Fungicide Use In Alfalfa: What Four Years of Research Has Taught Us

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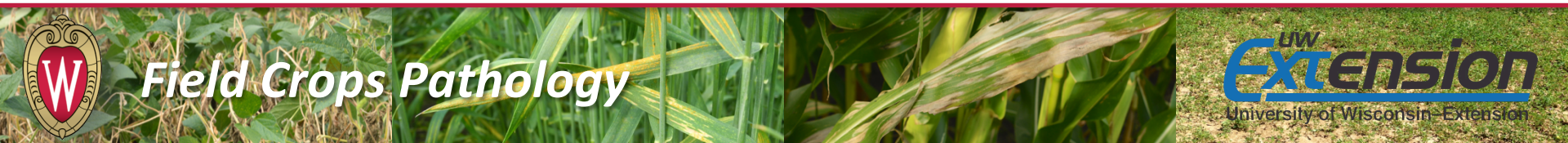

Fungicide Use on Alfalfa

- 1988 study – Some fungicide applications resulted in lower disease severity
- This resulted in higher yield in some treatments
- Products were contact (copper hydroxide and mancozeb) and acropetal penetrant (benomyl) fungicides

TABLE 2. Effects of fungicide treatment on final stand density and mean final disease severity defoliation index and yield over 10 harvests of Phytor alfalfa from 1983 to 1985

Treatment abbreviation[a]	Final disease severity (%)	Defoliation index[b]	Dry matter yield per harvest (Mg/ha)	Final stand density (plants/m^2)
M+B3	1.1	0.37	4.26	124
BE	4.2	0.47	3.97	76
BL	5.2	0.46	3.85	66
B2	3.2	0.45	4.05	86
B3	3.0	0.45	4.18	104
CuL	5.2	0.48	3.73	72
Cu2	4.1	0.48	3.85	79
ME	3.9	0.46	4.08	87
ML	4.5	0.47	3.82	68
M2	2.2	0.43	4.11	96
M3	1.4	0.40	4.23	102
Con	7.3	0.50	3.71	64
BLSD[c] (k = 100)	0.5	0.02	0.15	17

[a] Treatment abbreviations are a fungicide:application schedule combination. B, Cu, and M = benomyl, copper hydroxide, and mancozeb, respectively. E, L, 2, and 3 = application 26; 10; 26 and 10; and 26, 18, and 10 days before harvest, respectively; and Con = untreated check.

[b] Defoliation index = length from stem base to lowest leaf attached to main stem/total stem length.

[c] Waller-Duncan's Bayesian k-ratio least significant difference.

Broscious, S.C. and Kirby, H.W. (1988)

Headline® Fungicide Label

- FRAC group 11; QoI or strobilurin fungicide; very limited mobility in the plant (local penetrant)
- One of the first strobilurin fungicides labeled for Alfalfa
- Not labeled for clover, grasses, or other perennial forage crops(e.g. not for mixtures of alfalfa and other grasses)
- 14 day pre harvest interval = 1 spray per cutting
- Allowed up to 3 applications per year
  - 6 to 9 fl oz./ acre per application
  - **$21 to $31/acre for just the fungicide product**
  - Maximum total of 27 oz./ acre per year

Quadris® Fungicide Label

- FRAC group 11; QoI or strobilurin fungicide; some mobility in the plant (acropteal penetrant)
- One of the first strobilurin products labeled for plant disease control
- Labeled for clover, grasses, or other perennial forage crops(e.g. mixtures of alfalfa, clover, or grasses)
- 14 day pre harvest interval = 1 spray per cutting
- Allowed up to 3 applications per year
  - 6 to 15.5 fl oz./ acre per application
  - **$17 to $44/acre for just the fungicide product**
  - Maximum total of 46.5 oz./ acre per year

Some Other Fungicide Products

- **Endura®** – boscalid; FRAC Group 7 (SDHI); Forage rate is 6.5 oz./a; can also be applied to alfalfa for seed at higher rates

- **Fontelis®** – penthiopyrad; FRAC Group 7 (SDHI); 14-24 fl.oz./a; Label approved for alfalfa in 2013

- **Kocide 3000®** – copper hydroxide; FRAC Group M; 0.75 lbs./a

Recent Strobilurin Research

PMN International — Plant Health Progress — Search PMN

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When Do Foliar Pyraclostrobin Fungicide Applications Produce Profitable Soybean Yield Responses?

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Kyveryga, P. M., Blackmer, T. M., and Mueller, D. S. 2013. When do foliar pyraclostrobin fungicide applications produce profitable soybean yield responses? Online. Plant Health Progress doi:10.1094/PHP-2013-0928-01-RS.

Impact Statement

PMN International — Plant Health Progress — Search PMN

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Evaluating Headline Fungicide on Alfalfa Production and Sensitivity of Pathogens to Pyraclostrobin

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Samac, D. A., Halfman, B., Jensen, B., Brietenbach, F., Behnken, L., Willbur, J., Undersander, D., Blonde, G., and Lamb. J. F. S. 2013. Evaluating Headline fungicide on alfalfa production and sensitivity of pathogens to pyraclostrobin. Online. Plant Health Progress doi:10.1094/PHP-2013-0917-01-RS.

