawson	7.0
	Scarlet	9.5
HRSW Residue		
Prosaro	AC-Metcalfe	3.0
	Conlon	4.2
	Merit	4.7
	Pinnacle	4.0
	Rawson	4.3
	Scarlet	3.3
Untreated	AC-Metcalfe	3.5
	Conlon	3.7
	Merit	5.3
	Pinnacle	5.2
	Rawson	2.0
	Scarlet	2.5
LSD $_{(P=0.05)}$		

Three LSD= 2.4 for a_0 b_0c_0 vs. a_0 b_0c_1. Three LSD= 2.1 for a_0 b_0c_0 vs. a_0 b_1c_0. Three LSD= 2.1 for a_0 b_0c_0 vs. a_1 b_0c_0.