FINAL REPORT: Evaluating the Utility and Economics of Fungicide Use on Reduced-Lignin Alfalfa for High Quality Hay Production in the Seedling Year

Contact Information

PI: Damon Smith, Department of Plant Pathology, University of Wisconsin-Madison, 1630 Linden Drive, Madison, WI, 53706; 608-262-5716; damon.smith@wisc.edu

Co-PI: Dan Undersander, Department of Agronomy, University of Wisconsin-Madison, 1575 Linden Drive, Madison, WI, 53706

Co-PI: Bryan Jensen, Integrated Pest Management Program, University of Wisconsin-Madison, 1630 Linden Drive, Madison, WI, 53706

Co-PI: Scott Chapman, Departments of Entomology and Plant Pathology, University of Wisconsin-Madison, 1630 Linden Drive, Madison, WI, 53706

Justification of Research

Until the first decade of the 21st century, fungicide application on alfalfa for dairy production was a rare event. Very few fungicides were labeled for alfalfa production and the price of alfalfa was relatively low, resulting in low or no return on investment when fungicide treatments were applied. In rare cases fungicide application was found to be useful, but only when foliar disease levels were high (Broscious and Kirby, 1988).

More recently, research investigating the utility and economics of fungicide use on conventional alfalfa for dairy production has been conducted under the direction of the PI and Co-PIs from 2011-2014. In those trials, fungicide was applied in small research plots when alfalfa was six to eight inches in height. Very little foliar disease was observed at harvest for all trials conducted in this research (Smith et al., 2015). This suggests that frequent alfalfa harvest results in durations of time insufficient for foliar pathogens to become a significant yield or quality-limiting factor on modern alfalfa varieties.

With the recent release of reduced-lignin alfalfa the utility of fungicide application should be re-evaluated. In the reduced-lignin alfalfa system, alfalfa will be subjected to longer cutting intervals (35-40 days vs. 28-30 days). With longer interval cutting, the risk for economically impactful disease epidemics will increase. While diseases were typically not a problem in our previous research on conventional alfalfa, there could be foliar disease epidemics that impact yield and/or quality. In order to determine the impact of these diseases in this new alfalfa production system, we evaluated fungicide application compared to not treating on a 30-day cutting schedule or a 40-day cutting schedule. This was also compared to the same treatments on conventional alfalfa in order to assess quality and yield gains in the new production system. In addition, new fungicides will potentially be labeled for the 2016 field season. These new fungicides were evaluated for their utility in the reduced-lignin alfalfa production system.

Objectives

The objectives of this project were to:

1. Assess the utility of applying existing and new experimental fungicides to reduced-lignin alfalfa by evaluating foliar disease pressure, defoliation, yield, and quality for both 30-day and 40-day cutting intervals.
2. Determine the return of investment of using existing and newly labeled fungicides in a reduced-lignin alfalfa production system.

Procedures

A field trial was established at the Arlington Agricultural Research Station (AARS) located in Columbia and Dane Counties in Wisconsin in spring 2015. Two alfalfa varieties, DKA44-16RR (conventional, Roundup-Ready) and HarvXtra (reduced-lignin, Roundup-Ready), were seeded on April 17, 2015 using a small-plot, tractor-mounted seeder. Plots were 10 feet wide and 20 feet long. Seven fungicide treatments (Table 1) were applied to both alfalfa varieties using a 10-foot wide hand-held boom attached to a CO_2 pressurized backpack sprayer at a rate of 20 GPA, when six to eight-inch tall growth was achieved. A non-treated control was also included for a total of eight fungicide treatments. Treatments for the first crop were applied on June 1, 2015 (six-inch growth). On June 26, 2015 first cut (30-day cut) was conducted for the first crop by using a 30-inch wide small plot flail chopper to harvest one strip from one 5-ft section of each plot (randomly chosen section). Dry matter yield, foliar disease severity, defoliation and forage quality samples were collected at the time of harvest. Ten days later (July 6, 2015), another 30-inch wide strip was harvested (40-day cut) from the other 5-ft section of each plot. All yield, quality, and disease data were again collected. All remaining alfalfa was then removed from the entire trial on July 7, 2015. Thus the second crop was established. Fungicide treatments were applied to the second crop on July 17, 2015 (six-inch growth). The second crop 30-day cut was conducted on August 6, 2015 while the 40-day cut was conducted on August 17, 2015. All procedures and data acquisition were conducted in the same manner as on the first crop.

The experimental design was a split-split plot with 4 replicates. Alfalfa variety was considered the whole plot, fungicide treatment the sub-plot, and cutting treatment the sub-sub plot. All yield, quality, and disease data were analyzed using standard mixed-model analysis of variance and means separated for main effects and sliced effects (where appropriate) using the test of least significant difference.

