

# EFFECT OF FUNGICIDE SEED, IN-FURROW AND BAND TREATMENTS ON RHIZOCTONIA CROWN AND ROOT ROT IN MONTANA

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## Introduction

Rhizoctonia crown and root rot occurs in every region that sugarbeets are grown. The disease is caused by a complex of *Rhizoctonia solani* 2-2 isg IV and isg III B, with the isg III B become more predominant in areas where corn is significant in rotations. Since the labeling of azoxystrobin (Quadris) in the mid 1990s growers have used banded and infurrow applications of this fungicide or products such as Headline, Gem or Proline. Efficacy of banded applications was greatly improved when researchers (Jacobsen, Khan) showed that applications must be made before soil temperatures at the 4 inch depth exceeded 70F and after soils at this depth were 60F, rather than a specific growth stage. However, timing for late planting or springs when soils warm up quickly was a problem or where growers often has a small window for optimal timing. In our 15 years of *Rhizoctonia* work in MT, the period for optimal timing ranged from 3-17 days depending on the spring. Growers with large acreages frequently could not get optimal timing on all their acres. While *Rhizoctonia* resistant varieties are available, they frequently have lower yield potential, do not have a full component of other disease resistances such as Rhizomania, Curly Top, *Aphanomyces*, *Fusarium* Yellows, and *Cercospora* and in our experience have also responded to properly timed fungicide applications with both increased yields and reduced disease severity.

This research was initiated to determine if a combination of seed treatments or infurrow fungicide application could be combined with banded fungicide applications such that growers would have a large window to apply banded fungicide applications and achieve a high level of control. Seed treatment fungicides will give some protection but alone do not provide satisfactory control. Infurrow fungicide applications have given inconsistent control with control being excellent in some years and poor in other years. In comparison, properly time band applications have always given the best control in our research and that of most others. Also based on our storage work with *Rhizoctonia* infected beets that demonstrated that even a small percentage of infected beets will result in severe decay)both *Rhizoctonia* and secondary bacteria and fungi), improved control of *Rhizoctonia* crown and root rot is needed.

The *Rhizoctonia* problem in MT appears to be increasing in severity. I believe the primary reason is that our most popular varieties are more susceptible than varieties of 5-10 years ago. Also dramatic increase of corn in the rotation is suspected to contribute to higher inoculum levels in fields.

Based on work by Windels and her group we chose to closely examine penthiopyrad seed treatments as part of the package. Infurrow work done by the Michigan group indicated that infurrow applications of Quadris could also be part of the package.

## Methods and Materials

Research was done in both 2011 and 2012 at the Southern Agricultural Research Station at Huntley, MT. The soil type was a Yellowstone silty clay loam. In both years the field was inoculated with 39 lb./A of *Rhizoctonia* infested barley. Inoculum was incorporated with a K tool. In 2011 this was 35 days before planting and in 2012 immediately before planting. 2011 planting was delayed due to extremely wet conditions that prevented planting in May. Plots were planted with a Milton planter to achieve populations of 30,000 plants per acre in 24 inch rows. In 2011, a randomized complete block design with six replicates. Each plot was 3 rows, 30 ft. long. The variety was HM 9124 RR. In 2012, a split plot design using Beta 38 RR 9N (*Rhizoctonia* susceptible) and American Crystal 933 RR (*Rhizoctonia* resistant). A randomized complete block design was used for treatments. Treatments are described in the following tables. Each harvested root was rated on the Ruppel 0-7 scale and tare, sugar and SLM data were done by Western Sugar. *Rhizoctonia* root ratings were normalized by conversion to a disease index to give values 0-100

with 0 equaling no disease and 100 completely rotted roots. Data analysis was done using analysis of variance and if significant means were separated using Fisher's protected least significant differences.

