A Three-Year Summary of Fungicide Trials for Rust

Brandt Berghuis[1], Michelle Gilley[1], Jessica Halvorson[1], Bryan Hansen[1], Scott Fitterer[2], Dave Carruth[2], Blaine Schatz[3], Mark Halvorson[3], and Samuel Markell[1]

[1]Department of Plant Pathology, North Dakota State University, Fargo, ND, USA
[2]BASF North Dakota Farm, Davenport, ND
[3]Carrington Research Extension Center, Carrington, ND.

Introduction

Sunflower rust is caused from the fungal pathogen *Puccinia helianthi*. This disease is an economically important disease to sunflowers and yield losses can occur in all sunflower production regions in the United States. Foliar fungicides are an essential tool to reduce disease severity and mitigate yield loss of sunflower rust (Friskop et al. 2011). Research on confection hybrids indicates that the action threshold for spraying is 1% disease severity on the upper four fully expanded leaves at or before R5 (Friskop et al. 2015). Since the time of this study, additional fungicides have been labeled and their efficacy on oil seed and confection sunflower hybrids needs to be evaluated.

In 2016, we began a three-year study to evaluate fungicides for the management of rust on oil seed and confection sunflower hybrids. We present results on all three years. 2016 and 2017 results were previously presented at NSA research forum (Berghuis et al, 2016; Berghuis et al, 2017).

Materials and Methods

Between the years 2016-2018, fungicide trials were established to evaluate fungicides for the management of rust in Davenport ND, Leonard ND, Rothsay MN, and Carrington ND. In 2016, two trials were established in both Rothsay, MN and Leonard, ND. In 2017, two trials were established in both Davenport, ND and Carrington, ND. In 2018, two trials were established in Davenport, ND. Each location across all years had two separate experiments that consisted of one oil seed hybrid and one confection hybrid. All experiments were arranged in four-row plots in a randomized complete block design (RCBD). To facilitate an epidemic, urediniospores were suspended in Soltrol 170 mineral oil and inoculated at growth stages R2 and R4 using a modified leaf blower. Trials were designed with 11 fungicide treatments that included new, generic and pre-mixtures from three fungicide groups; demethylation inhibitors (FRAC 3/DMI/triazoles), succinate dehydrogenase inhibitors (FRAC 7/SDHI/carboxamides) and quinone outside inhibitors (FRAC 11/QoI/Strobilurins). Fungicides were applied at R-5.1 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were conducted by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R6 and R7 (Friskop et al 2011). A complete list of fungicide treatments is found in table 1.

In 2016, rust was established at both locations, with trials at Leonard, ND having greater disease severity than those at Rothsay, MN (Table 2-5). Rust severity on the susceptible (confection) hybrid Non-Treated Control's (NTC's) at R7 was 15.9% and 2.3% in Leonard, ND and Rothsay, MN, respectively. Rust severity on the moderately resistant (oilseed) hybrid Non-Treated

Control's (NTC's) at R7 was 2.0% and 0.6% in Leonard, ND and Rothsay, MN, respectively. Disease severity on the NTC plots in all trials was statistically higher than all fungicide-treated plots, except for Vertisan at 10 oz on the moderately resistant hybrid in Rothsay, MN and on the susceptible hybrid in Leonard, ND. Reduction in disease severity was generally consistent amoung FRAC groups for new, generic, and/or premixed fungicides. Fungicides that were most efficacious had DMI or QoI modes of action. A rate response was observed with Vertisan treatments with higher rates offering more control.

In 2017, rust was established at both locations, with trials at Davenport, ND having greater disease severity than those at Carrington, ND. Rust severity on oil seed hybrid on the NTC's at R7 was 0.2% and 2.8% in Carrington, ND and Davenport, ND, respectively. Rust severity on the confection hybrid on the NTC at R7 was 1.6% and 17.5% in Carrington, ND and Davenport, ND, respectively. Disease severity on the NTC plots in all trials was statistically higher than all fungicide-treated plots, except for Aproach on an oil seed hybrid in Carrington, ND, Aproach and Vertisan (20 fl oz/a) on confection hybrid in Carrington, ND and Vertisan (10 fl oz/a) on confection in Davenport, ND. Efficacy of fungicides generally was consistent within their respective FRAC groups. The most efficacious fungicides had DMI or QoI modes of action.