Results

Disease and severity differed for both crops. In the first crop, the primary foliar diseases were Leptosphaerulina leaf spot (caused by *Leptosphaerulina briosiana*) and downy mildew (caused by *Peronospora trifoliorum*). In the second crop, very low levels of downy mildew (<5%) were also present on the 30-day cut, but not on the 40-day cut. The primary foliar disease on the second crop was common leaf spot (caused by *Pseudopeziza medicaginis*).

First Crop Results

For the first crop there was a statistically significant interaction ($p<0.01$) in treatment effect on Leptosphaerulina leaf spot between the 30-day cut and the 40-day cut. There was no Leptosphaerulina leaf spot present on the 30-day cut, but severity ranged from 7% to 18% on the 40-day cut for both alfalfa varieties (Figure 1). Aproach at 12 fl oz, the tank-mix of Aproach and Fontelis, along with Headline, Quadris, and Priaxor significantly reduced leaf spot severity for the 40-day cut, first crop compared to not treating.

Downy mildew was not present on the 30-day cut in the first crop. However, on the 40-day cut, severity was 10.5% for DKA44-16RR and 16.3% for HarvXtra, which was significantly (p<0.01) higher. Fungicide treatment had no effect on downy mildew severity.

Defoliation was not observed for the 30-day cut in the first crop. However, in the 40-day cut defoliation was 4.1% for HarvXtra and 5.6% for DKA44-16RR, which was a significant (p<0.01) difference. There was a significant treatment effect for the 40-day cut on the first crop, which was consistent between both varieties (Figure 1). All fungicide treatments provided a significant reduction in defoliation over not treating. However, it should be noted that defoliation in the non-treated was less than 10%.

Yield, milk per ton, and milk per acre were not significantly (p>0.05) different among fungicide treatments for either cutting for both alfalfa varieties. In the first crop of this seedling year, yield was driven by cutting duration and was similar between both varieties. For the 30-day cut, yield was just 0.4 tons per acre, while it was significantly (p=0.03) higher for the 40-day cut at 1.1 tons per acre. Milk per ton (Figure 2) and milk per acre (Figure 3) were significantly different (p<0.05) for each variety within each cut. HarvXtra typically had better quality (milk per ton) and overall milk yield (milk per acre) than did DKA44-16RR for both cutting schedules.

Second Crop Results

For the second crop, cutting duration significantly affected common leaf spot severity for both alfalfa varieties (Figure 4). Severity was significantly less on the HarvXtra variety for the 40-day cut with little difference in severity between both varieties for the 30-day cut. This effect resulted in minimal defoliation (<10%) for both varieties for the 30-day cut and substantially higher defoliation for the 40-day cut. HarvXtra was 24% defoliated at the 40-day cut while DKA44-16RR was significantly (p=0.03) more defoliated at 28%.

Fungicide treatment effect on common leaf spot severity was significant and the response was consistent between both varieties. For the 30-day cut Aproach (12 fl oz rate) Quadris, Headline, and Priaxor resulted in a significant reduction in leaf spot severity over not treating with fungicide (Figure 5). For the 40-day cut, only Aproach at 12 fl oz and Headline resulted in a significant reduction in common leaf spot severity compared to not treating with fungicide.

Overall yield for HarvXtra alfalfa for both 30-day and 40-day cuttings was 0.73 tons of dry matter per acre. DKA44-16RR yielded significantly higher for the 30-day cut (0.83 tons of dry matter per acre) and the 40-day cut (0.79 tons of dry matter per acre). Quality of hay for the 30-day cut was comparable between both alfalfa varieties with DKA44-16RR producing 3,339 lbs. of milk per ton and HarvXtra producing 3,377 lbs. of milk per ton. The higher yield for DKA44-16RR resulted in significantly (p<0.01) more milk produced per acre (2,770 lbs. milk per acre) than HarvXtra (2,456 lbs. milk produced per acre). For the 40-day cut HarvXtra had significantly higher quality at 2,954 lbs. of milk per ton compared to 2,796 lbs. of milk per ton for DKA44-16RR. Higher yields and lower quality in DKA44-16RR resulted in similar values of milk produced per acre (2,194 lbs. milk per acre) at the 40-day cut compared to HarvXtra (2,145 lbs. milk per acre), which had lower yield and higher quality.

Both varieties of alfalfa responded similarly to fungicide treatment. Therefore, yields were combined across varieties for each fungicide treatment. For the 30-day and 40-day cuttings no fungicide treatment performed significantly better than the non-treated plots (Figure 6). Milk quality (milk per ton) was significantly ($p<0.01$) higher for Aproach (12 fl oz), the tank-mix of Aproach and Fontelis, Priaxor, and Headline treated plots versus not treating for the 30-day cut (Figure 7). In the 40-day cut only the Aproach plots at 12 fl oz had significantly higher milk quality compared to not treating with fungicide. Milk yield (milk produced per acre) was typically not influenced by fungicide application in the 30-day cutting, as most treatments were comparable to the non-treated plots, except Fontelis, which yielded significantly ($p<0.01$) lower than not-treating with fungicide (Figure 8). For the 40-day cut, milk yields were significantly higher ($p<0.01$) than the non-treated plots for Aproach at 12 fl oz and Priaxor.