Impact Statement

- Quite a bit of work done on "Plant Health Benefits" in corn and other crops
- Yield benefits have been inconsistent
  - Depends on disease levels
  - Hybrid/Variety
  - Environment (e.g. drought, excessive rains, etc.)
  - Date of planting
  - Other factors
- Recent research on soybean suggest that pyraclostrobin can increase the odds of a yield benefit when applied IF water is not limiting

- In alfalfa results yield increase was inconsistent across trials (2012 data during the drought)
- If disease levels were high and fungicide controlled the disease, there was an occasional increase in yield and sometimes crude protein

2011 - 2014 Methods

- Trials (n=35; year x location x cutting)
  - Arlington 2011-2014 (10 trials with 16 cuttings)
  - Monroe County 2011-2013 (3 trials with 7 cuttings)
  - Waupaca County 2012-2014 (4 trials with 12 cuttings)
- Randomized Complete Block Design
  - 4 replicates 2011-2012
    - 4 treatments (UTC, fungicide only, fungicide + insecticide, insecticide only)
  - 6 replicates , 2013-2014 (4 trials; Monroe Co, and Waupaca Co.)
    - 2 treatments (insecticide only, insecticide + fungicide)
    - Insecticide used only to rule out insect damage
  - 4 replicates, 2013-2014 (3 trials; Arlington, fungicide only)

2011 – 2014 Methods

- Minimum plot area = 400 sq. ft.
- Pesticide treatments applied with a CO_2-pressurized backpack sprayer
  - Headline®, Quadris®, Endura®, Fontelis®, Kocide 3000®
- 20 GPA application rate
- Plots harvested using a small-plot harvester
- DM Yield determined for all plots
- RFQ determined for all plots (except Arlington 2014)

Initial Results

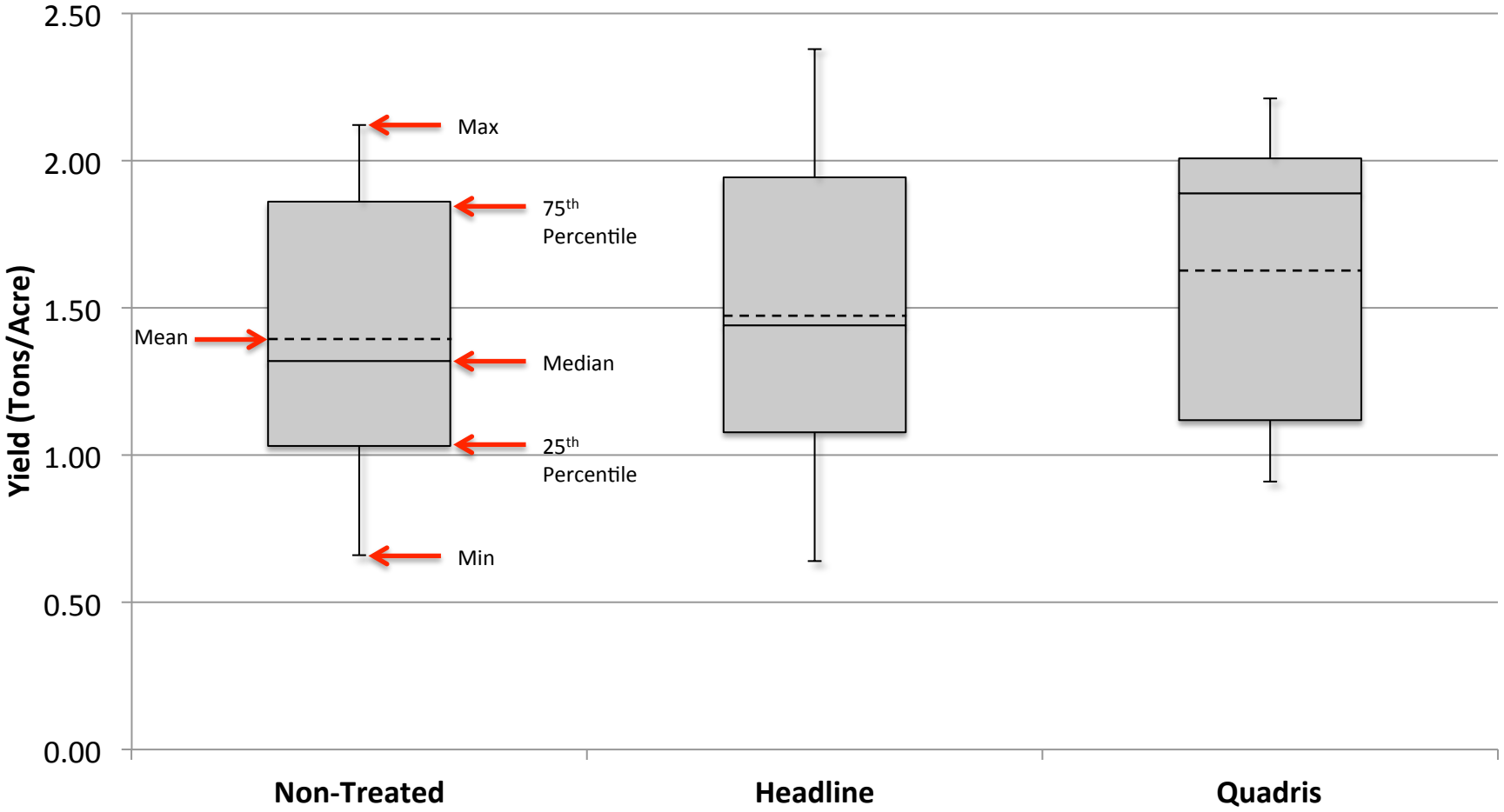
- 35 Separate Trials analyzed by ANOVA
- Significant treatment effect on YIELD identified for 12 trials = **34%** of trials
  - **Yield increase averaged 0.22 tons (Headline® or Quadris®)**
- Significant treatment effect on RFQ identified for 8 trials = **23%** of trials
  - Not always the fungicide treatment providing a higher RFQ
  - Most trials had RFQ above 150 (prime grade)