In 2018, rust was established in Davenport, ND on both the oilseed and confection sunflower hybrid trials. The confection hybrid trial in Davenport had greater disease severity than the confection hybrid in Carrington, ND. Rust severity on the NTC's at R7 was 0.4% and 10.3% on the oil seed and confection hybrid respectively. Disease severity on the NTC plots in the confection trial was statistically higher than in all fungicide-treated plots. Even with a lower disease severity on the oilseed hybrid, eight fungicides had statistically lower disease values. A rate response was observed with Vertisan treatments. The most efficacious fungicides had DMI or QoI modes of action.

This three year study 2016-2018 concluded with 10 trials. Across every trial there were statistical differences amoung fungicides in managing rust across all years. Generally, the most efficacious fungicides had DMI or QoI modes of action. Statistical differences were observed in yield data but not consistent throughout the trials. This is most likely attributed to impact of other pathogens and other environmental factors (i.e. hail damage and high winds).

Table 1. Treatments, FRAC group, rate, and active ingredients used in trials 2016-2018.

Treatments	Active Ingredient	FRAC Group	Rate (fl oz)
Non-treated Control	NA	NA	NA
Onset	Tebuconazole	3	4
Orius	Tebuconazole	3	4
TebuStar	Tebuconazole	3	4
Headline	Pyraclostrobin	11	6
Quadris	Azoxystrobin	11	6
Aproach	Picoxystrobin	11	6
Vertisan	Penthiopyrad	7	10
Vertisan	Penthiopyrad	7	20
Aproach Prima	Picoxystrobin, Cyproconazole	11+3	3.4
Priaxor	Fluxapyroxad, Pyraclostrobin	7+11	4
Priaxor + Onset	Fluxapyroxad, Pyraclostrobin, Tebuconazole	7+ 11, 3	4+2

Table 2. Sunflower rust severity at R6 and R7 for moderately resistant in Leonard, ND in 2016

				1st rating at R6	2nd Rating at R7		
No.	Fungicide*	Active Ingredient	Rate (fl oz/a)	Severity %	Severity %		Yield
1	NTC	…	…	0.18	2.0	a	4967
2	Onset	Tebuconazole	4	0.10	0.42	bc	4729
3	Orius	Tebuconazole	4	0.08	0.67	bc	5100
4	Tebustar	Tebuconazole	4	0.04	0.46	bc	4803
5	Headline	Pyraclostrobin	6	0.05	0.29	bc	4989
6	Quadris	Azoxystrobin	6	0.04	0.21	c	4933
7	Aproach	Picoxystrobin	6	0.08	0.49	bc	4866
8	Vertisan	Penthiopyrad	10	0.09	0.71	b	4582
9	Vertisan	Penthiopyrad	20	0.14	0.59	bc	4962
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	0.07	0.45	bc	4990
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	0.08	0.35	bc	5017
12	Priaxor+Onset	Pyraclostrobin, Tebuconazole	4, 2	0.05	0.23	bc	5048
LSD P=0.05							

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 3. Sunflower rust severity at R6 and R7 for Susceptible in Leonard, ND in 2016

				1st rating at R6		2nd Rating at R7	
No.	Fungicide*	Active Ingredient	Rate (fl oz/a)	Severity %		Severity %	
1	NTC	…	…	1.86	a	15.88	a
2	Onset	Tebuconazole	4	0.74	cd	3.25	d
3	Orius	Tebuconazole	4	0.55	d	2.24	d
4	Tebustar	Tebuconazole	4	1.11	bcd	3.99	cd
5	Headline	Pyraclostrobin	6	1.04	bcd	5.70	bcd
6	Quadris	Azoxystrobin	6	0.62	d	4.05	cd
7	Aproach	Picoxystrobin	6	0.99	bcd	9.03	b
8	Vertisan	Penthiopyrad	10	1.54	ab	14.75	a
9	Vertisan	Penthiopyrad	20	1.15	bcd	8.18	bc
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	0.78	cd	3.90	cd
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	1.38	abc	9.54	b
12	Priaxor+Onset	Pyraclostrobin, Tebuconazole	4, 2	0.69	d	2.99	d
LSD P=0.05							

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 4. Sunflower rust severity at R6 and R7 for moderately resistant in Rothsay, MN in 2016

