MANAGING FOLIAR FUNGICIDE APPLICATIONS IN REDUCED-LIGNIN ALFALFA SYSTEMS

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Introduction

In 2015, an alfalfa research trial was established at the Arlington Agricultural Research Station in Arlington, WI. Two cultivars of alfalfa (DKA44-16RR - Conventional Roundup Ready®; HarvXtra – Reduced-lignin, Roundup Ready ®) were sprayed with seven fungicide treatments and compared to a non-treated control. Yield, quality, and return on investment of the treatments were evaluated under two cutting duration schemes (30-day vs. 40-day) for both cultivars. Results of the entire study can be found at: http://fyi.uwex.edu/fieldcroppathology/files/2015/11/2015-DLS-MFA-FINAL-REPORT.pdf. In the 2015 study (seeding year), both cultivars responded to fungicide in a similar way (second crop specifically). In the 30-day cutting duration, fungicide application resulted in little discernable difference in disease level, defoliation, or quality compared to not treating with fungicide. Return on investment (ROI) calculations indicated that no positive return was achieved if the hay was sold, or was kept on the farm and fed to dairy cows, for the 30-day duration of cut. For the 40-day duration, significant differences in fungicide treatments were identified for disease levels, defoliation, and quality compared to the non-treated controls. These differences resulted in positive ROI (using the Milk 2006 model) for the second crop where the fungicides Headline® and Quadris® were used, under the scenario where hay would be kept on the farm and fed to dairy cows. If hay was sold, no positive ROI was identified for either treatment for this crop.

Considering these results, we continued this study in a second year using the same established stand of alfalfa. We investigated the first, second, and third crops in 2016. We considered these three crops together in this analysis to examine success of using fungicide in a 30-day cutting interval system, or a 40-day cutting interval system.

Objectives

The objectives of this project are:

1. Assess the utility of applying fungicides (labeled and non-labeled) to an <u>ESTABLISHED STAND</u> of reduced-lignin alfalfa by evaluating foliar disease pressure, defoliation, yield, and quality for both 30-day and 40-day cutting intervals for the combined 1st, 2nd, and 3rd crop.
2. Determine the return of investment (ROI), using hay price and milk price, when various fungicides (labeled products) were applied to conventional or reduced-lignin alfalfa.

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Materials and Methods

A field trial was previously established at the Arlington Agricultural Research Station (AARS) located in Columbia and Dane Counties in Wisconsin in spring of 2015. Two alfalfa varieties, one conventional variety and one reduced-lignin variety, were seeded on 17 April 2015. Plots were 10 feet wide and 20 feet long. In 2016, seven fungicide treatments (same treatments as in the 2015 trial) 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. Fungicides were applied to each crop when alfalfa was six inches tall. Details of the fungicide treatments can be found in Table 1. A non-treated control was also included for a total of eight treatments. Treatments for the first crop were applied on 22 April 2016. On 20 May 2016 first crop (30-day cutting interval) was conducted 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. Eleven days later (31 May 2016), another 30-inch wide strip was harvested (40-day cutting interval) 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 2 June 2016. Thus, the second crop was established. Fungicide treatments were applied to the second crop on 13 June 2016. The second crop 30-day cutting interval was conducted on 1 July 2016 while the 40-day cutting interval was conducted on 11 July 2016. All procedures and data acquisition were conducted in the same manner as on the first crop and the field was cleared on 11 July to establish the third crop. A third application of fungicide was applied on 19 July 2016. The third crop 30-day cutting interval was conducted on 11 August 2016 while the 40-day cutting interval was conducted on 22 August 2016. All procedures and data acquisition were conducted as described previously.

The experimental design was a split-split plot with four 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 compiled together for the entire season (e.g., average disease severity for the season, average season defoliation, total yield, etc.) and analyzed using standard mixed-model analysis of variance and means separated for treatment effects within each variety using the test of least significant difference.

Results

Applying fungicide over the course of the three crops resulted in significant (P<0.01) reductions in average severity for both alfalfa cultivars in the 30-day cutting interval (Table 2) and DKA44-16RR in the 40-day cutting interval (Table 3). There was no significant difference in average disease severity among fungicide treatments or the non-treated control for HarvXtra subjected to the 40-day cutting interval. Typically, Priaxor and Quadris treatments offered the most significant reduction in foliar disease severity compared to the non-treated control, where differences in disease were observed.

While differences in disease severity were detected among fungicide treatments for both cultivars for the 30-day cutting interval, this did not result in a significant difference (P>0.05) in defoliation during this cutting interval (Table 2). For the 40-day cutting interval, a significant (P=0.04) reduction in average defoliation was observed for all fungicide treatments compared to the non-treated control for both cultivars (Table 3).

Significant difference (P<0.05) in dry-matter yield was observed among all treatments for both cultivars subjected to both cutting intervals (Tables 2 and 3). For the 30-day cutting interval

Priaxor and Fontelis alone provided the highest yield, while Priaxor and Quadris applications resulted in the highest yields for the 40-day cutting interval.

