Corn Foliar Fungicide Research Results, 2007-2009, University of Wisconsin and UW-Extension

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Introduction

High corn market prices have generated considerable interest in the use of foliar fungicides as a means of enhancing corn yield.

Because sufficient data does not exist in Wisconsin to support the use of foliar fungicides in corn, staff at the University of Wisconsin Cooperative Extension Service and UW College of Agricultural and Life Sciences initiated a coordinated effort to generate data from replicated on-farm and small plot trials.

Comparisons of Small Plot and On-Farm Trials: Both small plot and on-farm strip trials have advantages and disadvantages. Some advantages of small plot research include the ability to control variables such as soil type/texture, drainage, soil compaction and pest interactions. It also allows the researcher to evaluate several different treatments in a small area. However, the value of large scale on-farm research is that the previously mentioned variables are not singled out and those results better represent "real world" scenarios. It is this combination of approaches that are important for improving the research process.

In order to address the questions about economical foliar fungicide use in corn, two approaches have been taken. Small scale, replicated plot studies have been conducted using on-farm trials during the 2008 and 2009 growing seasons. These are in addition to multiple University farm trials that tests several questions about the effect of disease and hybrid on grain yield. Secondly, large scale, replicated on-farm research trials have also been conducted across the same period. In this report, the discussion will be done by the different types of plot design because of the differences in trial types and also variation.

Plot design

Large scale, on-farm strip trials. Large, on-farm strip trials have been conducted in several Wisconsin counties as highlighted in Tables 1-3 at the end of the document. Plots were maintained using the individual grower production practices and each plot was replicated from two to four times. In each trial, comparisons were made either between a single fungicide and the untreated check or multiple products (2007 only). Fungicides included: Quilt (azoxystrobin + propiconazole) that was examined in 2007 and 2009 and/or Headline (pyraclostrobin) that was examined in all three years. Fungicides were applied within the labeled rates at each location and were applied using ground application equipment at the VT (2007) or R1 (2008 and 2009) stage of corn development. Two foliar disease ratings (as percentage severity) were made, the first just prior to fungicide application and the second during early September to determine final disease levels. Typically, these ratings were done at the treatment level and not necessarily within all plots. At black layer, the incidence of stalk rot and stalk lodging was also obtained using a stalk nudge test (typically in early October).

Small scale research plots. On-farm small plot research trials were conducted during the 2008 and 2009 growing seasons in several counties in the western portion of Wisconsin as highlighted in Tables 4 and 5. In these trials, different questions were asked including multiple treatment comparisons and multiple fungicide timings. Products examined included Headline (pyraclostrobin) @ 6 ounces per acre, Stratego

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(propiconazole + trifloxystrobin) @ 10 ounces per acre, and Quilt (azoxystrobin + propiconazole) @ 14 ounces per acre. For single application or first application trials (for multiple timings), the fungicide timing was at VT-R1. In 2009 at Monroe and La Crosse County, an R3 application was also applied and this was done based on questions that were received during 2008 growing season about application timing for foliar fungicides.

For the small plot research trials, all plots were a minimum of 10 feet wide and 50 feet long and were sprayed using a CO_2 powered backpack sprayer and hand harvested.

Results

Large scale, on-farm strip trial.

2007 Results (Table 1, end of document). Five of the eleven fields included more than one fungicide. As a result, there were 17 fungicide comparisons with the untreated check. In only one of the eleven trials was there a significant increase in grain yield (Dane County, $P < 0.10$, +7 bu/A with fungicide application). However, it was also noted that grain moisture was higher (0.9% increase) at this location in the plots treated with a foliar fungicide and the increase in yield would not have been enough to pay for the fungicide + application costs as well as the additional drying costs based on 2007 market values of $4.00/bu corn, $6.00/a application costs, $20/A fungicide costs, and a drying cost of 5 cents/bushel for a yield of 161 bu/A. In terms of fungicide efficacy, there were differences noted between fungicide treated and the untreated check. In the untreated check, disease severity was 17%, while it was 7% in the fungicide treated plots.

Overall, grain moisture was inconsistently affected with the application of a foliar fungicide. In four trials, there was a higher grain moisture level at harvest in plots that had received a foliar fungicide (1.0%, 0.9%, 0.7% and 0.5%, respectively). The incidence of stalk lodging (represented as the percentage lodge) was also inconsistently affected with the application of a foliar fungicide. Of the seventeen possible product comparisons, 5 significantly reduced the percentage lodging, while in the other 13 comparisons, there was no evidence of an effect of foliar fungicides.

