Sunflower (*Helianthus annuus*)

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Managing Sunflower Rust (*Puccinia helianthi*) in Early Onset Epidemics with Fungicides in North Dakota: 2010

MATERIALS AND METHODS

Fungicide trials conducted in 2010 are the first half of a two year study. Similar trials were conducted in 2008 and 2009. However, the 2010 trials focused on developing fungicide management strategies for early onset sunflower rust epidemics. The 2010 results will be presented in this report.

Nine to twenty fungicide programs and timings were evaluated for efficacy of early onset sunflower rust management at four locations in ND; namely, Carrington Research Extension Center (CREC), Cenex Harvest States in Grandin (CHS), Langdon Research Extension Center (LREC), and Vision Research Park near Mohall (VRP). Fungicide treatments were divided into two categories: timing treatments and fungicide programs. The timing treatments comprised of two fungicides; pyraclostrobin (Headline, BASF) and tebuconazole (Folicur, Bayer CropScience). These two fungicides were applied singularly or sequentially at three timings; V8-V12, R1, or R5.2-R5.5. Pyraclostrobin was incorporated at every location, while Tebuconazole was only included at the CHS plot. The fungicide programs involved a series of two fungicide applications applied at R1 and R5.2-R5.5. Additionally, at least one non-treated control was included at each location to serve as basis of comparison. All experimental trials were arranged in a randomized complete block design. Four-row plots were sown at CREC (27 May), CHS (XX), and LREC (19 May), while the VRP location was conducted within a producer's confection sunflower field (21 May). CREC, CHS, and LREC were seeded with the confection hybrid 'Jaguar' on 30-inch rows. Row length was 15 ft at the LREC and 25 ft at CREC, Grandin, and VRP. Fertilizers, herbicides, and/or insecticides were used as needed according to recommended sunflower production practices (Berglund, 2007).

Urediniospores of *Puccinia helianthi* isolate ND07-01 (race 336) were produced on susceptible sunflower hybrids grown in greenhouse conditions and harvested in May and June 2010, ensuring fresh viable spores. Urediniospores were quantitated to approximately 275,000 spores/ml in a soltrol 170 suspension and inoculated at CREC, CHS and LREC using a modified leaf blower. VRP relied on the presence of a natural rust infection (no artificial inoculation). All treatment rows were inoculated at CREC on 21 June. CHS and LREC treatment rows were inoculated on 29 June and 24 June, respectively. Moisture was applied as needed in the form of pivot irrigation at CREC. CHS, LREC, and VRP did not utilize any irrigation system. Disease was evaluated as the average percent leaf area covered by pustules, with the aid of assessment diagrams (Gulya et al. 1990), on the upper four leaves of ten randomly selected plants in each plot according to Shtienberg (1995). For analysis purposes, 'trace' levels of rust (>0 to 0.1%) were considered zero. Disease was evaluated at approximately R1, R3-4, R6, R-7 at CREC, R3, R5.1, R6 at CHS, R1, R4-5, R6, R6-7 at LREC, and at R3, R5.1, R6, R9 at VRP. Additionally, an early disease evaluation was performed in the late vegetative stage at CREC, LREC, and CHS using a modified evaluation technique (no statistical differences - data not shown). Yield data was obtained from the center two rows of each plot during harvest.

Fungicide Timing Treatments. To assess effectiveness of fungicide applications at different timings, fungicide applications were made singularly and sequentially. Fungicides were applied singularly at three growth stages: V8-V12, R1, or R5.2-R5.2-R5.5. Sequential treatments consisted of applications completed at V8-V-12 and R1, V8-V12 and R5.2-R5.5, R1 and R5.2-5.5, or at all three growth stages. Therefore, three singular applications and four sequential applications were utilized. Additionally, 0.25% NIS was incorporated into each fungicide application. VRP had a modified spraying program to accommodate disease progression (similar pattern except at R3, R5.2-R5.5, and R6). At all locations, 6.0 fl oz/A of Headline was used, while 4.0 fl oz/A of Folicur was at CHS. Fungicide application dates were 2 July, 12 July, and 5 August at CREC, 9 July, 30 July, and 10 August at CHS, 1 July, 13 July, and 2 August at LREC, and 28 July, 6 August, and 25 August at VRP.

