# INTEGRATING FUNGICIDE SEED, IN-FURROW FUNGICIDES AND FUNGICIDE BAND APPLICATIONS FOR IMPROVED CONTROL OF RHIZOCTONIA CROWN AND ROOT ROT

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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 (interspecific group) 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 had 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 the full component of other disease resistances such as Rhizomania, Curly Top, Aphanomyces, Fusarium Yellows, and Cercsopora needed by our growers 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 reseearch 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 in the storage pile will result in severe decay, both from Rhizoctonia and secondary bacteria and fungi), therefore improved control of Rhizoctonia crown and root rot is needed to manage storage losses.

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 inoculums levels in fields since it is a host to the isg IIIB strain.

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 (6/6) and in 2012 (4/24) immediately before planting. 2011 planting was delayed due to extremely wet conditions that prevented planting in late April-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 was used. 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. Infurrow sprays were made using a single nozzle/ row oriented just ahead of the closer at 7 gallon per acre. Band applications were made with a single nozzle creating a 7 inch band centered on the row at 18 gallon/ A. In 2011 the 4-6 leaf treatment was done on 6/20, the 8-10 leaf treatment on 7/8 and the 10-12 leaf treatment on 7/13. In 2011 treatment were done on 5/30, 6/6, and 6/15. Treatments are described in the following tables. Each harvested root was rated on the Rupple 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. Penthiopyrad 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 treatmentsalone , 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 Penthiopyrad seed treatment at the 14 or 28 gram/unit rate increased yields when Quadris was band applied at the 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, Dyanasty 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 Poncho-Beta 60g/unit,Apron 7.5 g/unit+Maxim 2.5g/unit<br>Infurrow rates are oz product/1000 row ft.<br>Quadris band treatments are 0.6 ozi/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- Penthiopyrad 14g/u +Apron-Maxim | 64.9 | 2980 |
| 6. ST 5- Penthiopyrad 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 4-6 leaf June 20, 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 leaf 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. Combinations 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. This treatment was equal to a properly time Quadris band treatment at the 4-6 leaf stage. In 2012 this treatment also increased percentage of healthy roots and 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 $1/200^{th}$ 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. Penthiopryrad seed treatment provided control for 38 days post planting in 2011 and 53 days in 2012.

Table 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** |
|---|---|---|---|---|
| Poncho-Beta-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- $CO_2$ 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 | 8.87* | 81.13* | 9113 | 298.0 |

| | | | | |
|---|---|---|---|---|
| Band 4-6 leaf | | | | |
| 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 |
| **Flsd 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- $CO_2$ Sprayer, 8002 nozzle, 30 psi, 12 gal./A