Return on Investment (ROI)

While there were no significant effects on hay and milk yield or quality when treating with fungicide in the first crop, and minimal hay and milk yield advantages in the second crop, it is possible to calculate the return on investment of treating alfalfa with fungicide vs. not treating. For purposes of these calculations only Quadris and Headline fungicides were used because they are currently labeled for use on alfalfa in Wisconsin and the typical products used by dairy farmers. List price for Quadris is currently $17.00 per acre (6 fl oz rate) while that for Headline is $21 (6 fl oz rate) for product alone. Costs of application can be highly variable depending on contracts with custom applicators vs. owning the spraying equipment. Therefore, an $8.00 application charge has been added to the fungicide price in these calculations as an approximate figure for application costs. Thus, the Quadris application is approximately $25 per acre while the Headline application is $29 per acre. ROI was calculated for both the value of the dry hay (Table 2) and the value of Milk (Table 3). Hay ROI was based on dry matter yield of prime grade hay and July and August 2015 average prices of $190 per ton. Milk ROI was based on milk per acre produced for each treatment and July and August 2015 average milk price of $17.50 cwt. For alfalfa hay, no positive return was observed in this trial for any of the treatment combinations analyzed (Table 2). For milk ROI, positive returns were observed for both Quadris and Headline on DKA44-16RR at the 40-day cut in the first crop and for the 40-day cut on HarvXtra for the second crop (Table 3). No other positive returns were observed.

Conclusions

1. Fungicide application to first crop of newly seeded alfalfa (conventional or reduced-lignin) does not appear to drastically improve alfalfa yield or quality, despite control of leafspot disease and defoliation in the 40-day cutting schedule.
2. Fungicide application to second crop of newly seeded alfalfa (conventional or reduced-lignin) might help control pathogen pressure for both cutting durations. This can result in marginally higher yield and quality. However, the advantage might only be consistently observed for a 40-day cutting duration.
3. Based on the results presented here, fungicide application (Headline or Quadris) does not offer a positive ROI on hay sold, for conventional or reduced-lignin alfalfa, regardless of cutting duration in the seedling year.
4. Fungicide application may offer a positive ROI for longer duration cutting (40-day duration) if the hay is kept on the farm for milk production due to marginally higher yields and improved hay quality when treating.

5. Further work on established stands of both varieties of alfalfa is needed, and planned, for 2016.

References

Broscious, S.C. and Kirby, H.W. 1988. Economic evaluation of fungicides for control of alfalfa foliar diseases. Phytopathology 78:934-939.

Smith, D.L., Chapman, S., Jensen, B., Blonde, G., and Halfman, B. 2015. Fungicide use in alfalfa: What four years of research has taught us. Proc. Of the 2015 Wisconsin Crop Management Conference. Vol. 54. Pgs. 107-108.

Table 1. Fungicide treatments applied to both conventional and reduced-lignin alfalfa in the seedling year in Wisconsin, 2015.

Fungicide Product (active ingredient)	Rate per acre
Aproach (picoxystrobin)[1,2]	6 fl oz
Aproach (picoxystrobin)[1,2]	12 fl oz
Fontelis (penthiopyrad)	1.5 pt
Aproach (picoxystrobin)[1] + Fontelis (penthiopyrad)	6 fl oz + 14 fl oz
Priaxor (pyraclostrobin + fluxapyroxad)[1,2]	4 fl oz
Headline (pyraclostrobin)[2]	6 fl oz
Quadris (azoxystrobin)[2]	6 fl oz

[1]Denotes an 'experimental' treatment, not yet labeled for use on alfalfa in Wisconsin in 2015
[2]Treatment included the adjuvant, Induce 90 SL, at 0.3% v/v.

Table 2. Hay return on investment when applying Headline or Quadris Fungicide to conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa in the seedling year.

	DKA44-16RR		HarvXtra	
	Headline	Quadris	Headline	Quadris
First Crop				
30-day	-$29.00[a]	-$26.90	-$42.30	-$34.50
40-day	-$6.20	-$6.00	-$21.40	-$19.30
Second Crop				
30-day	-$48.00	-$32.60	-$30.90	-$32.60
40-day	-$36.60	-$28.80	-$11.90	-$6.00

[a]ROI based on dry matter yield of prime grade hay and a July and August 2015 average price of $190 per ton. Quadris and Headline treatments were calculated to be $25 ($17 + $8 application charge) and $29 ($21 + $8 application charge), respectively.

Table 3. Milk return on investment when applying Headline or Quadris Fungicide to conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa in the seedling year.