## Results

Results of 2011 are given in Table 1. None of the seed treatments reduced disease severity or increased yields. Only the Vertisan infurrow treatment reduced disease severity at the 0.05 level of confidence while Quadris at the 0.6 oz rate infurrow treatments were significant at the 0.10 level of confidence. Quadris band treatments applied alone reduced disease severity when applied at the 4-6, and 10-12 leaf stages. When seed treatments were combined with band treatments, the Dynasty-Apron-Maxim, reduced disease severity when Quadris was band applied at the 4-6 leaf stage. Penthioopyrad seed treatment at the 14 or 28 gram/unit rates reduced severity when Quadris was band applied at the 4-6, 8-10 and 10-12 leaf stages. When Vertisan was applied infurrow disease severity was reduced when Quadris was band applied at the 4-6, 8-10 and 10-12 leaf stages. When Quadris was applied infurrow disease severity was reduced when Quadris was band applied at the 8-10 and 10-12 leaf stages.

At Huntley, yields were not increased by any of the seed treatments alone, while Vertisan and Quadris infurrow treatments increased yields. Quadris band treatment increased yield only at the 4-6 leaf stage timing. Yields were increased by Dynasty seed treatment plus Quadris band treatments at 4-6, 8-10 and 10-12 leaf stages Penthioopyrad seed treatment at the 14 or 28 gram/unit rate increased yields when Quadris was band applied at the 4-6, 8-10 and 10-12 leaf stages. When either Vertisan or Quadris was applied infurrow and Quadris was applied at the 4-6, 8-10 and 10-12 leaf stages yields were increased. The yields for Vertisan infurrow plus Quadris applied at the 8-10 or 10-12 leaf stage are statistically higher than Vertisan infurrow treatments applied alone

These data show that under these conditions, Dynasty seed treatment plus Quadris band treatments at the 4-6 leaf stage or penthiopyrad at either the 14 or 28 gram/unit rate plus Quadris band treatments as late as the 10-12 leaf stage, Vertisan or Quadris infurrow plus Quadris band treatments as late as the 10-12 leaf stage provided excellent control and high yields, similar to the Quadris 4-6 leaf band treatment. Use of Dynasty or penthiopyrad seed treatments or Vertisan or Quadris infurrow treatments should provide growers flexibility in timing Quadris band treatments. Further either penthiopyrad or Vertisan should help provide fungicide resistance management since both are a different chemical class than Quadris.

**Table 1. Effects of fungicide seed, infurrow and band treatments on Rhizoctonia crown and root rot severity and yield at Huntley in 2011.**

Treatment-all seed treated with Apron 7.5 g/unit+Maxim 2.5g/unit Infurrow rates are oz product/1000 row ft. Quadris band treatments are 0.15 oz ai/1000 row ft.	Rhizoctonia index 0-100	Lbs extractable sucrose/A
1. -Noninoculated	30.7 **	5345 **
2. -Inoculated	59.3	2114
3. ST 2-Dynasty 25g/u+ Apron/Maxim	45.0	2937
4. ST 3-Sedexane 2.5g/u + Apron/Maxim	54.3	3182
5. ST 4- Penthioopyrad 14g/u +Apron-Maxim	64.9	2980
6. ST 5- Penthioopyrad 28 + Apron-Maxim	63.2	2596
7. Vertisan 1.9 IF	32.5 **	4329 **
8. Quadris 0.6 IF	35.8 *	4308 **
9. Quadris Band 4-6 appied when soil temperature @4"=67F	32.7 **	5539**
10. Quadris Band 8-10	39.0	3199
11. Quadris Band 10-12	31.5 **	3708
19. ST 2 +Quadris Band 4-6	30.9 **	4739 **
20. ST2 + Quadris Band 8-10	37.6	4261**
21. ST2 +Quadris Band 10-12	38.1	4041 **
22. ST 3 +Quadris Band 4-6	39.5	3641
23. ST3 + Quadris Band 8-10	44.6	4769 **
24. ST3 +Quadris Band 10-12	44.8	2905
25. ST 4 +Quadris Band 4-6	30.6 **	4214 **
26. ST4 + Quadris Band 8-10	34.6 **	4290 **
27. ST4 +Quadris Band 10-12	31.7 **	4515 **