2008 Results (Table 2, end of document). In six of the nine trials, there was no evidence of a statistical yield advantage with the use of Headline. In two trials conducted in Green Lake County, there was a

statistical yield advantage with the application of fungicide (+24 and +6 bu/A, respectively). In the trial that had a +24 bu/A increase with the fungicide treatment, the severity level in the untreated check was 15% and included the following diseases: common rust, eyespot and Northern corn leaf blight. In the field trial where there was a +6 bu/A yield increase, disease severity was 8% in the untreated check and included common rust, eyespot and Northern corn leaf blight. In the LaCrosse trial, there was +10 bu/A difference between the Headline treated and the untreated check. This was one of the few trials where we saw a significant difference in grain yield in the absence of higher disease severity.

2009 Results (Table 3, end of document). Results from 2009 indicated that only in the Waupaca County trial was there a yield advantage with the application of a foliar fungicide (+16 bu/A). In this trial, there was also an increase in grain moisture (+1.2%) in the fungicide treated plots. Across all other parameters (pre and post application disease severity, stalk nudge test, top die back and stalk health) measured there was no evidence of a statistical difference between treated and untreated plots.

Small Scale Research Plot Results.

2008 Results (Table 4, end of document). In the small scale, on-farm research trials, there was no evidence of a statistical yield advantage with the use of a fungicide in any trial. In fact, in the Pepin County trial, there was a +28 bu/A difference for the untreated check compared to plots that had been

sprayed with Headline. Across all other measures there were no consistent trends in the .

2009 Results (Table 5, end of document). There was no evidence of a difference in grain yield with the R1 or R3 fungicide applications of Headline, Quilt or Stratego. While there were differences among treatments for grain moisture in the Monroe County trials, there was no clear trend with regards to those results.

Combined Analysis, 2007-2009 On-Farm Large Strip Trials. In order to most effectively understand when a foliar fungicide may be effective in corn grain production, we have examined our on-farm trial data to estimate the probability of a return on investment. We do this by asking the following question, "What is the probability that the observed yield difference between a fungicide treatment and the untreated check is greater than: 0, 2, 4, 6, 8, 10, 12 bu/A?" With the current corn grain commodity prices as well as the current foliar fungicide plus application costs (see next section), it may take approximately 6 to 8 bu/a to cover the cost of a treatment. Our current results indicate that the probability of a return on investment (averaged across all trials) is: 58, 51, 44, 35, 28, 23, and 19% for 0, 2, 4, 6, 8, 10, and 12 bu/A, respectively. When we stratified this data by trial type (large strip or small plot) we did not find any gross differences between the trial types nor did we see any dramatic differences by the type of active ingredient. Based on these results for Wisconsin, the probability of a return on investment for applying a foliar fungicide is low.

Economic Considerations for Using a Foliar Fungicide

Currently, it is being estimated that the cost of spraying a foliar fungicide in 2010 will be in the $20-30/A range (application cost plus fungicide product cost), depending on product. With the current corn commodity prices quite variable and hovering in the $3 to $4 per bushel range, Figure 1 is provided to show the necessary return in bushels per acre needed to cover the cost of foliar fungicides at different application and fungicide costs as well as different corn commodity prices.

Recommendations for use of Foliar Fungicides on Corn in 2010

Results of the on-farm trial network in WI has not found a consistent statistical yield benefit. Significantly higher stalk lodging was observed in the untreated plots at several locations; however, this did not translate into a yield reduction and more work is needed to quantify economical return for a reduction in stalk rot incidence.

Figure 1: Estimates on the number of bushels needed to cover the cost of a foliar fungicide application at different combinations of application and fungicide cost as well as different corn market values.

Application Cost	Fungicide Cost	Corn market value ($/bu)		
		2	4	6
6	10	8.0	4.0	2.7
6	15	10.5	5.3	3.5
6	20	13.0	6.5	4.3
6	25	15.5	7.8	5.2
8	10	9.0	4.5	3.0
8	15	11.5	5.8	3.8
8	20	14.0	7.0	4.7
8	25	16.5	8.3	5.5
10	10	10.0	5.0	3.3
10	15	12.5	6.3	4.2
10	20	15.0	7.5	5.0
10	25	17.5	8.8	5.8
12	10	11.0	5.5	3.7
12	15	13.5	6.8	4.5
12	20	16.0	8.0	5.3
12	25	18.5	9.3	6.2

Overall, the highest source of variation from our analyses occurs at the farm scale, indicating that other factors (e.g., hybrid resistance, soil type, farm management practices) may influence yield response.