- What about non-significant responses? Is there always some increase in yield or RFQ when spraying fungicide? Does it pay to spray anyway?

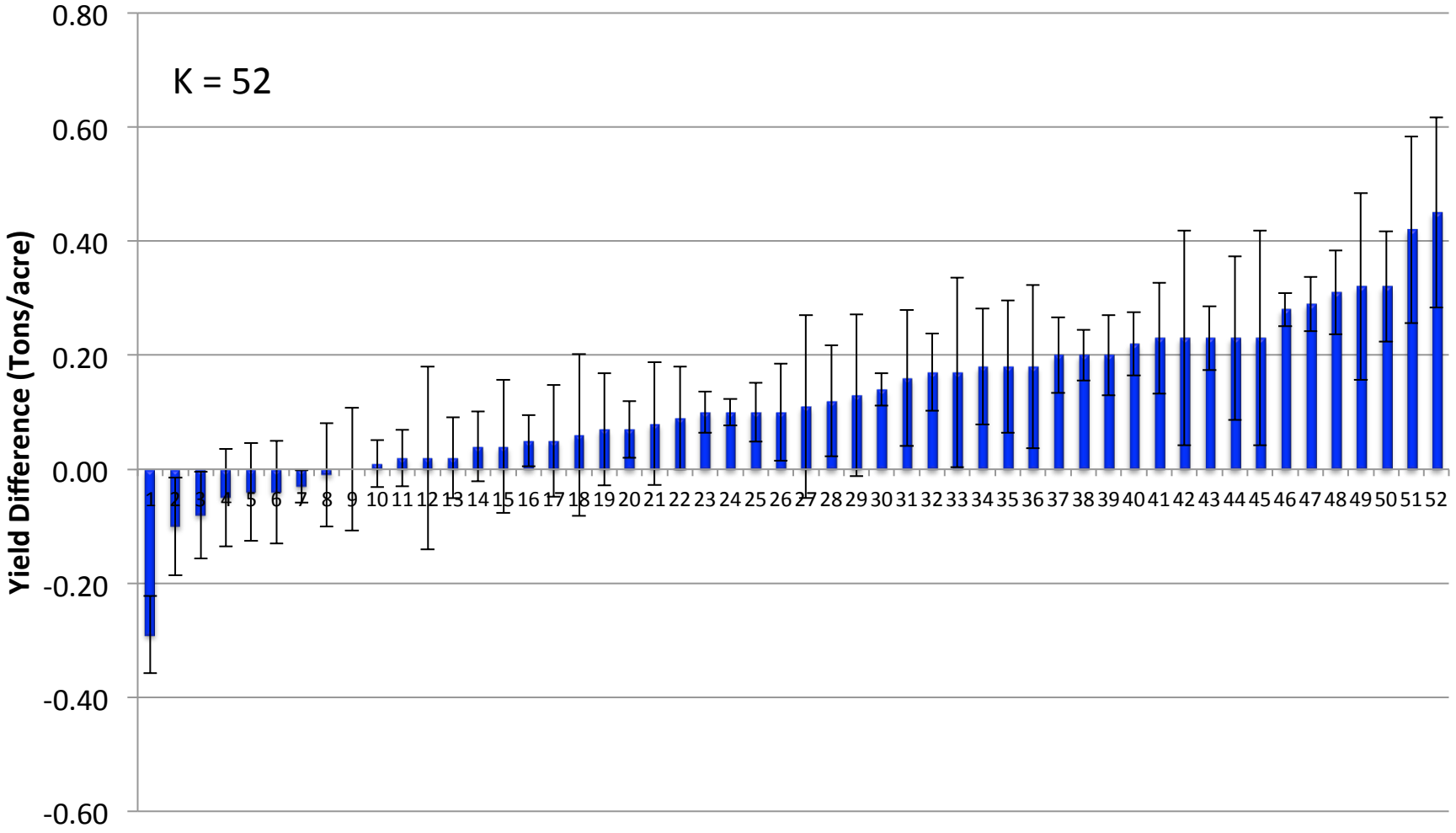
Meta-Analysis

- Large number of observations with Headline® (n=52) fungicide, followed by a few with Quadris® fungicide (n=12)
- Can use meta-analysis (widely used in medical research) to compare a specific treatment response to the non-treated across many trials and observations – **can make predictions of future responses based on the results**
- Uses mean difference in treated vs. non-treated within each trial AND the trial variance to measure the effect on a large scale
- Meta-analysis was performed to measure the effect of using Headline® or Quadris® on alfalfa yield and RFQ in a Wisconsin dairy production system
  - When insecticide was used, treatments were compared to insecticide ONLY treated plots
  - Interested in only the effect of fungicide in this analysis