				1st rating at R6	2nd Rating at R7	
No.	Fungicide*	Active Ingredient	Rate (fl oz/a)	Severity %	Severity %	
1	NTC	…	…	0.03	0.58	a
2	Onset	Tebuconazole	4	0.01	0.08	d
3	Orius	Tebuconazole	4	0.01	0.06	d
4	Tebustar	Tebuconazole	4	0.03	0.07	d
5	Headline	Pyraclostrobin	6	0.03	0.19	cd
6	Quadris	Azoxystrobin	6	0.01	0.09	d
7	Aproach	Picoxystrobin	6	0.02	0.29	bc
8	Vertisan	Penthiopyrad	10	0.03	0.44	ab
9	Vertisan	Penthiopyrad	20	0.03	0.34	bc
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	0.02	0.21	cd
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	0.02	0.14	cd
12	Priaxor+onset	Pyraclostrobin, Tebuconazole	4, 2	0.02	0.07	d
LSD P=.05						

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 5. Sunflower rust severity at R6 and R7 for susceptible in Rothsay, MN in 2016

				1st rating at R6		2nd Rating at R7	
No.	Fungicide*	Active Ingredient	Rate (fl oz/a)	Severity %		Severity %	
1	NTC	…	…	0.56	a	2.30	a
2	Onset	Tebuconazole	4	0.14	de	0.35	de
3	Orius	Tebuconazole	4	0.14	de	0.24	de
4	Tebustar	Tebuconazole	4	0.19	cde	0.23	de
5	Headline	Pyraclostrobin	6	0.32	b	0.55	cde
6	Quadris	Azoxystrobin	6	0.10	e	0.19	e
7	Aproach	Picoxystrobin	6	0.23	bcd	0.80	c
8	Vertisan	Penthiopyrad	10	0.45	a	1.72	b
9	Vertisan	Penthiopyrad	20	0.27	bc	1.38	b
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	0.16	cde	0.58	cde
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	0.19	cde	0.63	cd
12	Priaxor+Onset	Pyraclostrobin, Tebuconazole	4, 2	0.14	de	0.19	de
LSD P=.05							

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 6. Sunflower rust severity at R7 and yield for eleven different fungicide treatments at Carrington Research Extension Center on a confection hybrid in 2017.

				2nd Rating at R7		
No.	Fungicide	Active Ingredient	Rate (fl oz/a)	Severity %		Yield (lb/ac)
1	NTC	…	…	1.55	A	484.0
2	Onset	Tebuconazole	4	0.13	E	625.2
3	Orius	Tebuconazole	4	0.17	E	721.4
4	Tebustar	Tebuconazole	4	0.17	E	746.6
5	Headline	Pyraclostrobin	6	0.56	CDE	662.5
6	Quadris	Azoxystrobin	6	0.29	DE	800.8
7	Aproach	Picoxystrobin	6	1.20	AB	712.1
8	Vertisan	Penthiopyrad	10	0.96	BC	791.4
9	Vertisan	Penthiopyrad	20	1.14	AB	623.6
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	0.54	CDE	749.5
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	0.85	BCD	576.3
12	Priaxor+Onset	Pyraclostrobin, Tebuconazole	4, 2	0.21	E	586.7
LSD P=0.05						

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 7. Sunflower rust severity at R7 and yield for eleven different fungicide treatments at Carrington Research Extension Center on a oil seed hybrid in 2017.

				2nd Rating at R7		
No.	Fungicide	Active Ingredient	Rate (fl oz/a)	Severity %		Yield (lb/ac)
1	NTC	…	…	0.24	A	1676.8
2	Onset	Tebuconazole	4	0.05	E	1743.2
3	Orius	Tebuconazole	4	0.05	E	1479.9
4	Tebustar	Tebuconazole	4	0.05	E	2095.6
5	Headline	Pyraclostrobin	6	0.12	CD	1833.6
6	Quadris	Azoxystrobin	6	0.15	BCD	1956.3
7	Aproach	Picoxystrobin	6	0.21	AB	2063.1
8	Vertisan	Penthiopyrad	10	0.17	BCD	1693.4
9	Vertisan	Penthiopyrad	20	0.18	BC	1688.3
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	0.15	CD	1522.6
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	0.11	D	1613.1
12	Priaxor+Onset	Pyraclostrobin, Tebuconazole	4, 2	0.05	E	1715.7
LSD P=0.05						

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 8. Sunflower rust severity at R7 and yield for eleven different fungicide treatments at BASF North Dakota Research Farm in Davenport, ND on a confection hybrid in 2017.