Ultimately, the best management tactic for reducing the risk of corn diseases is the use of an IPM strategy that starts with hybrid selection for resistance to specific corn diseases. In addition, growers should consider other factors like crop rotation and residue management as part of the management program. Currently, we have seen the best yield response to a foliar fungicide application (both within Wisconsin and across the region) when disease severity has been higher (> 5%). Furthermore, timely field scouting and an assessment of environmental conditions (relative humidity, leaf wetness and temperature) are necessary to determine if the need for a fungicide is warranted.

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Useful References

Field Crops Plant Pathology, UW-Madison and UW-Extension, http://www.uwex.edu/ces/croppathology

Wisconsin Crop Manager, University of Wisconsin Integrated Pest and Crop Management, http://ipcm.wisc.edu/wcm

Summaries of Foliar Fungicide Trials in Wisconsin, Presented at the 2009 Wisconsin Crop Management Conference, Proceedings Available at http://www.soils.wisc.edu/extension/wfapmc

Summaries of the Wisconsin Corn Hybrid Performance Trials, http://corn.agronomy.wisc.edu

Tables 1-5 are on the following pages.

Table 1. Results of Large Scale On-Farm Corn Foliar Fungicide Trials 2007.

Year	Location (County)	Treatment [a]	Grain yield (bu/A)	Grain moisture (%)	Test weight (lb/bu) [c]	Percent lodging	Pre-spray disease severity (%)[e]	Post-spray disease severity (%)
2007	Chippewa	Untreated Check	42 a [b]	24.9	54.3	31 a	3	33
		Quilt @ 14	46 a	23.8	55.7	24 a		23
	Dane #1	Untreated Check	183 a	17.8 b	N/A [d]	12 a	3	3
		Quilt @ 14	191a	18.5 a	N/A	3 a		3
	Dane #2	Untreated Check	155 a	16.7 b	57.8	9 a	3	17
		Quilt @ 14	162 b	17.6 a	56.8	6 a		7
	Green Lake	Untreated Check	145 a	21.0 a	N/A	2 a	1	7
		Quilt @ 10	154 a	21.0 a	N/A	0 a		8
	La Crosse	Untreated Check	234 a	17.5 a	N/A	13 a	2	5
		Headline @ 10	243 a	17.6 a	N/A	10 a		5
	Ozaukee	Untreated Check	173 a	29.6 a	51.3	53 a	<1	10
		Headline @ 9	169 a	31.9 a	50.5	42 a		8
		Quilt @ 14	172 a	30.1 a	51.8	41 a		5
	Sheboygan	Untreated check	164 a	16.4 ab	56.0	76 a	<1	7
		Headline @ 9	168 a	16.2 b	56.5	52 b		4
		Quilt @ 14	166 a	16.6 a	56.3	43 b		5
	Washington	Untreated Check	202 a	16.7 b	55.6	40 a	<1	22
		Headline @ 9	202 a	17.2 a	55.4	3 a		15
		Quilt @ 14	202 a	16.6 b	55.5	25 a		12
	Monroe #1	Untreated Check	140 a	17.2 b	N/A	49 a	2	22
		Headline @ 6	143 a	17.5 a	N/A	31 a		15
		Quilt @ 14	144 a	18.0 b	N/A	39 a		12
	Monroe #2	Untreated Check	130 a	20.0 a	N/A	54 a	1	3
		Quilt @ 14	138 a	21.0 a	N/A	48 a		8
	Columbia	Untreated Check	182 a	N/A	N/A	18 a	1	2

		Headline @ 6	180 a	N/A	N/A	8 ab		2
		Quilt @ 14	189 a	N/A	N/A	11 ab		2
		Stratego @ 10	177 a	N/A	N/A	4 a		2

[a] Treatments are list with their respective rates in oz/A.
[b] Means followed by the same letter within each trial are not statistically different from one another based on Duncan's multiple range test (P=0.10).
[c] For test weight, values represent a combined sample for treated or untreated plots.
[d] N/A = Not Available
[e] For pre-spray and post-spray ratings, disease(s) was rated as single value across treated or untreated plots unless noted by letter designation as previously described where statistical comparisons could be made on replicated disease ratings.

Table 2. Results of Large Scale On-Farm Corn Foliar Fungicide Trials 2008.

