Sclerotinia head rot:

Improving the methods used to screen sunflowers for resistance and prospects for using fungicides for management



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 Facilitate the development of commercial sunflower hybrids with reduced susceptibility to Sclerotinia head rot

 Multi-location testing: supports the development of commercial hybrids with improved resistance to head rot



Blaine Schatz

Research Objectives

- (2) Improve the methods used to screen sunflowers for resistance to Sclerotinia head rot
- Screening nurseries have not always produced replicable results



Research Objectives

- (3) Evaluate the potential of modern fungicides for managing Sclerotinia head rot
- Several fungicides are effective against Sclerotinia diseases on other crops.
- Achieving satisfactory fungicide coverage is a challenge for Sclerotinia head rot of sunflower.



METHODS – Evaluation of hybrids for head rot resistance

PLOTS: Hybrids planted in one-row plots
 Row length: Carrington, 29 feet; Langdon, 26 feet; Oakes, 17 feet.

 DESIGN: Completely randomized block with 4 or 6 replicates
 Multilocation nurseries: 4 replicates
 Large screening nursery, Carrington: 6 replicates

 INOCULATION: approx. 15,000 ascospores of Sclerotinia
 sclerotiorum applied twice at flowering (R5.2 to R5.8)

MISTING: Microsprinklers utilized to facilitate disease



METHODS – Evaluation of hybrids for head rot resistance

LARGE SCREENING NURSERY: Carrington, ND

28 hybrids + 3 standard checks; 6 replicates

MULTI-LOCATION SCREENING NURSERIES:

Carrington, Langdon, and Oakes, ND

22 hybrids + 3 standard checks; 4 replicates per site

SELECTION NURSERY: Carrington, ND

3 hybrids + 3 standard checks; 4 replicates



LARGE SCREENING NURSERY - Carrington



SCLEROTINIA HEAD ROT SEVERITY INDEX - R9 growth stage - Oct. 17 & 19, 2012



Syngenta 'NX24122 Seeds 2000 'X6822' Seeds 2000 'Camaro Syngenta '3990 NS/CL/DM Genosys 'M12-217R' Genosys '12GCF07' Mycogen '8N270CLDM' (susc. check) Genosys 'M12-223R' Mycogen 'E101163' Genosys 'M12-187R' Genosys '12GCF09' Genosys 'M12-203R Syngenta 'NX24121' Genosys 'M12-193R' Genosys 'M12-189R' Mycogen 'E411501' Genosys 'M12-219R' Seeds 2000 'X2193' Genosys '12GCF05' Genosys 'M12-199R Genosys 'M12-209R Seeds 2000 'Cobalt' Seeds 2000 'X3293' Genosys 'M12-213R' Seeds 2000 'Torino' Seeds 2000 'X2793' Croplan '343 DMR HO' (resist. check) Syngenta 'NX24123' Mycogen 'E1013231' Seeds 2000 'X6878' Croplan '305 DMR NS' (susc. check)