Fungicide Programs. The efficacy of multiple spraying programs was evaluated at each test plot location. Two individual fungicides were applied sequentially at R1 and R5.2-R5.5. Spraying program was designed to protect the upper leaf canopy of the sunflower plant. Programs evaluated are listed below:

4.0 fl oz/A tebuconazole (Folicur, Bayer CropScience) and
10.3 fl oz/A prothioconazole + prothioconazole & fluopyram (Propulse, Bayer CropScience)

6.0 fl oz/A pyraclostrobin (Headline, BASF) and Experimental

20.0 fl oz/A penthiopyrad (Vertisan, DuPont) and 9.0 fl oz/A picoxystrobin (Aproach, DuPont)

6.0 fl oz/A pyraclostrobin (Headline, BASF) and 3.0 dry oz/A metconazole (Quash, Valent)

4.0 fl oz/A propiconazole (Tilt, Syngenta) and 6.2 fl oz/A azoxystrobin (Quadris, Syngenta)

4.0 fl oz/A tebuconazole (Folicur, Bayer CropScience) and 6.0 fl oz/A pyraclostrobin (Headline, BASF)

6.0 fl oz/A pyraclostrobin (Headline, BASF) and 6.0 fl oz/A pyraclostrobin (Headline, BASF)

4.0 fl oz/A tebuconazole (Folicur, Bayer CropScience) and 4.0 fl oz/A tebuconazole (Folicur, Bayer CropScience)

Each location incorporated all or some of these programs. All fungicide timings and programs were applied with backpack sprayers at 13 gpa at CREC, 20 gpa at CHS, 9.2 gpa at LREC, and 15 gpa at VRP. Application dates were 12 July and 5 August at CREC, 30 July and 10 August at CHS, 13 July and 2 August at LREC, and 6 August and 25 August at VRP.

Data analysis. Area under disease progress curve (AUDPC) and relative area under disease progress curve (rAUDPC) were calculated for each location. PROC GLM in SAS v. 9.2 was used for each rating date, AUDPC, rAUDPC, and yield. LSD mean separations were obtained at $P \leq 0.05$.

RESULTS

Disease progression varied among each location, however no location exhibited an “early” disease onset epidemic. This could be attributed to cool weather conditions occurring in late June/early July. Low levels of rust were first recorded on the lower leaves on 7 July for CREC, 28 July for CHS, 7 July for LREC, and 28 July for VRP. Disease intensity was greatest at VRP and lowest at CHS. Yield was not obtained at CREC and CHS.

CREC Location. All timing treatments had statistically lower AUDPC values than the non-treated control. Specifically, any treatment including timing 3 had numerically lower AUDPC values compared to other timing treatments. This suggests the importance of the T3 application for this disease progression. With regards to the fungicide programs, every program effectively reduced disease intensity. The Folicur and Propulse program yielded the lowest AUDPC value, while Vertisan and Picoxystrobin had the highest AUDPC value. As mentioned previously, yield data was not obtained due to extensive damage caused by sunflower midge.

CHS Location. The amount of fungicides evaluated was greatest at the CHS location. In addition to Headline, Folicur was also evaluated for timing efficacy. A single application at timing 1, regardless of chemical, resulted in the highest AUDPC value. Most of the other timings significantly reduced the amount of disease. The fungicide program of Vertisan and Picoxystrobin had a statistically higher AUDPC value compared to the other fungicide programs. Yield data was not obtained due to abnormal high winds causing lodging within the plot.

LREC Location. The lowest AUDPC values for the timing treatments were for the sequential applications of T1,T2,T3 and for T1,T3. The fungicide programs all had significantly lower AUDPC values than the non-treated control. The lowest AUDPC value was recorded for the fungicide combination of Folicur and Propulse. All of the timing treatments had yield statistically similar to the non treated control. Some of the fungicide programs had significantly higher yield than the non-treated control.