				2nd Rating at R7		
No.	Fungicide	Active Ingredient	Rate (fl oz/a)	Severity %		Yield (lb/ac)
1	NTC	…	…	17.50	A	2456.3
2	Onset	Tebuconazole	4	0.61	EF	2682.5
3	Orius	Tebuconazole	4	0.47	F	2497.3
4	Tebustar	Tebuconazole	4	0.82	EF	2647.9
5	Headline	Pyraclostrobin	6	7.85	CD	2864.7
6	Quadris	Azoxystrobin	6	4.75	DE	2696.8
7	Aproach	Picoxystrobin	6	11.75	BC	2546.6
8	Vertisan	Penthiopyrad	10	13.87	AB	2471.5
9	Vertisan	Penthiopyrad	20	11.10	BC	2486
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	4.29	DE	2639.4
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	9.47	C	2710
12	Priaxor+Onset	Pyraclostrobin, Tebuconazole	4, 2	0.83	EF	2801.2
LSD P=0.05						

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 9. Sunflower rust severity at R7 and yield for eleven different fungicide treatments at BASF North Dakota Research Farm in Davenport, ND on a oil seed hybrid in 2017.

				2nd Rating at R7		
No.	Fungicide	Active Ingredient	Rate (fl oz/a)	Severity %		Yield (lb/ac)
1	NTC	…	…	2.80	A	2886.9
2	Onset	Tebuconazole	4	0.17	C	3086
3	Orius	Tebuconazole	4	0.21	C	3109
4	Tebustar	Tebuconazole	4	0.12	C	3023.9
5	Headline	Pyraclostrobin	6	0.77	BC	3151.7
6	Quadris	Azoxystrobin	6	1.01	B	3096.5
7	Aproach	Picoxystrobin	6	1.27	B	3238.6
8	Vertisan	Penthiopyrad	10	1.11	B	3036.7
9	Vertisan	Penthiopyrad	20	1.00	B	3188.5
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	1.02	B	3124.2
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	1.11	B	3248.5
12	Priaxor+Onset	Pyraclostrobin, Tebuconazole	4, 2	0.14	C	3302.8
LSD P=0.05						

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 10. Sunflower rust severity at R7 and yield for eleven different fungicide treatments at BASF North Dakota Research Farm in Davenport, ND on a oil seed hybrid in 2018.

				2nd Rating at R7		
No.	Fungicide	Active Ingredient	Rate (fl oz/a)	Severity %		Yield (lb/ac)
1	NTC	…	…	.39	AB	2601.8
2	Onset	Tebuconazole	4	.13	C	2789.1
3	Orius	Tebuconazole	4	.13	C	2592.3
4	Tebustar	Tebuconazole	4	.14	C	2691.5
5	Headline	Pyraclostrobin	6	.32	AB	2380.0
6	Quadris	Azoxystrobin	6	.25	BC	2779.8
7	Aproach	Picoxystrobin	6	.28	BC	2723
8	Vertisan	Penthiopyrad	10	.48	A	2575.8
9	Vertisan	Penthiopyrad	20	.28	BC	2824.4
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	.28	BC	2671.6
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	.38	AB	2657.4
10	Priaxor + Onset	Pyraclostrobin, Tebuconazole	4, 2	.13	C	2631.2
LSD P=0.05						

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

Table 11. Sunflower rust severity at R7 and yield for eleven different fungicide treatments at BASF North Dakota Research Farm in Davenport, ND on a confection hybrid in 2018.

				2nd Rating at R7		
No.	Fungicide	Active Ingredient	Rate (fl oz/a)	Severity %		Yield (lb/ac)
1	NTC	…	…	10.17	A	2250.5
2	Onset	Tebuconazole	4	.29	D	2733.7
3	Orius	Tebuconazole	4	.19	D	2801.4
4	Tebustar	Tebuconazole	4	.21	D	2603.1
5	Headline	Pyraclostrobin	6	1.60	CD	2867.3
6	Quadris	Azoxystrobin	6	.46	D	3018.6
7	Aproach	Picoxystrobin	6	2.82	BCD	2609.4
8	Vertisan	Penthiopyrad	10	4.6	B	2571.6
9	Vertisan	Penthiopyrad	20	4.46	BC	2376.4
10	Aproach Prima	Picoxystrobin, Cyproconazole	3.4	.65	D	2387.1
11	Priaxor	Fluxapyroxad, Pyraclostrobin	4	1.61	CD	2773.8
12	Priaxor + Onset	Pyraclostrobin, Tebuconazole	4, 2	.20	D	2946.7
LSD P=0.05						

Fungicides were applied at R5 to the center two rows (row 2 and 3) using a backpack sprayer and 8002 nozzle tips at 20 gal/ac. Disease severity values were concluded by evaluating the top four leaves of ten arbitrarily selected plants at growth stages R7.

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