COMBINED Carrington, ND Carrington, ND Langdon, ND Oakes, ND MULTI-LOCATION NURSERIES Carrington trials Trial #1 Trial #2 (10 replicates) (6 replicates) (4 replicates) (4 replicates) (4 replicates) Oct. 17 & 19, 2012 Oct. 19, 2012 Sept. 28, 2012 Sept. 10 & 14, 2012 Disease 3 5 Syngenta '3990 NS/CL/DM' 11 a * a * ab 1 ab * a * 3 Syngenta 'NX24122' 5 7 ab abc 9 a а а Incidence Mycogen 'E101321' 4 5 3 0 3 ab a a а а Seeds 2000 'X6878' 7 11 6 35 abc 4 а a-d abc a-d 11 8 9 Syngenta 'NX24123' a-d 5 a-d 4 abc a а 8 6 7 **Croplan** '343 DMR HO' (resistant check) a-d 11 a-d abc 6 a а 43 Seeds 2000 'X2793' 9 9 9 a-d abc 14 ab а С 16 18 Seeds 2000 'X6822' 9 7 a-d 12 a-d а abc ab 10 19 10 11 Seeds 2000 'X3293' ab 6 а-е a-d abc а 11 11 Seeds 2000 'Cobalt' 11 ab a-d 1 8 a-e ab а 16 34 12 Genosys 'M12-213R' 10 ab 10 а-е а-е С а 13 16 25 Genosys '12GCF05' abc 8 abc 0 a-d а-е а 13 16 Seeds 2000 'X2193' 8 24 14 а-е abc abc bc ab 15 18 Mycogen 'E411501' 10 a-d 9 10 а-е abc abc а 17 20 13 9 Genosys 'M12-193R' abc a-d 11 а-е abc а 20 5 Syngenta 'NX24121' a-f 21 abc 20 abc 17 а-е ab 24 25 59 Genosys 'M12-187R' 23 abc 12 abc b-g cd а-е Within-column means 27 26 30 Mycogen 'E101163' 11 11 c-g abc a-f abc а followed by different letters 29 Genosys 'M12-203R' 24 36 22 d-g abc c-f 27 abc abc are significantly different 31 25 39 13 Genosys '12GCF09' def abc 30 efg abc a-d (P < 0.05; Tukey multiple comparison procedure). 29 36 52 Genosys 'M12-223R' 31 efg abc 33 b-f abc bcd 39 42 62 Genosys '12GCF07' 34 21 fg b-f abc d 42 42 12 Mycogen '8N270CLDM' (susceptible check) 44 26 ef abc a-d g 44 43 45 22 Genosys 'M12-217R' 50 ef abc bcd q 53 44 38 45 25 Croplan '305 DMR NS' (susceptible check) a-d bc С q 20 40 20 40 30 60 20 30 60 0 0 40 0 0 0

MULTI-LOCATION NURSERIES COMBINED Carrington trials

COMBINED Carrington, ND Carrington, ND Langdon, ND Oakes, ND

MULTI-LOCATION NURSERIES		Carrington trials (10 replicates)		Trial #1 (6 replicates) Oct. 17 & 19, 2012		Trial #2 (4 replicates)		(4 replicates)		(4 replicates)	
Disease Syn	genta '3990 NS/CL/DM'	0.12	a *	0.04	a *	0.24	a *	0.02	a *	0.50	a *
	Syngenta 'NX24122'	0.13	а	0.06	ab	0.25	а	0.13	ab	0.37	а
Severity	Mycogen 'E101321'	0.17	а	0.21	abc	0.12	а	0.00	а	0.13	а
	Seeds 2000 'X6878'	0.31	ab	0.18	abc	0.50	ab	0.18	abc	1.65	abc
Index	Syngenta 'NX24123'	0.38	abc	0.26	a-d	0.55	abc	0.04	а	0.28	а
Croplan '343 DMR HO' (resistant check)		0.37	abc	0.27	a-d	0.51	abc	0.22	abc	0.25	а
Seeds 2000 'X2793'		0.39	abc	0.38	a-d	0.39	ab	1.45	bc	0.57	abc
	Seeds 2000 'X6822'	0.43	abc	0.33	a-d	0.59	abc	0.54	abc	0.69	abc
	Seeds 2000 'X3293'	0.49	abc	0.50	a-e	0.46	ab	0.49	abc	0.21	а
	Seeds 2000 'Cobalt'	0.55	a-d	0.56	a-d	0.54	abc	0.03	а	0.22	а
	Genosys 'M12-213R'	0.57	7 a-d	0.46	a-d	0.74	а-е	1.45	с	0.46	а
	Genosys '12GCF05'	0.65	ja-d	0.80	a-f	0.42	ab	0.00	a	1.10	abc
	Seeds 2000 'X2193'	0.64	. a-d	0.80	a-f	0.39	ab	0.77	abc	0.38	а
	Mycogen 'E411501'	0.68	} a-d	0.80	a-f	0.51	ab	0.31	abc	0.48	ab
	Genosys 'M12-193R'	0.8	5 a-d	0.99	a-f	0.64	a-d	0.30	abc	0.39	а
	Syngenta 'NX24121'	0.98	a-e	0.98	a-f	0.98	a-f	0.18	abc	0.73	abc
	Genosys 'M12-187R'	1.19	b-f	1.25	c-f	1.09	a-f	0.50	abc	2.81	с
Within-column means followed by different letters are significantly different	Mycogen 'E101163'	1.26	b-f	1.12	c-f	1.47	b-f	0.30	abc	0.45	ab
	Genosys 'M12-203R'	1.32	c-f	1.07	b-f	1.69	b-f	1.18	abc	1.01	abc
(<i>P</i> < 0.05; Tukey	Genosys '12GCF09'	1.52	def	1.23	c-f	1.94	c-f	0.55	abc	1.38	abc
multiple comparison procedure).	Genosys 'M12-223R'	1.49	def	1.41	def	1.62	b-f	1.52	abc	2.48	bc
	Genosys '12GCF07'	1.92	ef	2.09	f	1.66	b-f	1.01	abc	2.61	с
Mycogen '8N270CLDM' (susceptible check)		2.04	f	1.96	f	2.15	def	0.23	abc	1.09	abc
Genosys 'M12-217R'		2.14		2.10	f	2.20	ef	0.64	abc	2.36	bc
Gropian 305 DMR NS (susceptible check)		2.17		1.83	ef	2.66		1.57	C	1.15	abc
		0 1.0	2.0	0 1.0 2.0)	0 1.5	3.0	0 1.0	2.0	0 1.5	3.0