VRP Location. The highest amount of disease pressure occurred at the VRP location. All treatments had lower AUDPC values than the non-treated control, with the exception of a Headline application at T3. Based off this disease progression, the most efficacious single application is at the R5+ stage. The sequential timing treatment of T1, T2, T3 provided the lowest AUDPC values. The highest yield was obtained for Headline at T2, while the non-treated control had the lowest yield.

Overall, data suggests a single V8-V12 fungicide application may not be effective in controlling rust (based off 2010 disease progression). An application at R5-R5.5 is considered to be an important application for sunflower rust management. The initiation of a spraying program effectively reduces the amount of disease pressure imposed on sunflowers.

Although the 2010 data reinforces previous recommendations on normal disease onset of rust, early epidemic recommendations still need to be evaluated. Artificial inoculation will be completed in the early vegetative stages to accommodate the presence of an early onset epidemic. Providing the environment is suitable for an early rust disease progression, 2011 trials will provide answers on the management of early onset rust.

SELECTED LITERATURE

Berglund, D. R. 2008. 2007 National Sunflower Association Survey: yield, cultural practices and yield limiting factors. http://www.sunflowernsa.com/research/researchworkshop/documents/Berglund_2007_NSA_Survey_08.pdf

Gulya et al. 1990. Sunflower Rust – NDSU Cooperative Extension Service Publication. PP-998

Shtienberg, D. 1995. Rational suppression of sunflower rust: Development and evaluation of an action threshold. Plant Disease 79:506-510.

Table 1. Sunflower Rust Fungicide Trials – Carrington Research and Extension Center

				Disease Severity				
	CARRINGTON 10		7/7/2010	7/29/2010	8/18/2009	8/31/2010		
	SF RUST FUNGICIDE TRIAL		~R1	R3-R4	R6	R7		
ID	Treatment	Timing	r0	r1	r2	r3	AUDPC	rAUDPC
1	Non-treated Control		0 a	0.52 a	3.98 a	7.33 a	124.02 a	0.0226 a
2	Headline @ 6.0 fl oz	1	0 a	0.14 bc	1.94 b	5.43 ab	70.07 b	0.0127 b
3	Headline @ 6.0 fl oz	1,2	0 a	0.10 bc	1.51 b	3.99 bc	52.92 bc	0.0010 bc
4	Headline @ 6.0 fl oz	1,3	0 a	0.16 bc	0.96 b	1.48 de	28.72 c	0.0052 c
5	Headline @ 6.0 fl oz	1,2,3	0 a	0.04 c	0.94 b	1.63 de	26.77 c	0.0049 c
6	Headline @ 6.0 fl oz	2	0 a	0.13 bc	1.25 b	3.38 dc	45.24 bc	0.0082 bc
7	Headline @ 6.0 fl oz	2,3	0 a	0.08 bc	1.08 b	1.33 e	28.03 c	0.0051 c
8	Headline @ 6.0 fl oz	3	0 a	0.30 ab	1.48 b	2.18 dce	44.83 bc	0.0082 bc
9	Folicur @ 4.0 fl oz, Propulse @ 10.3 fl oz	2,3	0 a	0.15 bc	0.83 b	1.33 e	25.27 c	0.0046 c
10	Headline @ 6.0 fl oz, Confidential	2,3	0 a	0.08 bc	0.93 b	1.41 e	26.07 c	0.0047 c
11	Vertisan @ 20.0 fl oz, Picoxystrobin @ 9.0 fl oz	2,3	0 a	0.18 bc	1.31 b	2.25 dce	40.11 bc	0.0073 bc
12	Headline @ 6.0 fl oz, Quash @ 3.0 fl oz	2,3	0 a	0.17 bc	1.31 b	1.70 de	36.17 c	0.0066 c
LSD $_{P=0.05}$			0	0.26	1.22	1.93	31.66	0.0058

*Yield was not obtained due to extensive sunflower insect damage.