	DKA44-16RR		HarvXtra	
	Headline	Quadris	Headline	Quadris
First Crop				
30-day	-$34.78[a]	-$31.12	-$66.98	-$50.72
40-day	$37.15	$20.33	-$29.35	-$28.85
Second Crop				
30-day	-$87.28	-$53.70	-$41.78	-$44.60
40-day	-$21.30	-$16.43	$22.45	$32.58

[a]ROI based on milk per acre produced for each treatment and July and August 2015 average milk price of $17.50 cwt. Quadris and Headline treatments were calculated to be $25 ($17 + $8 application charge) and $29 ($21 + $8 application charge), respectively.

Figure 1. Leptosphaerulina leaf spot severity and defoliation of conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa sprayed with eight fungicide treatments on alfalfa first crop, 40-day cut. Both alfalfa varieties responded similarly to fungicide application, therefore results are pooled for both alfalfa varieties. Bars of the same color, with the same letter, are not significantly different from each other based on the test of least significant difference (LSD).

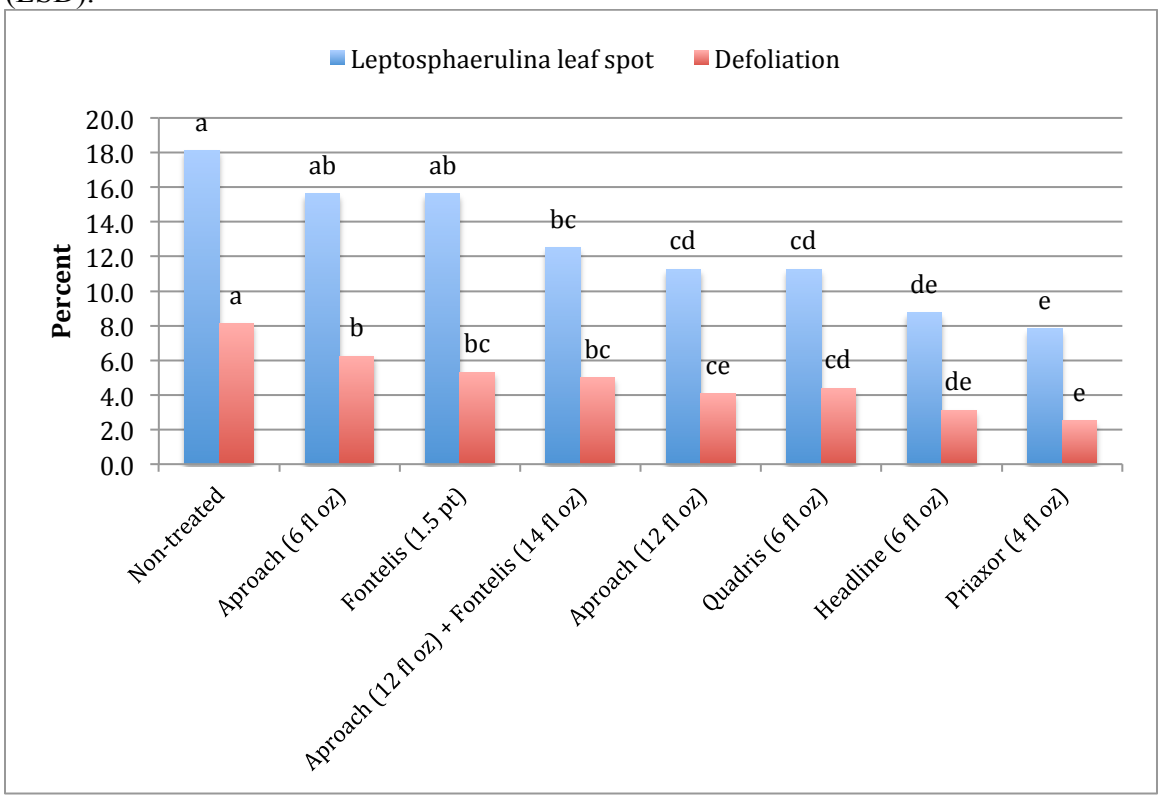

Figure 2. Milk per ton for conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa sprayed with eight fungicide treatments on alfalfa first crop using a 30-day vs. 40-day cutting schedule. There was no significant fungicide treatment effect for either variety, therefore data across fungicide treatments are pooled.