REPEATABILITY OF RESULTS

Correlation of results across trials: Sclerotinia head rot incidence



Correlation of results across trials:

Sclerotinia head rot severity index

Below the axis: Pearson correlation coefficient Above the axis: *P*-level associated with correlation
 KEY:
 P > 0.05

 $0.01 < P \le 0.05$
 $P \le 0.01$

METHODS - Susceptibility to head rot after flowering

LOCATIONS: Carrington, Langdon, and Oakes, ND

DESIGN: Completely randomized split-split-plot, 4 or 6 replications MAIN FACTOR: bagged vs. unbagged heads (Carrington and Langdon only) SUB-FACTOR: susceptible vs. partially resistant hybrid SUB-SUB-FACTOR: inoculation timing (R5, R6, R7, R8, non-inoculated)

INOCULATION: ascospores of *Sclerotinia sclerotiorum* applied twice at appropriate growth stage

51,000 spores to the front of head + 15,000 spores to the back of head in each inoculation

MISTING: At each growth stage, overhead irrigation was applied for 4 days after the first inoculation.



National Sunflower Association

CARRINGTON - Susceptibility to head rot after flowering (2012)

Within-column means followed by different letters are significantly different (P < 0.05; Fisher's protected least significant difference).

Susceptible Hybrid: Inoculated - R5

Croplan 305 DMR NS

Resistant Hybrid:

Croplan 343 DMR HO

Inoculated - R5

Non-inoculated

Inoculated - R6

Inoculated - R7

Inoculated - R8

- Inoculated R6
- Inoculated R7
- Inoculated R8
- Non-inoculated



Sclerotinia head rot

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CARRINGTON - Susceptibility to head rot after flowering (2012)

Within-column means followed by different letters are significantly different (P < 0.05; Fisher's protected least significant difference).

Susceptible Hybrid: Inoculated - R5

Mycogen 8H288 CL DM

Resistant Hybrid:

Proseed E-8

Inoculated - R5

Inoculated - R6

Inoculated - R7

Inoculated - R8

Non-inoculated

- Inoculated R6
- Inoculated R7
- Inoculated R8

Non-inoculated

(percent incidence) UNBAGGED BAGGED HEADS HEADS 25 50 75 0 25 50 75 b b 4 а а 4 а а а а 2 4 а а 25 50 75 0 25 50 75 0 27 56 b b 4 а а 2 ()а а ()а а

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Sclerotinia head rot

LANGDON - Susceptibility to head rot after flowering (2011 and 2012)

Within-column means followed by different letters are significantly different (P < 0.05; Fisher's protected least significant difference).

