EFFECT OF FUNGICIDE AND FUNGICIDE APPLICATION TIMING ON REDUCING YIELD LOSS TO RHIZOCTONIA CROWN AND ROOT ROT

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Introduction

Rhizoctonia crown and root rot caused by the fungus, *Rhizoctonia solani* AG 2-2 is one of the most damaging sugarbeet diseases worldwide. This *R. solani* strain can also cause damping-off and has been reported to attack both dry beans and soybeans. Losses are highest in warm, irrigated, production areas where sugarbeets are cropped intensively. Once soil populations of this fungus are built up, rotation is of little value and growers are dependent on relatively ineffective cultural controls such as avoiding cultivating soil into the row, maintaining adequate, balanced fertility for good crop growth and maintaining adequate soil drainage. However, maintaining rotations with non-host crops such as corn, small grains or alfalfa and avoiding beans or soybeans before beets will help keep soil populations of this strain of Rhizoctonia low. The *R. solani* AG 4 strain causes damping-off can attack some of these non hosts and literature suggests that damping-off from this strain may be more severe on beets following alfalfa. Where disease pressure is high, growers can plant specialty varieties with resistance. Available resistance is incomplete and these varieties typically have yield potentials 10-20% less than the best approved varieties, although some varieties such as Beta 4546 and HM RH5 are 0-10% lower yielding than the best approved varieties. However, these varieties may not have other important disease resistant characteristics such as resistance to the Curly Top and Rhizomania viruses, Fusarium Yellows, Aphanomyces Black Root Rot, or Cercospora Leaf Spot. Because methods for predicting Rhizoctonia disease development and loss have not been developed, growers have long wanted a control where yield potential is not compromised. Since 1995, we have explored the potential for chemical control by preventing crown infections of young plants. Our research and that of others clearly shows that most infections occur through the crown from sclerotia deposited there primarily during cultivation and that application of effective fungicides to the crown prior to infection will provide good control. Prediction of crown infection has been difficult and various researchers have reached different conclusions as to when fungicide protection is needed. Recent research (Khan and Nelson, 2003 and Jacobsen etal, 2003) has shown the importance of temperatures > 70-75^{0}F for infection and disease development.

Research from 1995-2000 served as the basis for a full EPA label for Quadris (now formulated as Amistar) in 2000. Data summarizing Quadris/Amistar data from 1998-2004 are shown in Table 1. 2004, 2002 and 2001 were years of high disease severity while 2000 and 2003 were of moderate disease severity and 1998 and 1999 were years of low disease severity based on the effects of inoculation. Disease severity in 2002 and 2004 were the highest seen in our research on this topic. Two factors favored disease development, severe curly top virus infection and very warm conditions following inoculation. In 2004 we focused on examining the effect of rate of strobilurin fungicide and timing of application based on either plant growth stage or on soil temperature at the 4" depth.

Materials and Methods

Field research was done at the Eastern Agricultural Research Center at Sidney, MT on a Savage silty-clay loam soil in 1997-1999 and at the Southern Agricultural Research Center at Huntley, MT in 2000, 2001, 2002, 2003 and 2004. The plot design was a randomized complete block with six replications. Plots were single rows 30 ft long with 24' row spacing and all plots except the uninoculated controls were inoculated with approximately 14 grams / plot of ground barley infected with *R. solani* AG 2-2 at the 4 leaf stage. Fungicide applications were made at planting or emergence, just prior to application of inoculum at the 4 leaf stage or at the 8, 10, 12-14 leaf stage using a 6 inch band applied over the row with a single Spraying Systems 8002 VS nozzle @30psi= 18 gallons/acre. In 2004, applications were compared using a split plot design comparing Beta 8636 and Acclaim a Rhizomania resistant variety. Fungicide applications were made at planting 5/26/2004 (these plots were replanted due to killing frosts May 11-12), at the first date that soil temperatures averaged 60, 65, 70, 75, 80, and 85^{0}F and when plants averaged the 4 and 8 leaf growth stages. Plants were inoculated with approximately 14 grams of ground barley inoculum (Rupple et. al., 1979) when plants averaged the four leaf stage (6/29). Fungicide was applied before inoculum

application and plots were cultivated and irrigated following inoculum application. Plots were thinned to 60 plants per 30 row ft. at the 2-4 leaf stage and stand counts made. Plots were harvested in mid October and each harvested root was rated for Rhizoctonia root rot on the 0-7 scale with missing plants rated as 7 (Rupple et. al., 1979) and samples sent to Holly Sugar (1997-1999) or Western Sugar (2000, 2001,2002,2003, 2004) for determination of tare, % sugar and sugar loss to molasses.