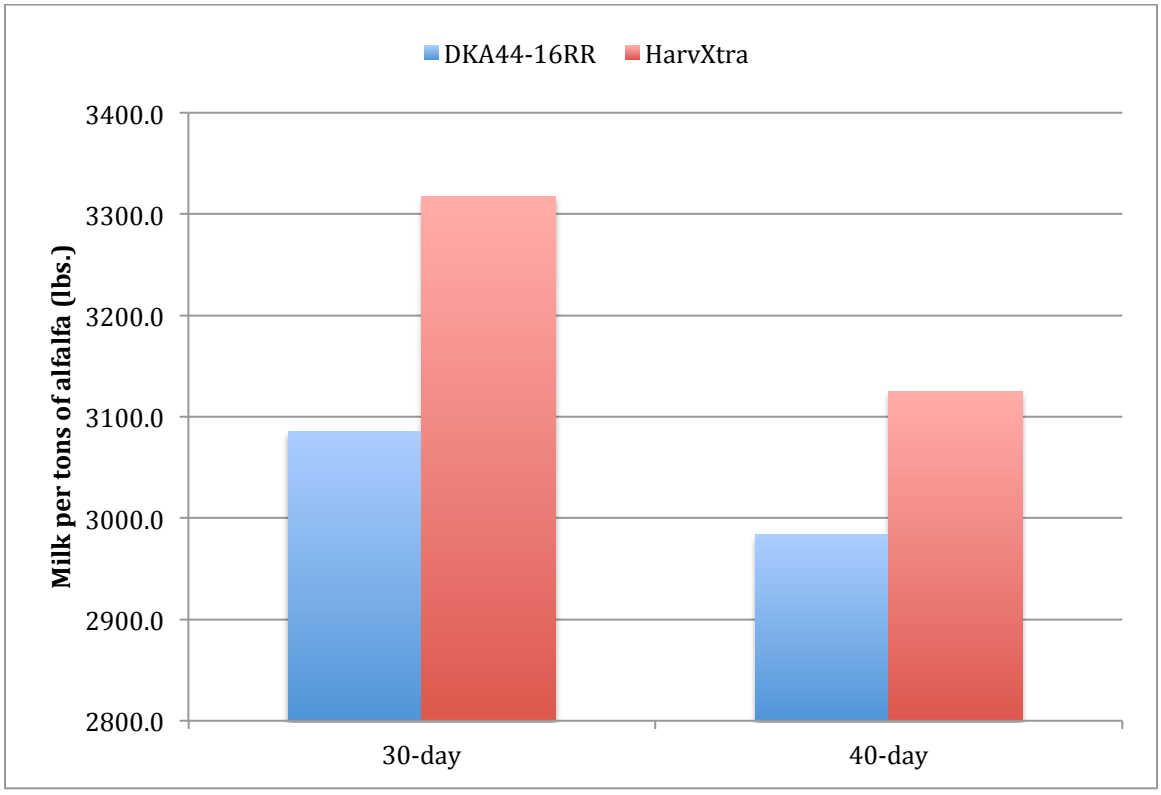

Figure 3. Milk per acre produced by conventional (DKA44-16RR)and reduced-lignin alfalfa (HarvXtra) sprayed with eight fungicide treatments on alfalfa first crop using a 30-day vs. 40-day cutting schedule. There was no significant fungicide treatment effect for either variety, therefore data across fungicide treatments are pooled.