Table 2a. Sunflower Rust Fungicide Trials – Cenex Harvest States Grandin – Timing Applications

	GRANDIN 2010		
	SF RUST FUNGICIDE TRIAL		
ID	Treatment	Timing	AUDPC
2	Headline @ 6.0 fl oz	1	42.86 a
3	Headline @ 6.0 fl oz	1,2	15.43 b
4	Headline @ 6.0 fl oz	1,3	14.59 b
5	Headline @ 6.0 fl oz	1,2,3	7.65 b
6	Headline @ 6.0 fl oz	2	36.02 a
7	Headline @ 6.0 fl oz	2,3	7.43 b
8	Headline @ 6.0 fl oz	3	14.33 b
9	Folicur @ 4.0 fl oz	1	50.64 a
10	Folicur @ 4.0 fl oz	1,2	8.40 b
11	Folicur @ 4.0 fl oz	1,3	10.44 b
12	Folicur @ 4.0 fl oz	1,2,3	5.25 b
13	Folicur @ 4.0 fl oz	2	6.17 b
14	Folicur @ 4.0 fl oz	2,3	6.25 b
15	Folicur @ 4.0 fl oz	3	13.99 b
LSD $_{P=0.05}$			14.97

*Yield was not obtained due to extreme weather conditions (high wind caused lodging).

Table 2b. Sunflower Rust Fungicide Trials – Cenex Harvest States Grandin – Spraying Programs

			Disease Severity				
	GRANDIN 2010		7/28/2010	8/6/2010	8/25/2010		
	SF RUST FUNGICIDE TRIAL		R3	R5.1	R6		
ID	Treatment	Timing	r0	r1	r2	AUDPC	rAUDPC
17	Folicur @ 4.0 fl oz, Propulse @ 10.3 fl oz	2,3	0 a	0 c	0.59 c	6.17 c	0.0014 c
18	Headline @ 6.0 fl oz, Confidential	2,3	0 a	0.01 b	0.70 c	7.56 c	0.0017 c
19	Vertisan @ 20.0 fl oz, Picoxystrobin @ 9.0 fl oz	2,3	0 a	0.04 b	2.48 b	26.94 b	0.0060 b
20	Headline @ 6.0 fl oz, Quash @ 3.0 fl oz	2,3	0 a	0.04 b	0.55 c	6.73 c	0.0015 c
21	Tilt @ 4 fl oz, Quadris @ 6.2 fl oz	2,3	0 a	0.04 b	0.93 c	10.61 c	0.0023 c
22	Folicur @ 4.0 fl oz, Headline @ 6.0 fl oz	2,3	0 a	0.01 b	0.50 c	5.36 c	0.0012 c
23	Non-treated Control		0 a	0.17 a	7.25 a	80.01 a	0.0178 a
LSD $_{P=0.05}$			0	0.09	1.14	12.52	0.0028

*Yield was not obtained due to extreme weather conditions (high wind caused lodging).