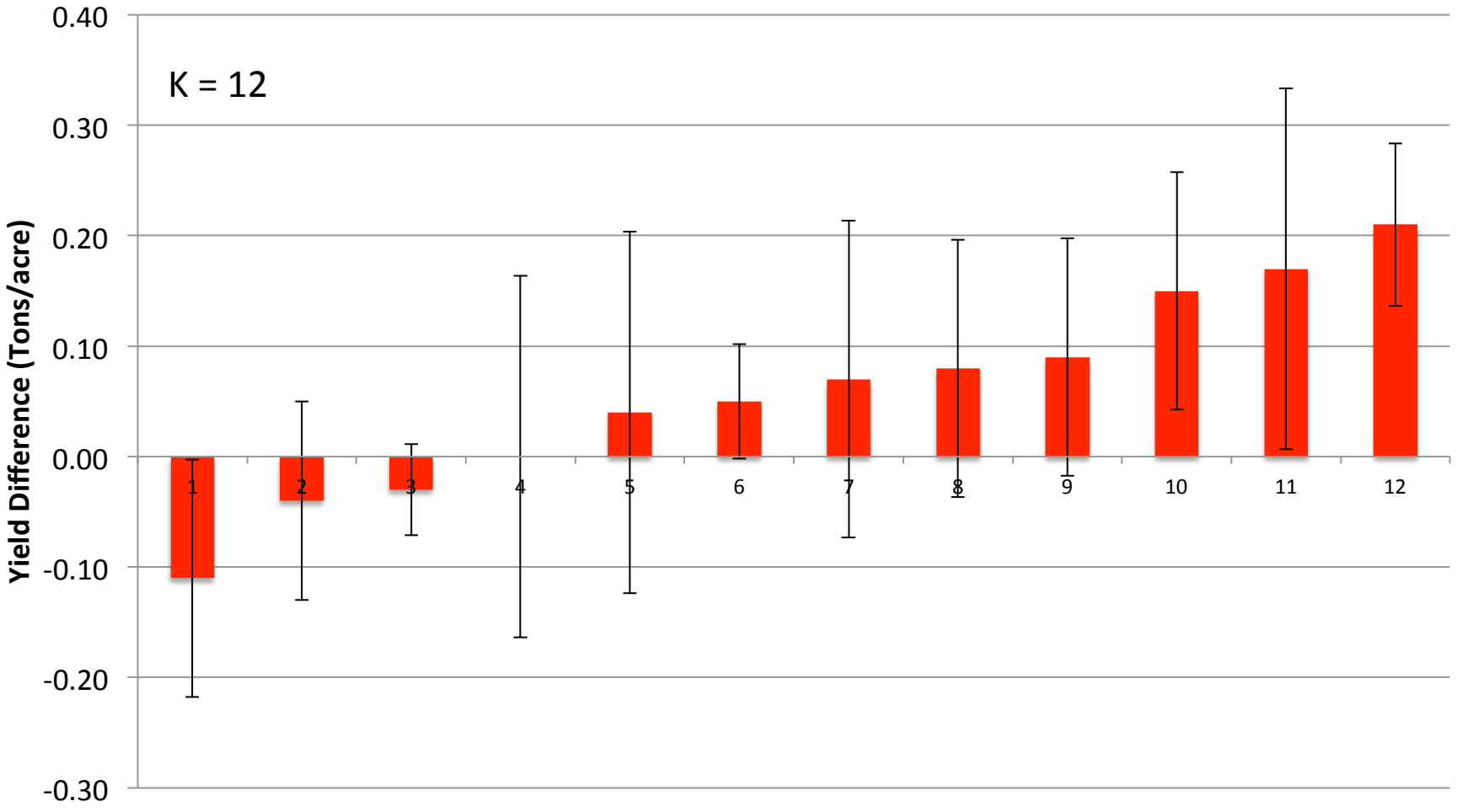
Box Plots Summarizing Yield Distribution For Three Fungicide Treatments Across All Observations