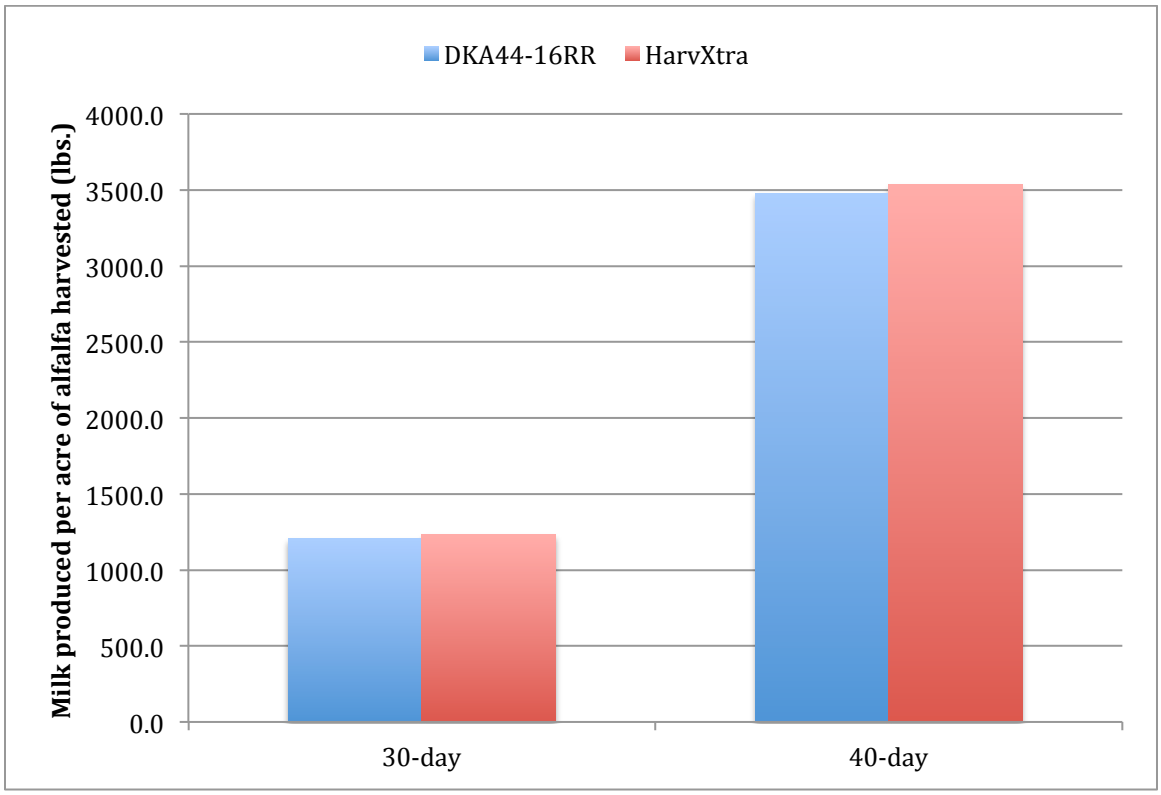

Figure 4. Common leaf spot severity of conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa for second crop, 30 vs. 40-day cut. Response to fungicide treatment was similar between both varieties, therefore results are pooled across fungicide treatment.

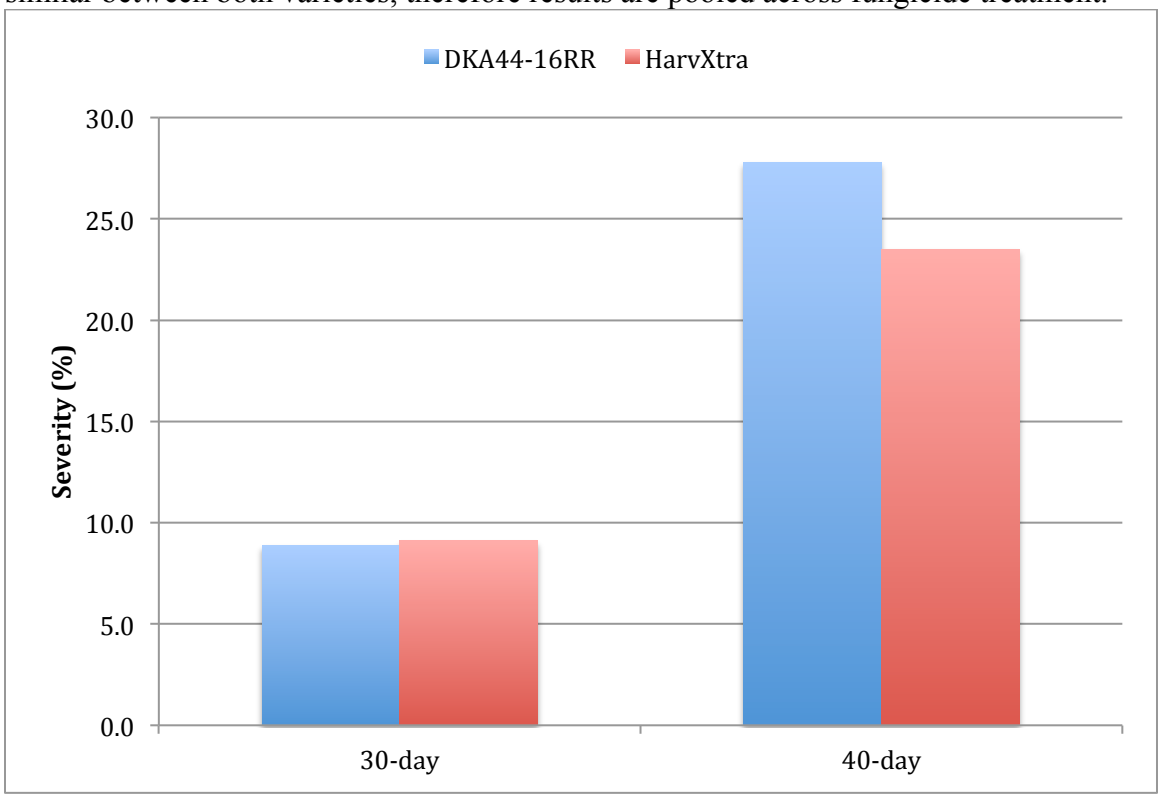

Figure 5. Common leaf spot severity of conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa sprayed with eight fungicide treatments on alfalfa second crop, 30 vs. 40-day cut. Both alfalfa varieties responded similarly to fungicide application, therefore results are pooled across varieties. Bars of the same color, with the same letter, are not significantly different from each other based on the test of least significant difference (LSD).