28. ST 5 +Quadris Band 4-6	26.1 **	4295 **
29. ST5 + Quadris Band 8-10	30.6 **	4295**
30. ST5 +Quadris Band 10-12	28.7**	4905 **
31. Vertisan IF + Quadris Band 4-6	23.5 **	5129 **
32. Vertisan IF +Quadris Band 8-10	24.1 **	6138 **
33. Vertisan IF + Quadris Band 10-12	24.7 **	6439 **
34. Quadris IF + Quadris Band 4-6	39.1	4146**
35. Quadris IF +Quadris Band 8-10	22.4 **	4728**
36. Quadris IF +Quadris Band 10-12	20.0**	5633 **
Flsd.05	25.8	1878
Flsd.0.1	23.5	1739

\* Significant at  $P < 0.1$  ; \*\* significant at  $P < 0.05$  from inoculated check

Planted June 6, 2011

var. HM 9124 RR Sprays 2-4 leaf June 20, 4-6 June 30, 8-10 , 8-10 July 8, 10-12 leaf July 13.

Harvested 10/11-12/2011

Data for 2012 are presented in Tables 2 for the susceptible variety BetaSeeds BTS38RR 9N and in Table 3 for American Crystal 933. The two varieties were significantly different at  $P < 0.05$  with the American Crystal 933 being less susceptible to Rhizoctonia crown and root rot. For the more susceptible BTS38RR 9N penthiopyrad seed treatments did not reduce disease severity nor increase the % healthy roots, or yields. Infurrow Vertisan and quadris treatments reduced disease severity and increased % healthy roots. The 7 gm/kg seed penthiopyrad treatment had reduced disease severity when combined with Quadris band treatment at the 4-10 leaf stage and had increased percentage of healthy roots at harvest. The combinations of Vertisan or Quadris infurrow treatments with Quadris band treatments at the 4-12 leaf stages gave the best control.

For the more resistant AC 933, none of the penthiopyrad seed treatments gave either reduced disease or increases in healthy roots or yields. The infurrow Vertisan and Quadris treatments gave significantly lower disease severity, increased % of healthy roots and Quadris provide increase yields. Quadris band treatments at the 4-10 leave stage reduced disease severity and the 4-6 leaf band treatment had an increased percentage of healthy roots. The penthiopyrad seed treatment at 14 g/kg seed when combined with Quadris band treatments at the 4-12 leaf stages provide both decreased disease severity and increased percentage of healthy roots and the 14 g/kg seed treatment plus Quadris band at the 10-12 leaf stage also provided higher yields. Cominations of Quadris infurrow and Quadris band treatments at the 4-12 leaf stages gave reduced disease severity and increased percentage of healthy roots. Yield were significantly higher for the Quadris infurrow plus Quadris band treatment applied at the 8-10 leaf stage. Vertisan infurrow plus Quadris band at the 4-6 and 10-12 leaf stages reduced disease severity and at all band times increase percent healthy roots. The Vertisan infurrow plus Quadris band at 10-12 leaf stage also provided significantly higher yields.

## Conclusions

In two years of research the combination of penthiopyrad seed treatment at the 14 gram/kg seed and Quadris band application at 4-12 leaf stages provided reduced disease severity. Equal to a properly time Quadris band treatment at the 4-6 leaf stage. In 2012 this treatment also increased percentage of healthy roots at increased yields. When comparison are made only on penthiopyrad seed treatment rates there is no difference in the 14 and 28 gram /kg rates in 2011 nor in the 7, 14 or 28 gram rates in 2012 relative to disease control when combined with Quadris band treatment. Vertisan or Quadris infurrow treatments worked well alone in both years but in 15 years of research Quadris infurrow treatments have failed in 5 years. The infurrow plus band treatments at up to the 12 leaf stage provide good disease control. It should be pointed out that the 14g/kg seed rate is 1/200<sup>th</sup> of the amount of fungicide as applied with the infurrow treatments. Growers should be excited about the prospects of a seed treatment that will allow them to apply band treatments at any time from the 4-12 leaf stages-nearly 3 weeks in these studies. Thus the combination of penthiopyrad seed treatment and Quadris band will allow a wider treatment window and will allow reduced fungicide use compared the the infurrow treatments. In addition, penthiopyrad is a different mode of action fungicide compared to Quadris and this could be important in resistance management.