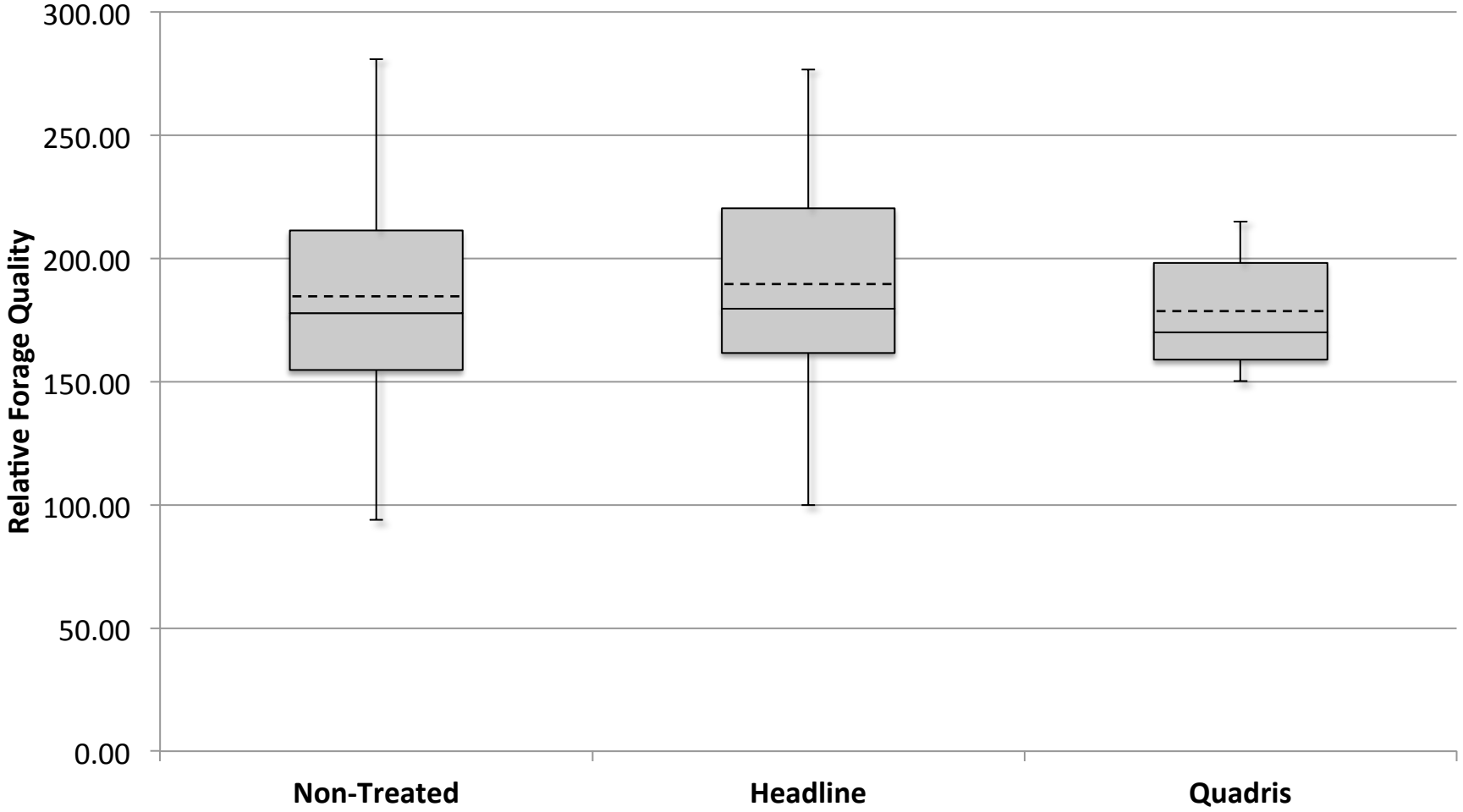
Yield Difference Between Alfalfa Treated with Headline® Fungicide or Not Treated



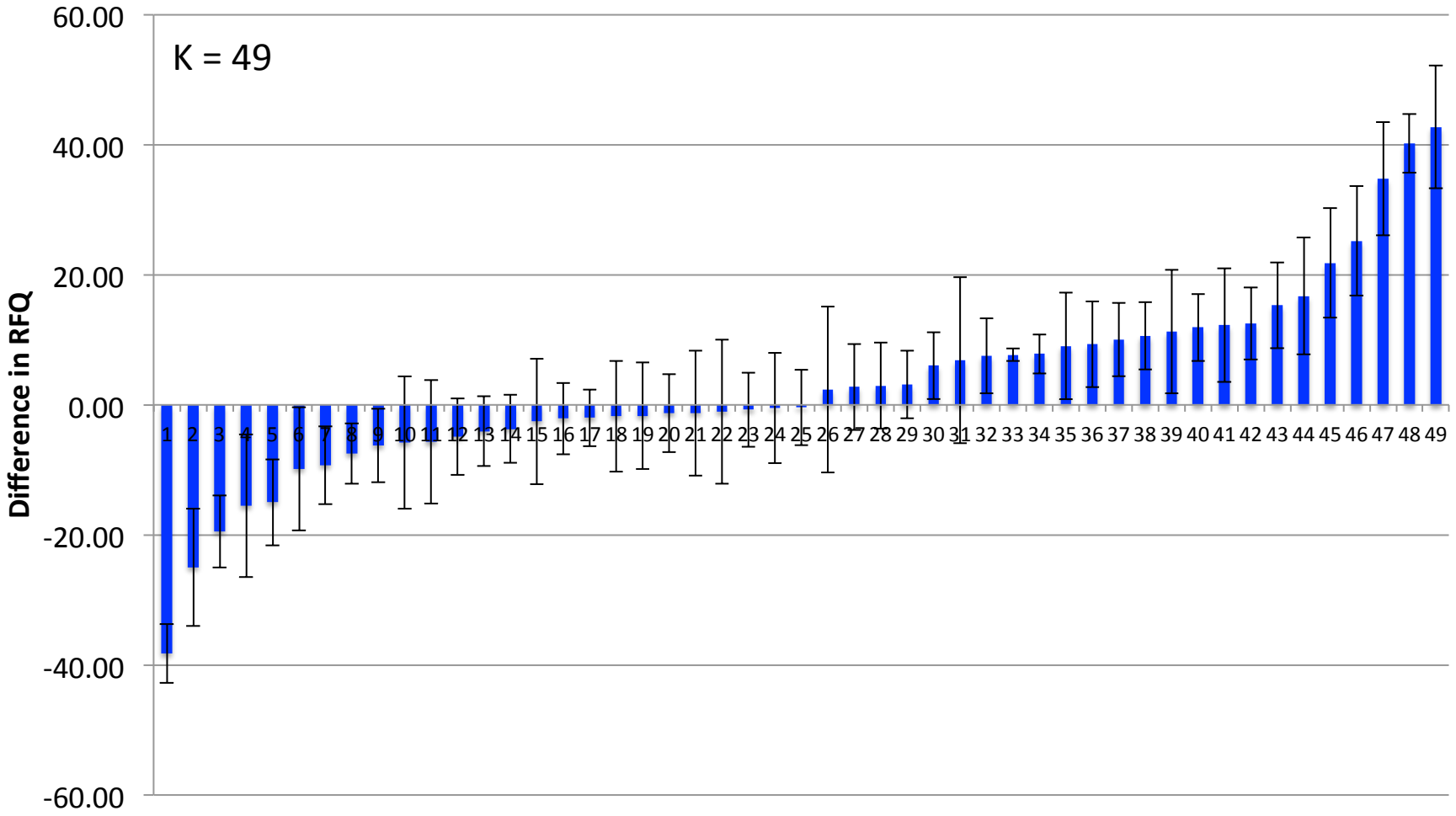
Yield Difference Between Alfalfa Treated with Quadris® Fungicide or Not Treated