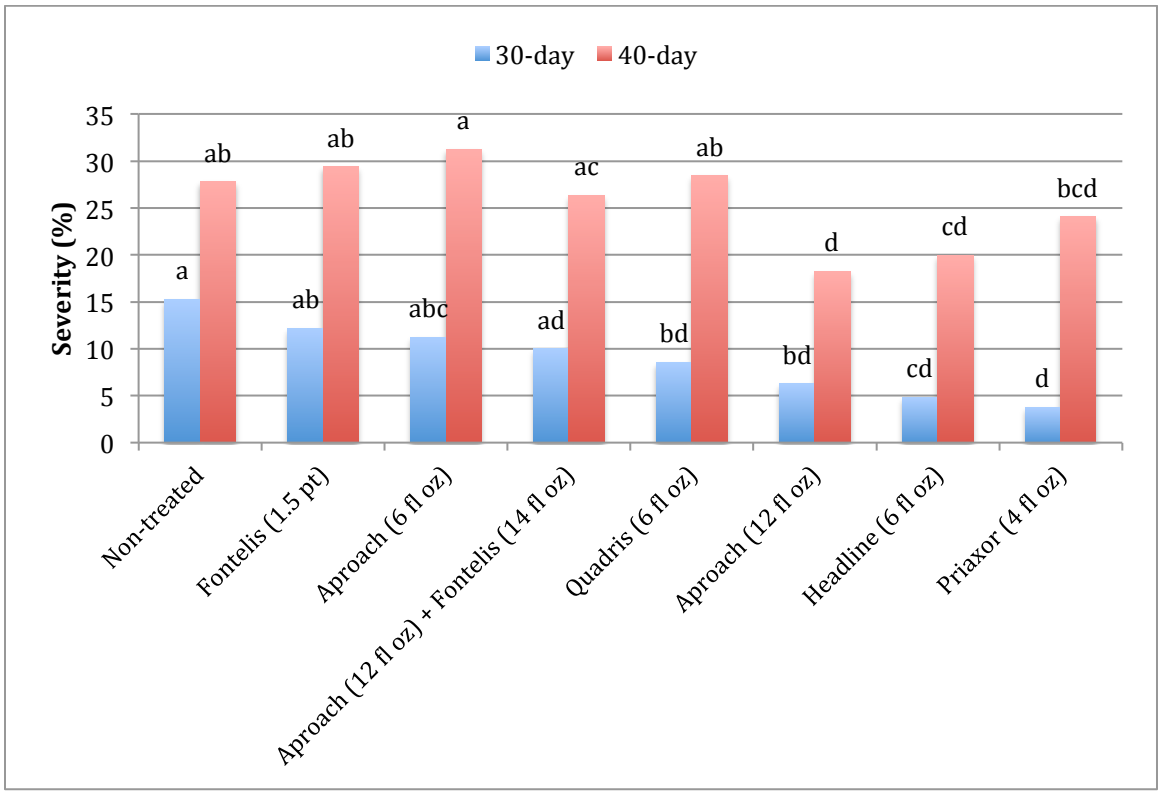

Figure 6. Dry matter yield of conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa sprayed with eight fungicide treatments on alfalfa second crop, 30 vs. 40-day cut. Both alfalfa varieties responded similarly to fungicide application, therefore results are pooled across varieties. Bars of the same color, with the same letter, are not significantly different from each other based on the test of least significant difference (LSD).