**Tabel 2. 2012 Huntley Sugarbeet Rhizoctonia Integrated fungicide seed treatment, in-furrow and band spray experiment- Cultivar BTS 38 RR 9N Inoculated 39lb/A Rhizoctonia infested barley**

Treatment	Disease Index 0-100	% Healthy	Extractable Sugar lb/A	Sugar/Ton
Apron/Maxim (AM)	35.45	40.66	5174	278.3
AM +Penthiopyrad 7 g/kg	44.15	35.28	4152	198.1
AM+Penthiopyrad 14 g/kg	29.85	54.03	5640	298.2
AM+Penthiopyrad 28 g/kg	42.07	32.33	4109	245.2
AM + Vertisan 1.2 oz /1000ft IF	7.25*	85.58*	8272	289.3
AM+ Quadris 0.15 oz /1000ft IF	9.60*	82.28*	6332	305.8
AM+ Quadris Band 4-6 leaf soil temp@4in.=62F	12.56	78.21*	6929	293.3
AM+ Quadris Band 8-10 leaf	22.85	63.39	5311	286.1
AM+ Quadris Band 10-12 leaf	32.24	55.08	5768	297.7
AM+ Penthiopyrad 7 g/kg + Quadris Band 4-6 leaf	10.37*	78.93*	7857	298.3
AM+Penthiopyrad 7 g/kg +Quadris Band 8-10 leaf	11.50*	77.15*	7569	288.7
AM+Penthiopyrad 7 g/kg +Quadris Band 10-12 leaf	13.2	80.35*	8149	294.8
AM+ Penthiopyrad 14 g/kg +Quadris Band 4-6 leaf	15.07	75.63*	83.24	290.1
AM+ Penthiopyrad 14 g/kg+ Quadris Band 8-10 leaf	19.28	69.08*	4765	284.5
AM+ Penthiopyrad 14 g/kg +Quadris Band 10-12 leaf	13.98	70.63*	7800	300.1
AM+ Penthiopyrad 28 g/kg+ Quadris Band 4-6 leaf	33.12	46.08	5912	276.0
AM+ Penthiopyrad 28 g/kg +Quadris Band 8-10 leaf	28.77	59.05	6788	292.8
AM+ Penthiopyrad 28 g/kg +Quadris Band 10-12 leaf	13.75	71.10*	8267	292.2
AM + Vertisan 1.2 oz /1000ft IF+ Quadris Band 4-6 leaf	17.05	74.78*	6889	288.9
AM+ Vertisan 1.2 oz /1000ft IF+ Quadris Band 8-10 leaf	7.88*	84.95*	7550	291.7
AM+ Vertisan 1.2 oz /1000ft IF+ Quadris Band 10-12 leaf	3.88*	88.28*	8534	297.0
AM+ Quadris 0.15 oz /1000ft IF+Quadris band 4-6 leaf	6.25*	89.40*	8695	293.5
AM+ Quadris 0.15 oz /1000ft IF+Quadris band 8-10 leaf	13.83	77.25*	8379	289.5
AM+ Quadris 0.15 oz /1000ft IF+Quadris band 10-12 leaf	22.77	66.13	4714	280.8
Flsd P<0.05	23.5	26.9	3845	46.4