Susceptible Hybrid:

2012: Croplan 305 DMR NS 2011: Mycogen 8H288 CL DM

Resistant Hybrid:

2012: Croplan 343 DMR HO

2011: Proseed E-8

- Inoculated R5
- Inoculated R6
- Inoculated R7
- Inoculated R8 Non-inoculated



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REPEATABILITY OF RESULTS FROM SCREENING NURSERIES

2011: Repeatable results were obtained when inoculations were conducted over multiple days such that each head was inoculated twice at the same growth stage.

	Morden	Sidney	Carrington	Crookston	Oakes	Langdon		
Morden		0.6604	0.9951	0.0214	0.6818	0.088		
Sidney	-0.08		0.0363	0.3822	0.8688	0.1129		
Carrington	0	0.51		0.7352	0.9807	0.0367		
Crookston	0.47	0.18	0.09		0.0064	0.0007		
Oakes	0.08	0.03	0	0.53		0.0119		
Langdon	0.37	0.32	0.50	0.63	0.49			



CORRELATION, DISEASE INCIDENCE

<u>Below axis</u>: Pearson correlation coefficient <u>Above axis</u>: P-value associated with correlation

Sidney, MT (2011):

All plants inoculated on Aug 2-3 and Aug. 8, irrespective of growth stage.

•Disease incidence correlated with flowering date.



REPEATABILITY OF RESULTS FROM SCREENING NURSERIES

2012: Results from Langdon were poorly correlated with results from other trials.



CORRELATION, DISEASE INCIDENCE

<u>Below axis</u>: Pearson correlation coefficient <u>Above axis</u>: P-value associated with correlation

Oakes, ND (2012):

Inoculations were conducted on 6 dates over a 14-day period.

Disease incidence did not correlate with flowering date.



REPEATABILITY OF RESULTS FROM SCREENING NURSERIES

2012:

Carrington, trial 1:

Inoculations conducted on 8 dates over a 24-day period.

Carrington, trial 2:

Inoculations conducted on 8 dates over a 23-day period.

<u>Oakes:</u>

Inoculations conducted on 6 dates over a 14-day period.

Langdon:

Inoculations conducted on 3 dates over a 5-day period.

METHODS – FUNGICIDE EVALUATIONS

PLOTS: Harvested plot size = 2 rows, each 26 to 30 ft long Carrington: 29 x 5 ft Langdon: 26 x 5 ft Scottsbluff: 30 x 5 ft

DESIGN: Randomized complete block with 4 replications

FUNGICIDE APPLICATIONS:

Carrington – 20 gallons water/ac, 35 psi Langdon – 15 gallons water/ac, 35 psi Scottsbluff – 35 gallons water/ac, 20 psi

INOCULATION:

30,000 ascospores of *S. sclerotiorum* were applied per head at early to mid flowering

Carrington, Langdon: 10,000 ascospores/head on each of three different dates Scottsbluff: 15,000 ascospores/head on each of two different dates

MISTING: Microsprinklers utilized to facilitate disease.

FUNGICIDE EFFICACY TESTING – Scottsbluff, NE

Non-inoculated, non-treated check Inoculated, non-treated check **Topsin 4.5FL** 40 fl oz/ac (A,B) Vertisan 200EC 20 fl oz/ac (A,B) Aproach 2.08SC 20 fl oz/ac (A,B) **Endura 70WG** 9.0 oz/ac (A,B) **Quash 50WDG** 3.0 oz/ac (A,B) **Omega 500F** 16 fl oz/ac (A,B) **Rovral 4F** 2.0 pt/ac (A,B) **Switch 62.5WG** 14.0 oz/ac (A,B)