Year	Location (County)	Treatment [a]	Grain yield (bu/A)	Grain moisture (%)	Test weight (lb/bu) [c]	Percent lodging	Pre-spray disease severity (%)[e]	Post-spray disease severity (%)
2008	Chippewa	Untreated Check	187 a [b]	N/A[d]	N/A	3.0 a	3	10
		Headline @12	186 a	N/A	N/A	3.7 a		10
	Dane	Untreated Check	205 a	24.3 a	N/A	N/A	N/A	N/A
		Headline @ 6	209 a	25.5 a	N/A	N/A		N/A
	Green Lake #1	Untreated Check	167 a	17.0 a	54.7	0 a	< 1	15
		Headline @ 6	191 b	18.1 a	54.5	0 a		15
	Green Lake #2	Untreated Check	207 a	20.2 a	53.7	0 a	< 1	8.0
		Headline @ 6	213 b	21.0 a	53.0	0 a		3.7
	Jefferson	Untreated Check	164 a	24.0 a	N/A	N/A	N/A	N/A
		Headline @ 6	160 a	24.5 a	N/A	N/A		N/A
	LaCrosse #1	Untreated Check	146 a	16.0 a	N/A	11.0 a	1	10
		Headline @ 6	160 a	16.4 a	N/A	9.0 a		5
	La Crosse #2	Untreated Check	218 a	21.9 a	N/A	9.5 a	1	2
		Headline @ 6	228 b	21.8 a	N/A	5.5 a		5
	Sheboygan	Untreated Check	154 a	23.1 a	51.3 a	10.5 a	< 1	2
		Headline @ 12	158 a	22.9 a	52.3 a	10.2 a		1
	Waupaca	Untreated Check	169 a	35.4 a	51.8 a	N/A	N/A	N/A
		Headline @ 6	171 a	33.0 a	52.3 a	N/A		N/A

[a] Treatments are list with their respective rates in oz/A.

[b] Means followed by the same letter within each trial are not statistically different from one another based on Duncan's multiple range test (P=0.10).

[c] For test weight, values represent a combined sample for treated or untreated plots. When there were replicated observations for test weight, statistical analyses were conducted.

[d] N/A = Not Available.

[e] For pre-spray and post-spray ratings, disease(s) was rated as single value across treated or untreated plots unless noted by letter designation as previously described where statistical comparisons could be made on replicated disease ratings.

Table 3. Results of Large Scale On-Farm Corn Foliar Fungicide Trials 2009.

Year	Location (County)	Treatment [a]	Grain yield (bu/A)	Grain moisture (%)	Test weight (lb/bu) [c]	Percent lodging	Pre-spray disease severity (%)[e]	Post-spray disease severity
2009	Dodge	Untreated Check	213 a	21.3 a	N/A	0.3 a	0	1.0
		Headline @ 6	222 a	21.4 a	N/A	0.0 a		1.0
	Sheboygan	Untreated Check	159 a	30.2	46.0	7.3 a	1	2.7
		Headline @ 6	150 a	30.1	46.7	8.7 a		0
	Washington	Untreated Check	166 a	22.5	50.0	11.7 a	1	5.0
		Headline @ 6	164 a	22.9	50.1	14.7 a		2.3
	Waupaca	Untreated Check	168 a	31.4 a	50.0 a	9 a	N/A	20 a
		Headline @ 6	183 b	32.6 a	50.1 a	6 a		18 a
	Columbia	Untreated Check	190 a	20.5	N/A	1.0 a	1	1.0
		Quilt @ 14	188 a	20.6	N/A	0.8 a		0.5

[a] Treatments are list with their respective rates in oz/A.
[b] Means followed by the same letter within each trial are not statistically different from one another based on Duncan's multiple range test (P=0.10).
[c] For test weight, values represent a combined sample for treated or untreated plots.
[d] N/A = Not Available.
[e] For pre-spray and post-spray ratings, disease(s) was rated as single value across treated or untreated plots unless noted by letter designation as previously described where statistical comparisons could be made on replicated disease ratings.

Table 4. Results of Small Scale On-Farm Foliar Fungicide Trials 2008.