- Significantly different from Apron Maxim seed treatment at P=0.05

Planted: 4/24-25/2012-24" rows 5.5" spacing. Harvested: 9/19-21/2012

Band Sprays applied: 5/30/12, 6/6/12, 6/15/12- CO<sub>2</sub> Sprayer, 8002 nozzle, 30 psi, 12 gal./A

**Table 3. 2012 Huntley Sugarbeet Rhizoctonia Integrated fungicide seed treatment, in-furrow and band spray experiment- Cultivar AC 933 RR Inoculated 39lb/A Rhizoctonia infested barley**

Treatment	Disease Index 0-100	% Healthy roots	Extractable Sugar lb/A	Sugar/Ton
Apron/Maxim + Poncho Beta (AM)	31.05	48.15	6365	286.5
AM +Penthiopyrad 7 g/kg	29.05	47.08	5491	271.4
AM+Penthiopyrad 14 g/kg	26.45	59.23	7957	305.8*
AM+Penthiopyrad 28 g/kg	26.65	50.48	6438	299.3
AM + Vertisan 1.2 oz /1000ft IF	12.65*	78.65*	9254	302.0
AM+ Quadris 0.15 oz /1000ft IF	10.52*	82.38*	10345*	306.1*
AM+ Quadris Band 4-6 leaf soil temp. @4in=62F	9.06*	83.13*	9156	302.3
AM+ Quadris Band 8-10 leaf	13.53*	69.33	8720	293.8
AM+ Quadris Band 10-12 leaf	17.19	69.27	6524	291.9
AM+ Penthiopyrad 7 g/kg + Quadris Band 4-6 leaf	7.52*	85.65*	11154*	307.0*
AM+Penthiopyrad 7 g/kg +Quadris Band 8-10 leaf	24.12	65.13	7378	305.0*
AM+Penthiopyrad 7 g/kg +Quadris Band 10-12 leaf	17.07	64.60	8141	287.1
AM+ Penthiopyrad 14 g/kg +Quadris Band 4-6 leaf	10.57*	80.5*	9022	298.2
AM+ Penthiopyrad 14 g/kg+ Quadris Band 8-10 leaf	14.33*	73.55*	9560	297.6
AM+ Penthiopyrad 14 g/kg +Quadris Band 10-12 leaf	11.10*	82.23*	11276*	301.5
AM+ Penthiopyrad 28 g/kg+ Quadris Band 4-6 leaf	40.78	26.43	5950	281.8
AM+ Penthiopyrad 28 g/kg +Quadris Band 8-10 leaf	11.27*	78.08*	8375	290.2
AM+ Penthiopyrad 28 g/kg +Quadris Band 10-12 leaf	22.32	63.75	7180	302.5
AM + Vertisan 1.2 oz /1000ft IF+ Quadris Band 4-6 leaf	8.87*	81.13*	9113	298.0
AM+ Vertisan 1.2 oz /1000ft IF+ Quadris Band 8-10 leaf	18.85	71.43*	7101	280.2
AM+ Vertisan 1.2 oz /1000ft IF+ Quadris Band 10-12 leaf	9.00*	81.80*	10305*	293.6
AM+ Quadris 0.15 oz /1000ft IF+Quadris band 4-6 leaf	13.05*	82.45*	9513	300.1

AM+ Quadris 0.15 oz /1000ft IF+Quadris band 8-10 leaf	9.65*	84.58*	11887*	298.5
AM+ Quadris 0.15 oz /1000ft IF+Quadris band 10-12 leaf	6.95*	88.6*	8904	297.6
FIsd P<0.05	14.5	26.9	3750	17.8

- Significantly different from Apron Maxim seed treatment alone P=0.05

Planted: 4/24-25/2012-24" rows 5.5" spacing. Harvested: 9/19-21/2012

Band Sprays applied: 5/30/12, 6/6/12, 6/15/12- CO<sub>2</sub> Sprayer, 8002 nozzle, 30 psi, 12 gal./A