INTEGRATED MANAGEMENT STRATEGIES FOR 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. Losses are highest in warm, irrigated, production areas where sugarbeets are planted 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 or small grains and avoiding beans or alfalfa before beets will help keep soil populations of this strain of Rhizoctonia low. Where disease pressure is high, growers can plant specialty varieties with resistance. Available resistance is incomplete and these varieties typically have yield potentials 10-15% less than the best approved varieties, although some newer varieties such as Beta 4546 used in this research are 0-10% lower yielding than the best approved varieties. However, these varieties may not have other important disease resistant characteristics. Because predicting disease development and loss is difficult, 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 cultivation will provide good control. Research from 1995-2000 served as the basis for a the full EPA label for Quadris in 2000. Data summarizing Quadris data from 1997-2001 are shown in Table 1. 1997 and 2001 were years of high disease severity while 2000 was of moderate disease severity and 1998 and 1999 were years of low disease severity based on the effects of inoculation. Our objective in 2001 trials was to evaluate proven fungicides and experimental fungicides on a high yielding susceptible variety (Beta 8754) and to further examine the effect of a post emergence and a preplant herbicide on both a high yielding susceptible variety (Beta 8754) and a high yielding resistant variety(Beta 4546).

Materials and Methods

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 and 2001. The plot design was a split plot (varieties) randomized complete block with six replications. Plots were single rows 30 ft long and all plots except the uninoculated controls were inoculated with 14 grams / plot of ground barley infected with *R. solani* AG 2-2 at the 4 leaf stage. Fungicide applications were made 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. Following application plots at the 4 leaf stage plots were cultivated and irrigated. Plots were harvested in late September and rated for Rhizoctonia root rot on the 0-7 scale (Rupple et. al., 1979) and samples sent to Holly Sugar (1997-1999) or Western Sugar (2000, 2001) for determination of tare, % sugar and sugar loss to molasses. The Liberty-Link transgenic versions of Beta 8754 and Beta 4546 were used in the herbicide studies.

Results

Results for Quadris(1997-2001) are presented are presented in Table 1. Overall the Quadris 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 significant returns. In the last 2 years, 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. Data for the effect of Quadris, USF 2004, Headline and MSU 127 on control of Rhizoctonia crown and root rot on the variety Beta 8754 in 2001 at Huntley are given in Table 2.

Table 1. Effect of various rates and timing of Quadris on extractable sugar yield per acre in 1997, 1998, 1999, 2000 and 2001through control of Rhizoctonia crown and root rot.

Treatment oz. ai. /1000row ft.-timing	Extractable Sucrose/Acre					
	1997	1998	1999	2000	2001	Average 1998-2001
non inoculated check	7400*	6981	9725	9783	9758 *	8729*
inoculated check	5380	6236	8843	8650	7313	7284
Quadris 0.075-4 leaf	nd	7384	7896	nd	nd	
Quadris 0.075-4+ 8 leaf	nd	7673	9396	10706*	10048*	9456*
Quadris 0.1-4 leaf	6920*	nd	nd	nd	9120	
Quadris 0.15-4 leaf	nd	7176	9282	8893	9254	8651*
Quadris 0.15-8 leaf	nd	nd	nd	10308*	9809*	
Quadris 0.15-4+8 leaf	nd	nd	nd	10168*	nd	
Quadris 0.15-row closure	nd	nd	nd	9087	nd	
Quadris 0.2-4 leaf	6120	nd	8935	nd	nd	
FLSD P=0.1	945	1474	956	1376	2140	503

*=significantly different from inoculated check

Table 2. Effect of crown applied fungicides and application timing on control of Rhizoctonia crown and root rot at Huntley, MT in 2001.

Treatment oz.ai./1000 row ft.	Leaf stage treated	Disease Index 0-100	% sucrose	Ton /A	Extractable sucrose/A	Gross $/A @ $23.00 nsp
1. uninoculated		15.5ef	15.81 a	31.0 abcd	9758 abc	1139 abcd
2. Quadris 0.10	@ plant	33.4 bcd	15.53 a	27.0 defg	8392 bcde	974 c-f
3. Quadris 0.15	@ plant	35.9 bc	16.29 a	23.6 efgh	7813 cde	930 defg
4. inoculated		41.5 ab	15.61 a	23.4 fgh	7317 de	851 efg
5. MSU 127	4 + 8	55.2 a	15.78 a	20.6 h	6738 e	799 fg
6. Quadris 0.10	@ plant+4	21.4 cdef	15.55 a	33.7 abc	10460 ab	1214 abc
7. Quadris 0.10	4	13.7 f	15.00 ab	30.4 abcd	9120 abcd	1042 a-g
8. Quadris 0.15	4	16.8 ef	15.71 a	29.5 a-f	9254 abcd	1106 a-e
9. Quadris 0.075	4 + 8	18.5 def	15.86 a	31.7 abcd	10048 ab	1176 abcd
10. USF 2004 0.15	4	20.6 cdef	15.62 a	29.4 a-f	9190 abcd	1070 a-f
11. USF 2004 0.15	6	34.9 bcd	15.71 a	23.1 gh	7358 de	862 efg
12. USF 2004 0.15	8	33.5 bcd	15.51 a	29.6 a-e	9187 abcd	1065 a-f
13. USF 2004 0.15	10	31.8 bcde	15.90 a	28.2 b-g	8955 abcd	1049 a-f
14. USF 2004 0.15	12-14	33.7 bcd	13.55 b	26.6 d-h	7239 de	789 g
15. Quadris 0.15	8	23.7 cdef	15.82 a	30.9 abcd	9809 abc	1149 abcd
16. USF 2004 0.075	4 + 8	26.2 bcdef	15.60 a	27.6 c-g	8625 bcde	1003 b-g
17. Headline 0.075	4 + 8	10.7 f	15.67 a	34.5 a	10785 a	1255 ab
18. Quadris 0.075 + MSU 127	4 +8	13.3 f	15.96 a	34.3 ab	10930 a	1282 a
Flsd 0.05		16.4	1.95	6.14	2140	276