Table 3. Sunflower Rust Fungicide Trials – Langdon Research and Extension Center

				Disease Severity					
	LANGDON 2010		7/7/2010	7/29/2010	8/11/2010	8/24/2010			
	SF RUST FUNGICIDE TRIAL		~R1	R4-R5	R6	R6-R7			
ID	Treatment	Timing	r0	r1	r2	r3	AUDPC	rAUDPC	Yield (lb/A)
1	Non-treated Control		0 a	0.41 ab	2.80 a	8.25 a	97.11 a	0.0202 a	1133.9 de
2	Headline @ 6.0 fl oz	1	0 a	0.43 ab	2.58 abc	5.88 bc	79.14 abc	0.0165 abc	1173.2 de
3	Headline @ 6.0 fl oz	1,2	0 a	0.19 ef	2.88 a	5.93 bc	79.17 abc	0.0165 abc	1338.9 abcde
4	Headline @ 6.0 fl oz	1,3	0 a	0.33 bcde	1.80 cdef	4.28 de	56.96 def	0.0119 def	1548.2 abcd
5	Headline @ 6.0 fl oz	1,2,3	0 a	0.16 f	1.50 ef	2.90 efg	41.11 fg	0.0086 fg	1495.9 abcd
6	Headline @ 6.0 fl oz	2	0 a	0.25 cdef	2.15 abcde	6.35 bc	73.56 bcd	0.0153 bcd	1343.3 abcde
7	Headline @ 6.0 fl oz	2,3	0 a	0.52 a	2.68 ab	5.13 cd	77.19 bc	0.0161 bc	1312.7 bcde
8	Headline @ 6.0 fl oz	3	0 a	0.40 abc	2.43 abcd	6.73 ab	82.19 ab	0.0171 ab	942.0 e
9	Folicur @ 4.0 fl oz, Propulse @ 10.3 fl oz	2,3	0 a	0.31 bcdef	1.24 f	1.95 g	34.14 g	0.0071 g	1792.5 a
10	Headline @ 6.0 fl oz, Confidential	2,3	0 a	0.20 def	1.78 cdef	4.15 def	53.62 ef	0.0118 ef	1700.9 ab
11	Vertisan @ 20.0 fl oz, Picoxystrobin @ 9.0 fl oz	2,3	0 a	0.35 bcd	1.89 bcdef	4.93 cd	62.72 cde	0.0131 cde	1234.2 cde
12	Headline @ 6.0 fl oz, Quash @ 3.0 fl oz	2,3	0 a	0.30 bcdef	2.19 abcde	2.68 fg	51.03 efg	0.0163 efg	1452.3 abcd
13	Tilt @ 4 fl oz, Quadris @ 6.2 fl oz	2,3	0 a	0.38 abc	1.61 def	3.33 efg	49.23 efg	0.0103 efg	1687.8 abc
LSD $_{P=0.05}$			0	0.15	0.86	1.55	19.16	0.004	466.6

Table 4. Sunflower Rust Fungicide Trials – Vision Research Park - Mohall

				Disease Severity					
	BOTTINEAU 2010		7/28/2010	8/6/2010	8/25/2010	9/17/2010			
	SF RUST FUNGICIDE TRIAL		R3	R5.1	R6	R9			
ID	Treatment	Timing	r0	r1	r2	r3	AUDPC	rAUDPC	Yield (lb/A)
1	Non-treated Control		0 a	2.78 a	9.08 a	27.60 a	546.83 a	0.1072 a	1000.4 d
2	Headline @ 6.0 fl oz	1	0 a	0.10 b	3.58 b	25.75 ab	372.60 cd	0.0731 cd	1202.9 cd
3	Headline @ 6.0 fl oz	1,2	0 a	0.16 b	0.73 c	19.73 c	244.34 e	0.0479 e	1333.0 abcd
4	Headline @ 6.0 fl oz	1,3	0 a	0.06 b	9.10 a	16.85 c	385.75 bc	0.0756 bc	1258.0 cd
5	Headline @ 6.0 fl oz	1,2,3	0 a	0.18 b	0.95 c	5.23 d	82.49 f	0.0162 f	1448.0 abc
6	Headline @ 6.0 fl oz	2	0 a	2.48 a	2.20 bc	20.23 bc	313.44 cde	0.0615 cde	1633.1 ab
7	Headline @ 6.0 fl oz	2,3	0 a	2.95 a	2.73 bc	16.65 c	290.00 de	0.0569 de	1543.0 abc
8	Headline @ 6.0 fl oz	3	0 a	2.40 a	9.48 a	20.03 c	462.86 ab	0.0908 ab	1303.0 bcd
9	Folicur @ 4.0 fl oz	1,2,3	0 a	0.05 b	0.83 c	5.25 d	78.40 f	0.0154 f	1560.6 abc
10	Folicur @ 4.0 fl oz	2,3	0 a	2.50 a	2.45 bc	15.18 c	260.96 e	0.0569 de	1673.1 a
LSD $_{P=0.05}$			0	0.64	2.00	5.57	88.28	0.0173	360.59

*Timing scheme differs from previous three locations.