Interestingly, application of fungicide did not provide a significant (*P*>0.05) increase in RFQ over the non-treated control for either cultivar subjected to 30-day or 40-day cutting intervals (Tables 2 and 3). However, for the 40-day cutting interval, HarvXtra provided significantly higher (*P*=0.02) RFQ values compared to DKA44-16RR regardless of fungicide treatment. No differences in RFQ were noted between cultivars for the 30-day cutting interval.

Application of fungicide did not result in a significant (*P*>0.05) increase in total milk production over the non-treated control for either cultivar subjected to the 30-day cutting interval (Table 2). For the 40-day cutting interval, application of fungicide did result in significant (*P*<0.01) increases in total milk production for both cultivars. However, the HarvXtra cultivar tended to give marginally higher (*P*=0.08) total milk production for the 40-day cutting interval. For DKA44-16RR subjected to the 40-day cutting interval, Priaxor resulted in the highest overall milk production (Table 3). For HarvXtra subjected to the 40-day cutting interval, highest milk production was achieved with Quadris fungicide followed by alfalfa treated with Priaxor fungicide.

Using hay pricing to calculate return on investment (ROI), Headline, Priaxor and Quadris fungicide used on either cultivar subjected to the 30-day cutting interval generally resulted in negative ROI (Table 4). Two exceptions were identified where Priaxor provided a slight positive ROI for DKA44-16RR subjected to the 40-day cutting interval, while Quadris provided a positive ROI for the HarvXtra cultivar subjected to the 40-day cutting interval.

Using milk pricing resulted in a larger number of positive ROI cases. For DKA44-16RR subjected to the 30-day cutting interval, both Priaxor and Quadris provided positive ROI estimates (Table 5). No positive ROI estimates were observed for HarvXtra subjected to the 30-day cutting interval. Using milk pricing to calculate ROI for the 40-day cutting interval resulted in positive ROI for both cultivars and all fungicides except for Headline applied to DKA44-16RR (Table 5).

Conclusions

Previous research where fungicide has been applied to alfalfa in Wisconsin has resulted in infrequent cases where fungicide resulted in a significant increase in yield or a positive return on investment, because subjecting alfalfa to timely cutting (e.g., 30-day cutting intervals) usually results in plants with low foliar disease, undetectable defoliation, and extremely high quality. Plants under this optimal production system typically don't respond to fungicide application, or respond infrequently.

Subjecting alfalfa stands to longer cutting intervals (e.g., 40-day cutting interval) results in more disease pressure, detectable defoliation, and an inherent reduction in overall quality. Applying fungicide to alfalfa stands subjected to these longer cutting intervals appears to result in a higher likelihood of positive ROI. Combining reduced-lignin alfalfa with fungicide application on alfalfa stands subjected to long cutting durations may further increase the likelihood and magnitude of positive ROI in Wisconsin.

Table 1. Fungicide treatments applied to both conventional and reduced-lignin alfalfa on an established stand in Wisconsin, 2016.

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)[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 2016
[2]Treatment included the adjuvant, Induce 90 SL, at 0.3% v/v.

Table 2. Season-long average disease severity, average defoliation, total yield, RFQ, and total estimated milk production of conventional or reduced-lignin alfalfa treated with fungicide or not treated and harvested on a 30-day cutting interval in Wisconsin in 2016.

	DKA44-16RR					HarvXtra				
	Disease severity (%)[a,f]	Defoliation (%)[b]	Total yield (tons/a)[c,f]	RFQ[d]	Total milk production (lbs/a)[e]	Disease severity (%)[a,f]	Defoliation (%)[b]	Total yield (tons/a)[c,f]	RFQ[d]	Total milk production (lbs/a)[e]
Priaxor (4 fl oz)	2.7 c	0.2	2.9 a	212.8	9441.6	2.8 c	0.5	2.9 ab	227.8	9561.9
Fontelis (1.5 pt)	5.2 b	1.1	2.8 ab	208.8	9144.0	3.5 bc	0.4	2.9 a	224.6	9684.2
Quadris (6 fl oz)	5.7 ab	1.2	2.8 ab	209.5	9030.5	5.0 ac	0.4	2.7 bc	219.0	8890.0
Aproach (12 fl oz) + Fontelis (14 fl oz)	4.4 bc	1.0	2.8 ab	209.2	8958.5	4.5 ac	0.5	2.7 bc	222.3	8982.2
Aproach (12 fl oz)	5.8 a	1.1	2.8 ab	212.4	8923.0	4.5 ac	0.9	2.7 bc	229.8	9072.4
Headline (6 fl oz)	4.8 bc	0.6	2.8 ab	208.8	8872.6	4.9 ac	1.0	2.8 ac	221.3	9305.6
Non-treated	7.9 a	2.8	2.6 b	216.9	8710.8	6.7 a	0.9	2.8 ac	217.6	9419.3
Aproach (6 fl oz)	5.6 b	0.7	2.7 b	208.2	8526.4	5.7 ab	1.2	2.6 c	229.3	8930.6
Pr>F	<0.01	ns	0.04	ns	ns	<0.01	ns	0.04	ns	ns

[a]Average disease severity of crops 1-3.
[b]Average defoliation of crops 1-3.
[c]Total dry-matter yield for crops 1-3.
[d]Average RFQ of crops 1-3.
[e]Total milk production of crops 1-3 as estimated by the Milk 2006 model.
[f]Means with the same letter are not significantly different based on the test of least significant difference (LSD) at P=0.05.