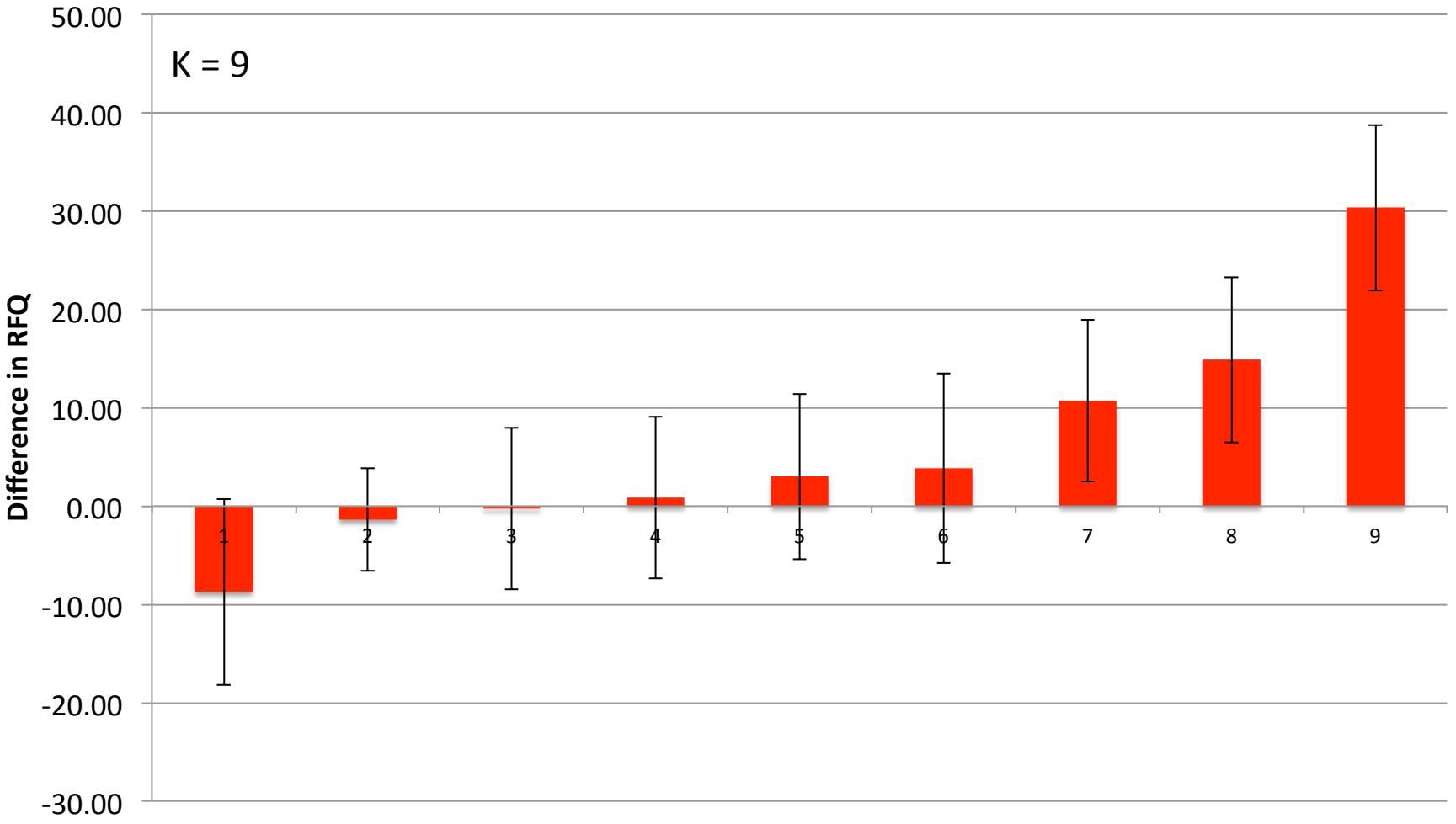
Box Plots Summarizing RFQ Distribution For Three Fungicide Treatments Across all Observations