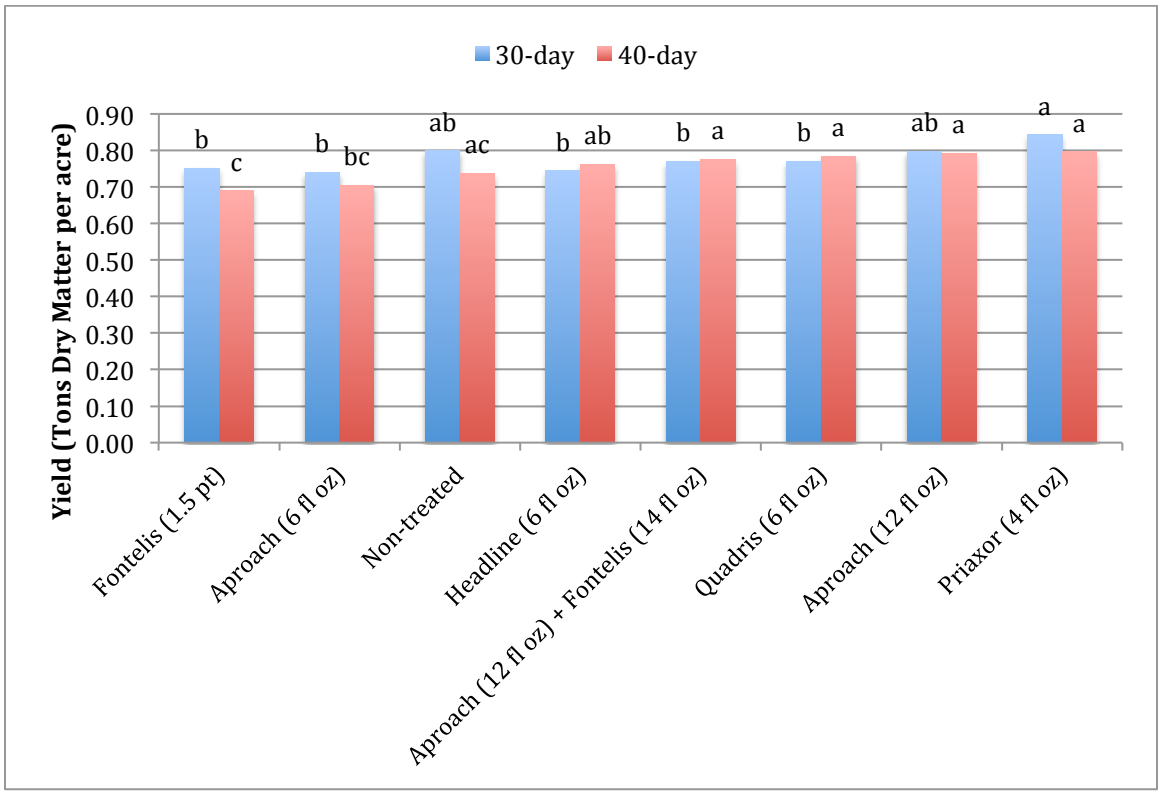

Figure 7. Milk produced per ton dry matter for conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa sprayed with eight fungicide treatments on alfalfa second crop, 30 vs. 40-day cut. Both alfalfa varieties responded similarly to fungicide application, therefore results are pooled across varieties. Bars of the same color, with the same letter, are not significantly different from each other based on the test of least significant difference (LSD).

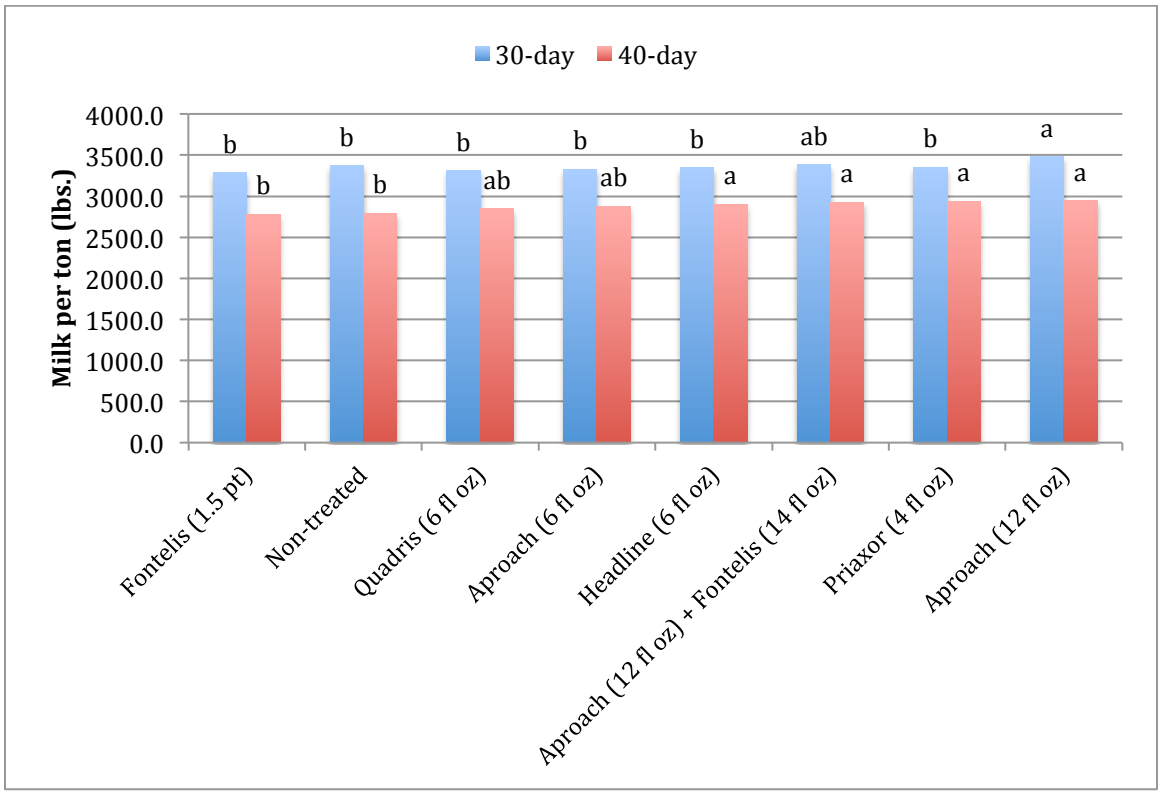

Figure 8. Milk produced per acre for conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa sprayed with eight fungicide treatments on alfalfa second crop, 30 vs. 40-day cut. Both alfalfa varieties responded similarly to fungicide application, therefore results are pooled across varieties. Bars of the same color, with the same letter, are not significantly different from each other based on the test of least significant difference (LSD).