*** values followed by the same letter do not differ at P=0.05**

All fungicide treatments except USF 2004 (Flint-Bayer) applied at the 6, 8, 10, and 12-14 leaf stage and the biological MSU 127 applied alone provided reduced disease severity and increased yield and gross returns. When timing of Quadris application is considered, at planting applications are ineffective and optimal timing/rate were the 4 leaf stage (0.10 and 0.15 oz) and the 0.075 oz rate applied at the 4 plus 8 leaf stage. Least effective was the 0.15 oz rate applied at the 8 leaf stage in terms of disease control although yields were excellent for this treatment. When the fungicide USF 2004 was used at the 0.15 oz rate the best results were with the 4 leaf stage timing followed by the 4 + 8 leaf stage at the 0.075 oz rate. Headline (BAS 500) at the 0.075 oz rate applied at the 4 + 8 leaf stage and Quadris 0.075 + MSU 127 applied at the 4 + 8 leaf stage gave the best disease control and the highest gross returns. However this is the first year in 3 years of tests that Headline has given control equal to Quadris. For Montana conditions it appears that the application window is between the 4 and 8 leaf stage for optimum results.

The effect of interactions between Quadris fungicide, herbicides and varieties on control of Rhizoctonia crown and root rot for 2000 and 2001 are given in Table 3.

Table 3. Effect of Quadris fungicide application, herbicide treatment and variety on management of Rhizoctonia crown and root rot at Huntley, MT for the years 2000 and 2001combined.

Treatment	Beta 8754 LL (susceptible)		Beta 4546 LL (resistant)	
	Rhixoctonia Index 0-100[3]	Ton/A	Rhixoctonia Index 0-100[3]	Ton/A
No herbicide- I-NQ	**29.2**	**20.48**	**31.9**	**18.34**
No herbicide- I-Q	**9.3**	**31.50**	**2.7**	**21.45**
No herbicide- NI- NQ	**6.9**	**33.90**	**8.4**	**21.89**
No herbicide- NI-Q	**3.0**	**35.09**	**7.5**	**19.92**
Betamix Progress+Stinger[1]-I-NQ	**36.1**	**18.30**	**33.7**	**15.24**
Betamix Progress+Stinger-I-Q	**6.8**	**30.46**	**14.1**	**20.05**
Betamix Progress+Stinger-NI-NQ	**7.1**	**29.91**	**6.2**	**21.82**
Betamix Progress+Stinger-NI-Q	**7.2**	**33.68**	**3.0**	**22.05**
Nortron[2]-I-NQ	**29.5**	**19.61**	**35.1**	**16.98**
Nortron-I-Q	**7.0**	**35.05**	**9.6**	**23.46**
Nortron-NI-NQ	**9.0**	**33.92**	**12.1**	**22.01**
Nortron-NI-Q	**5.8**	**31.20**	**9.6**	**21.28**
Flsd P=0.05	**5.4**	**3.15**	**5.4**	**3.15**

I=inoculated, NI=not inoculated

Q =Quadris 0.075 oz. ai./1000 row ft applied at the 4 + 8 leaf stage, NQ= no Quadris

1. **Betamix-Progress (1.5 pt) + Stinger (4.0 fl.oz.)-applied 3 applications post emergence**
2. **Nortron (6 pts/A) applied PPI**
3. **Rhizoctonia Index 0=no root or crown rot, 100=root completely rotted**

Quadris applications were highly effective in reducing disease severity on both “”resistant” and “susceptible” varieties. Based on fungicide cost a 4-10 fold return on investment can be expected where Rhizoctonia crown and root rot causes damage. This two year study shows that the “resistant” variety Beta 4546 has a lower yield potential than the susceptible Beta 8754 but 4546 does not show as much yield loss from Rhizoctonia inoculation. From an economic perspective a grower achieves optimal returns from planting the susceptible variety and spraying it with Quadris. This study also shows that Betamix-Progress applied post emergent in 3 applications does increase potential Rhizoctonia crown and root rot severity but this can be corrected by Quadris application. The preplant incorporated Norton has no effect on Rhizoctonia as has been shown in previous studies..

This research was supported by the Western Sugar Joint Grower Research Board, and the Beta Seeds, Bayer, BASF and Syngenta companies.