Difference in RFQ Between Alfalfa Treated with Headline® Fungicide or Not Treated



Difference in RFQ Between Alfalfa Treated with Quadris® Fungicide or Not Treated



Meta-Analysis Results for Headline® and Quadris® (Not partitioning by cutting)

	Yield Advantage Over Not Treating						
	K	Mean Difference from Non-treated	SE	*P*	CL Lower	CL Upper	95% Prediction Interval (Tons/a)
Headline®	52	0.11 tons	0.02	<0.01	0.07	0.15	-0.10 to 0.31
Quadris®	12	0.05 tons	0.03	0.12	-0.01	0.10	--

	RFQ Advantage Over Not Treating						
	K	Mean Difference from Non-treated	SE	*P*	CL Lower	CL Upper	95% Prediction Interval
Headline®	49	2.85	2.11	0.17	-1.28	6.98	--
Quadris®	9	5.68	3.48	0.10	-1.15	12.51	--

*Purposes of these analyses are to identify differences that are significantly greater than zero

Meta-Analysis Results for Headline® and Quadris® (Not partitioning by cutting)

- Only the application of Headline® resulted in a significant increase in yield over not treating (0.11 tons/a)

- No significant increase in RFQ was observed over not treating with either fungicide

- What about the cutting effect? Could application of fungicide at a particular cutting result in an increase in yield or RFQ?

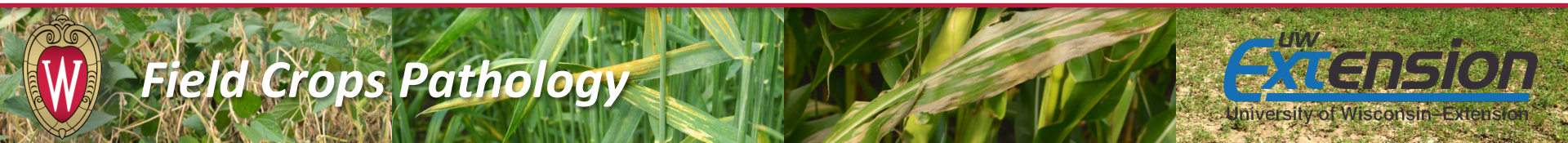
Meta-Analysis Results for Headline® and Quadris® (Partitioned by cutting)

Headline®	**Yield Advantage Over Not Treating**		
	Mean Difference	SE	*P*
Cut 1 vs. Cut 2	-0.04 tons	0.04	0.31
Cut 1 vs. Cut 3 or 4	<0.01 tons	0.04	0.95
Cut 2 vs. Cut 3 or 4	0.04 tons	0.04	0.27

Quadris®	**Yield Advantage Over Not Treating**		
	Mean Difference	SE	*P*
Cut 1 vs. Cut 2	0.09 tons	0.05	0.09
Cut 1 vs. Cut 3 or 4	0.05 tons	0.07	0.50
Cut 2 vs. Cut 3 or 4	-0.05 tons	0.06	0.36

Headline®	**RFQ Advantage Over Not Treating**		
	Mean Difference	SE	*P*
Cut 1 vs. Cut 2	-3.89	4.97	0.43
Cut 1 vs. Cut 3 or 4	-1.81	5.29	0.73
Cut 2 vs. Cut 3 or 4	2.08	5.17	0.68

Quadris®	**RFQ Advantage Over Not Treating**		
	Mean Difference	SE	*P*
Cut 1 vs. Cut 2	5.81	6.82	0.39
Cut 1 vs. Cut 3 or 4	18.32	11.84	0.12
Cut 2 vs. Cut 3 or 4	12.51	12.03	0.30



Meta-Analysis Results for Headline® and Quadris® (Partitioned by cutting)

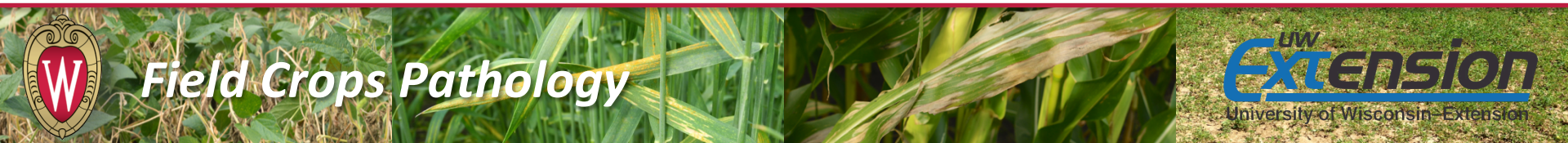
- No difference in yield or RFQ could be attributed to cutting timing for both Headline® and Quadris®

- In the 2011-2014 meta-analysis only Headline® resulted in an average yield increase of 0.11 tons/acre
- What about economics of applying Headline®?