C.V.: 32.0

23.6

Fungicide applications

A: Aug. 22 at early bloom; B: Sept. 1 at late bloom to flowering complete

Sclerotinia stalk rot incidence Yield pounds/acre percent 10 20 30 1000 2000 Non-inoculated, non-treated check 31 1887 b а Non-inoculated, non-treated check 26 ab 166 а **Topsin 4.5FL** 40 fl oz/ac (A,B) 18 462 а а Vertisan 200EC 20 fl oz/ac (A,B) 19 а а Aproach 2.08SC 20 fl oz/ac (A,B) 24 ab 849 а **Endura 70WG** 9.0 oz/ac (A,B) 27 152ab а **Quash 50WDG** 3.0 oz/ac (A,B) 25 2133 ab а **Omega 500F** 16 fl oz/ac (A,B) 16 1803 а а **Rovral 4F** 2.0 pt/ac (A,B) 19 91 а а **Switch 62.5WG** 14.0 oz/ac (A,B) ab а C.V.: 35.7 23.6

Fungicide applications

A: Aug. 22 at early bloom; B: Sept. 1 at late bloom to flowering complete

FUNGICIDE EFFICACY TESTING – Scottsbluff, NE

Sclerotinia stalk rot incidence Yield pounds/acre percent 10 20 30 1000 2000 Non-inoculated, non-treated check 31 1887 b а Non-inoculated, non-treated check 26 ab 166 а **Topsin 4.5FL** 40 fl oz/ac (A,B) 18 462 а а Vertisan 200EC 20 fl oz/ac (A,B) 19 а а Aproach 2.08SC 20 fl oz/ac (A,B) 24 ab 849 а **Endura 70WG** 9.0 oz/ac (A,B) 27 152ab а **Quash 50WDG** 3.0 oz/ac (A,B) 25 2133 ab а **Omega 500F** 16 fl oz/ac (A,B) 16 1803 а а **Rovral 4F** 2.0 pt/ac (A,B) 19 91 а а **Switch 62.5WG** 14.0 oz/ac (A,B) ab а C.V.: 35.7 23.6

Fungicide applications

A: Aug. 22 at early bloom; B: Sept. 1 at late bloom to flowering complete

FUNGICIDE EFFICACY TESTING – Scottsbluff, NE

Sclerotinia head rot incidence percent 20 Non-inoculated, non-treated check 22 34 Inoculated, non-treated check **Topsin 4.5FL** 40 fl oz/ac (A,B) 31 Vertisan 200EC 20 fl oz/ac (A,B) 31 Aproach 2.08SC 20 fl oz/ac (A,B) 27 **Endura 70WG** 9.0 oz/ac (A,B) 24 **Quash 50WDG** 3.0 oz/ac (A,B) 39 **Omega 500F** 16 fl oz/ac (A,B) 34 **Rovral 4F** 2.0 pt/ac (A,B) 38 **Switch 62.5WG** 14.0 oz/ac (A,B) 38

FUNGICIDE EFFICACY TESTING - Langdon, ND

Yield pounds/acre 1000 2000 а 1961 а а 880 а 1982 а 076а 1664 а 2133 а 1585 а 1828 a

24.4

40

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ab

ab

ab

ab

b

ab

b

ab

C.V.: 34.5

Fungicide applications

A: Aug. 1 at early bloom; B: Aug. 11 at late bloom to flowering complete

percent 2 Non-inoculated, non-treated check 2 Inoculated, non-treated check 2 **Topsin 4.5FL** 40 fl oz/ac (A,B) 4 Vertisan 200EC 20 fl oz/ac (A,B) 2 Aproach 2.08SC 20 fl oz/ac (A,B) 3 **Endura 70WG** 9.0 oz/ac (A,B) Quash 50WDG 3.0 oz/ac (A,B) 6 **Omega 500F** 16 fl oz/ac (A,B) Rovral 4F 2.0 pt/ac (A,B) 4 Switch 62.5WG 14.0 oz/ac (A,B) 3

FUNGICIDE EFFICACY TESTING – Carrington, ND



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Fungicide applications

A: Aug. 7 at early bloom; B: Aug. 21 at late bloom

C.V.: 71.3



Thank you!

Funding: USDA National Sclerotinia Initiative