Table 3. Season-long average disease severity, average defoliation, total yield, RFQ, and total estimated milk production of conventional or reduced-lignin alfalfa treated with fungicide or not treated and harvested on a 40-day cutting interval in Wisconsin in 2016.

	DKA44-16RR					HarvXtra				
	Disease severity (%)[a,f]	Defoliation (%)[b,f]	Total yield (tons/a)[c,f]	RFQ[d]	Total milk production (lbs/a)[e,f]	Disease severity (%)[a]	Defoliation (%)[b,f]	Total yield (tons/a)[c,f]	RFQ[d]	Total milk production (lbs/a)[e,f]
Quadris (6 fl oz)	12.3 bc	12.9 bc	2.8 bc	137.3	7103.2 b	12.4	12.1 ab	3.0 a	164.0	8606.0 a
Priaxor (4 fl oz)	8.2 c	7.3 c	3.0 a	140.0	7836.7 a	9.7	10.2 b	3.0 a	158.9	8431.2 ab
Aproach (12 fl oz) + Fontelis (14 fl oz)	15.2 b	14.8 b	2.7 bc	137.3	6926.4 b	13.5	12.3 ab	2.9 ab	159.2	8142.8 abc
Aproach (12 fl oz)	11.8 bc	12.3 bc	2.7 bc	142.3	7072.0 b	10.8	12.5 ab	2.9 ab	160.7	8087.5 abc
Headline (6 fl oz)	14.3 b	12.9 bc	2.8 bc	137.4	7210.7 b	10.4	13.4 ab	2.8 b	157.2	7935.9 bcd
Fontelis (1.5 pt)	14.8 b	14.2 b	2.9 ab	138.6	7357.9 ab	12.4	12.7 ab	2.8 b	157.4	7759.3 cd
Aproach (6 fl oz)	13.6 b	12.5 bc	2.7 bc	138.7	6866.0 b	13.8	17.5 a	2.8 b	152.7	7744.1 cd
Non-treated	20.1 a	21.5 a	2.7 bc	137.7	6873.5 b	13.4	14.8 ab	2.8 b	150.8	7457.6 d
Pr>F	<0.01	<0.01	<0.01	ns	<0.01	ns	<0.01	<0.01	ns	<0.01

[a]Average disease severity of crops 1-3.
[b]Average defoliation of crops 1-3.
[c]Total dry-matter yield for crops 1-3.
[d]Average RFQ of crops 1-3.
[e]Total milk production of crops 1-3 as estimated by the Milk 2006 model.
[f]Means with the same letter are not significantly different based on the test of least significant difference (LSD) at *P*=0.05

Table 4. Hay return on investment when applying 3 applications of Headline, Priaxor, or Quadris Fungicide to conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa in Wisconsin, 2016[a].

	DKA44-16RR				HarvXtra		
	Headline (6 fl oz)	Priaxor (4 fl oz)	Quadris (6 fl oz)		Headline (6 fl oz)	Priaxor (4 fl oz)	Quadris (6 fl oz)
30-day cutting Interval	($29.28)	($5.01)	($8.22)		($68.92)	($49.15)	($56.86)
40-day Cutting Interval	($37.65)	$4.62	($12.09)		($46.65)	($8.88)	$14.91

[a]ROI based on dry matter yield of prime grade hay and a June - August 2016 average price of $180 per ton. Headline, Priaxor, and Quadris season programs were calculated to be $60, $54, and $35, respectively. These estimates DO NOT incorporate a custom application fee.

Table 5. Milk return on investment when applying 3 applications of Headline, Priaxor, or Quadris Fungicide to conventional (DKA44-16RR) and reduced-lignin (HarvXtra) alfalfa in Wisconsin, 2016[a].

	DKA44-16RR				HarvXtra		
	Headline (6 fl oz)	Priaxor (4 fl oz)	Quadris (6 fl oz)		Headline (6 fl oz)	Priaxor (4 fl oz)	Quadris (6 fl oz)
30-day cutting Interval	($33.51)	$66.46	$18.06		($78.87)	($30.39)	($121.75)
40-day Cutting Interval	($4.62)	$104.72	$3.23		$18.60	$106.43	$154.50

[a]ROI based on milk per acre produced for each treatment and June – August 2016 average milk price of $16.47 cwt. Headline, Priaxor, and Quadris season programs were calculated to be $60, $54, and $35, respectively. These estimates DO NOT incorporate a custom application fee.