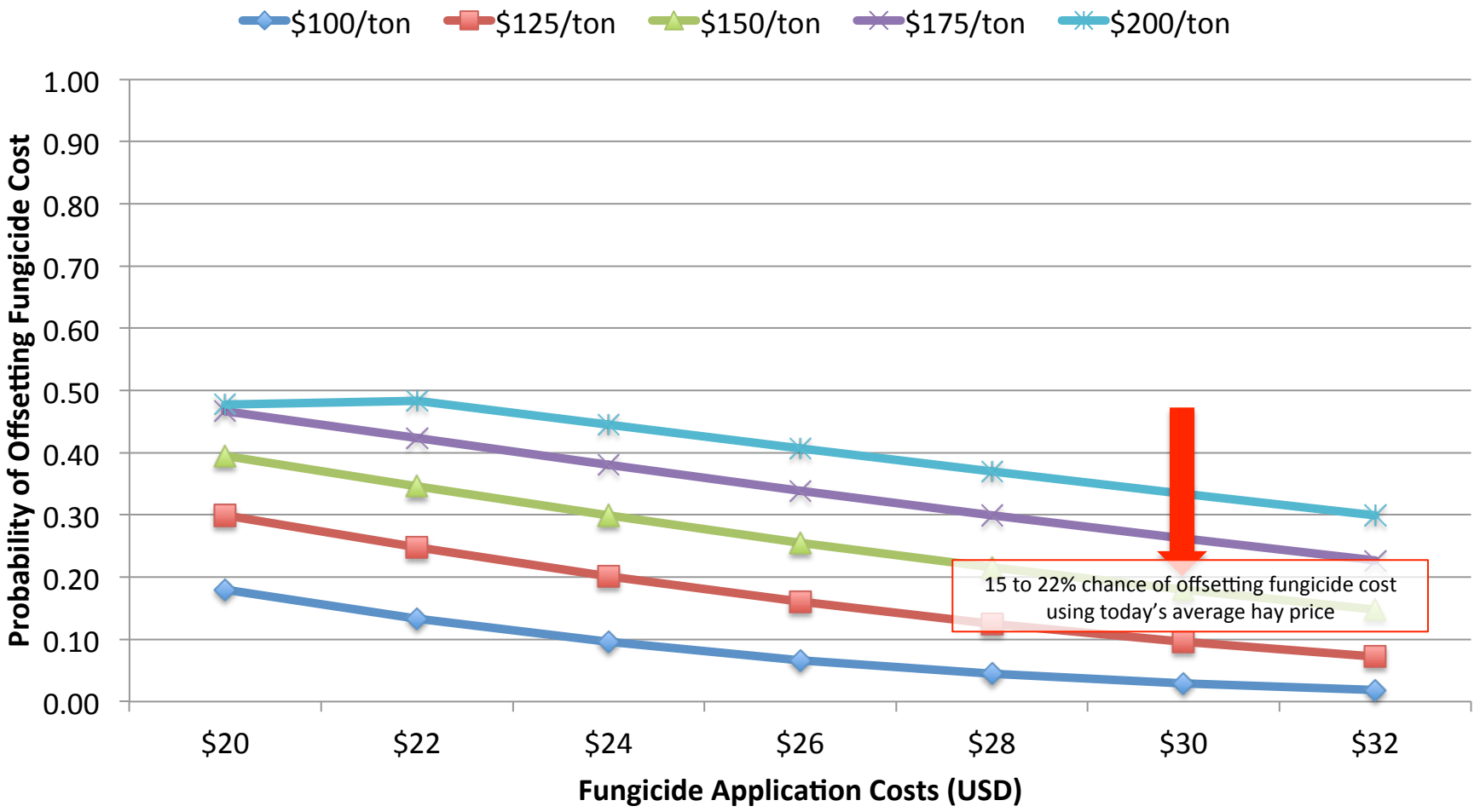
Break-Even Scenarios for Alfalfa (Tons/A)

January 12, 2015 Average Price
Large round bale (Prime Grade)

	Fungicide Application Cost ($/A)				
Alfalfa ($/Ton)	$20	$24	$28	$32	$36
$150	0.13	0.16	0.19	0.21	0.24
$200	0.10	0.12	0.14	0.16	0.18
$250	0.08	0.10	0.11	0.13	0.14
$300	0.07	0.08	0.09	0.11	0.12
$350	0.06	0.07	0.08	0.09	0.10
$400	0.05	0.06	0.07	0.08	0.09
$450	0.04	0.05	0.06	0.07	0.08
$500	0.04	0.05	0.06	0.06	0.07



Probability that a Headline® Fungicide application WILL offset the fungicide application costs



Summary

- In alfalfa for dairy production in Wisconsin, with low levels of disease, application of fungicide (specifically Headline®) :
  - Will result in highly variable yield and RFQ responses
  - Has little effect on yield and RFQ within a specific cutting time
  - Does sometimes result in a increase in yield over not treating when using Headline® (0.11 tons/a)
  - Will only pay for itself about 15 to 22% of the time

- Response to application of fungicide in alfalfa for beef production might be different
  - Longer cutting schedule might = more disease pressure
  - Have not examined response in this system

- Money might be better spent on a good quality variety, sound fertilizer program, and timely harvest rather than fungicide
  - Alfalfa genetics better than 30 years ago allowing for better disease tolerance, higher yields, and better quality

Questions?

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