Year	Location (County)	Treatment [a]	Grain yield (bu/A)	Grain moisture (%)	Test weight (lb/bu)	Percent lodging	Pre-spray disease severity (%)[c]	Post-spray disease severity
2008	Monroe #1	Untreated Check	183 a[b]	25.7 a	50.2 a	7 a	1	1
		Quilt @ 14	186 a	24.4 a	50.2 a	9 a		1
		Stratego @ 10	184 a	25.2 a	48.9 b	11 a		1
		Headline @ 6	191 a	25.2 a	48.1 b	6 a		1
	Monroe #2	Untreated Check	184 a	26.5 a	52.2 b	4 b	<1	1
		Quilt @ 14	186 a	22.4 a	53.3 ab	9 a		1
		Stratego @ 10	190 a	24.5 a	53.0 ab	6 b		1
		Headline @ 6	179 a	22.6 a	54.1 a	6 b		1
	Pepin	Untreated Check	227 a	22.8 a	53.8 a	19 b	1	1
		Quilt @ 14	216 ab	22.2 a	53.1 a	22 ab		2
		Stratego @ 10	212 ab	23.9 a	51.5 b	20 ab		3
		Headline @ 6	199 b	23.0 a	52.6 ab	24 a		3
	Trempealeau	Untreated Check	137 a	19.2 a	53.5 a	15 a	<1	N/A
		Quilt @ 14	107 a	21.3 a	51.4 b	20 a		N/A
		Stratego @ 10	135 a	20.2 a	52.6 ab	17 a		N/A
		Headline @ 6	123 a	21.0 a	51.7 b	23 a		N/A
	La Crosse	Untreated Check	217 a	21.6 a	54.3 a	6 a	1	4
		Quilt @ 14	225 a	20.4 a	54.8 a	7 a		2
		Stratego @ 10	217 a	21.2 a	53.8 a	5 a		3
		Headline @ 6	217 a	21.6 a	54.3 a	2 b		2

[a] Treatments are list with their respective rates in oz/A.

[b] Means followed by the same letter within each trial are not statistically different from one another based on Duncan's multiple range test (P=0.10).

[c] For pre-spray and post-spray ratings, disease(s) was rated as single value across treated or untreated plots unless noted by letter designation as previously described where statistical comparisons could be made on replicated disease ratings.

Table 5. Results of Small Scale On-Farm Foliar Fungicide Trials 2009.

Year	Location (County)	Treatment [a]	Grain yield (bu/A)	Grain moisture (%)	Test weight (lb/bu) [c]	Percent lodging	Pre-spray disease severity (%)[d]	Post-spray disease severity
2009	Buffalo	Untreated Check	155 a[b]	25.1 a	N/A	25 a	1	8
		Headline @ 6	156 a	25.9 a	N/A	19 a		6
		Quilt @ 14	153 a	25.5 a	N/A	26 a		4
		Stratego @ 10	162 a	25.7 a	N/A	19 a		3
	La Crosse	Untreated Check	166 a	30.0 a	N/A	1 a	< 1	7
		Headline @ 6	166 a	29.7 a	N/A	1 a		7
		Quilt @ 14	134 a	30.9 a	N/A	1 a		5
		Stratego @ 10	171 a	30.5 a	N/A	1 a		5
		Headline @ 6 at R3	164 a	30.6 a	N/A	1 a		5
	Pepin	Untreated Check	170 a	26.2 a	N/A	8 a	1	N/A
		Headline @ 6	175 a	26.4 a	N/A	5 a		N/A
		Quilt @ 14	160 a	26.5 a	N/A	10 a		N/A
		Stratego @ 10	170 a	25.5 a	N/A	10 a		N/A
	Monroe #1	Untreated Check	137 a	32.4 b	N/A	23 a	<1	5
		Headline @ 6	136 a	33.3 b	N/A	23 a		4
		Quilt @ 14	135 a	34.8 a	N/A	20 a		2
		Stratego @ 10	138 a	32.0 b	N/A	19 a		3
		Headline @ 6 at R3	140 a	32.6 b	N/A	21 a		4
	Monroe #2	Untreated Check	137 a	29.9 a	N/A	19 a	<1	1
		Headline @ 6	146 a	30.2 a	N/A	15 b		1
		Quilt @ 14	140 a	29.7 ab	N/A	12 c		1
		Stratego @ 10	144 a	28.4 b	N/A	13 c		1

[a] Treatments are list with their respective rates in oz/A.
[b] Means followed by the same letter within each trial are not statistically different from one another based on Duncan's multiple range test (P=0.10).
[c] N/A = Not available.
[d] For pre-spray and post-spray ratings, disease(s) was rated as single value across treated or untreated plots unless noted by letter designation as previously described where statistical comparisons could be made on replicated disease ratings.