Results:

Results for Quadris(1998-2004) are presented are presented in Table 1. Overall the Quadris/Amistar 0.075 oz.ai./1000 row ft. treatment applied at the 4 plus 8 leaf stage appears to be the best treatment although the 0.15 oz. ai./1000 row ft. rate applied at the 4 leaf stage treatment provided equally significant returns in 2002, 2003 and 2004. In 2000 and 2001, the 0.15 oz ai./1000 row ft applied at the 8 leaf stage provided statistically equal yields to applied at the 4 leaf stage. However in the severe disease years 2002 and 2004 this treatment was not effective.

Table 2. Effect of various rates and timing of Quadris on extractable sugar yield per acre in 1998- 2003 through control of Rhizoctonia crown and root rot.

Treatment oz. ai. /1000row ft.-timing	Extractable Sucrose/Acre						
	1998	1999	2000	2001	2002	2003	2004
non inoculated check	6981	9725	9783	9758 *	4375 *	9701*	6113*
inoculated check	6236	8843	8650	7313	65	7956	833
Quadris 0.075-4+ 8 leaf	7673	9396	10706*	10048*	3347 *	10779*	5435*
Quadris 0.15-4 leaf	7176	9282	8893	9254	3315* (0.4 oz)	10861*	6561*
Quadris 0.15-8 leaf	Nd	nd	10308*	9809*	0	nd	2214
Quadris 0.15-4+8 leaf	Nd	nd	10168*	nd	3394 *	10034*	nd
@planting or @emergence	nd	nd	nd	7813	nd	8929*	1500
FLSD P=0. 05	1474	956	1376	2140	834	719	2110

*=significantly different from inoculated check

Results for the 2004 trials are given in Table 2. Analysis showed that neither yield nor disease was different between the two varieties and the data shown represent the combination of the data for the two varieties. Application of Amistar based on average soil temperature at the 4" depth showed that optimal disease control was accomplished with application at 65-70^{0}F with applications at lower or higher temperatures providing less control. Disease control from applications made at 60, 75, 80 and 85^{0}F did not differ from the non sprayed inoculated control. Applications made at the 4 or 4+8 leaf stage provided superior control to applications made at planting or at the 8 leaf stage. Soil temperature was 70-75^{0}F at the 4 leaf stage. Application based on temperature appears to be another tool growers can use to time fungicide application. Field results also seem to confirm that while inoculum can be deposited in the crown, that infection that can be controlled by fungicide application does not take place until soil temperatures at the 4" depth exceed 70^{0}F. Review of soil temperature data for 2002 show that the 8 leaf stage application was applied @ 77^{0}F. Based on the greenhouse research and 2003 field trials (Khan and Nelson, 2003 and Jacobsen etal, 2003) it is not surprising that no control was achieved. The addition of MSU 127 Bacillus-based biological control did not improve Amistar performance. Application in a 3" band was statistically equal to the 6" band application. Both Headline and Gem provided inferior performance compared to Amistar.

Table 2. Effect of fungicide application and timing based on either temperature or plant growth stage on yield and Rhizoctonia crown and root rot severity at Huntley, MT in 2004.

Treatment - rate oz ai./1000 row ft	Disease Index 0-100	Tons/Acre	% Sucrose	Sugar/Acre
Non-Inoculated	18.08	18.99	16.1	6113
Inoculated @ 4 leaf	86.0	2.74	15.2	833
Amistar 0.15oz @60°F[1]	70.8	4.69	15.6	1462
Amistar 0.15oz @65°F	69.5	10.59	16.4	3475
Amistar 0.15oz @70°F	50.9	14.76	16.0	4724*
Amistar 0.15oz @75°F	78.6	5.61	16.0	1794
Amistar 0.15oz @80°F	76.3	9.99	15.5	3096
Amistar 0.15oz @85°F	84.4	2.77	16.5	915
Amistar 0.15oz @ plant	85.1	5.32	14.1	1500
Amistar 0.15oz @ 4 leaf	40.5	20.63	15.9	6561*
Amistar 0.15 oz @ 8 leaf	77.6	7.33	15.1	2214
Amistar 0.075oz @ 4 leaf	53.0	16.99	16.1	5471*
Amistar 0.075oz @ 8 leaf	82.3	5.22	15.8	1651
Amistar 0.075oz @ 4&8 leaf	43.1	17.53	15.5	5435*
Gem 0.15 oz @ 4 leaf	69.3	9.71	15.2	2953
Headline 0.2 oz @ 4 leaf	71.9	7.96	15.5	2467
Amistar 0.15 oz @ 4 leaf (3”band)	45.7	14.79	16.5	4881*
Amistar 0.15 oz + MSU 127 @ 4 leaf	46.0	16.34	15.9	5195
Amistar 0.075 oz + MSU 127 @ 4 leaf	50.9	12.06	15.5	3740
Amistar 0.075 oz + MSU 127 @ 4&8 leaf	48.9	15.96	15.8	5045*
$LSD_{(0.05)}$	10.7	6.74	n.a.	1254

1. Temperature at 4 inch depth

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