### Sclerotinia head rot:

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



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<sup>4</sup> University of Nebraska, Panhandle Research Extension Center, Scottsbluff

- (1) Assess the relative susceptibility of sunflowers to head rot during and after bloom
  - Results will help guide inoculation methods used in resistance screening nurseries
  - Results will inform fungicide efficacy research



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



- (3) Evaluate the potential of modern fungicides for managing Sclerotinia head rot
  - Several fungicides are known to be effective against head rot when fungicides are applied to the front of heads
  - Fungicide efficacy against head rot has not been rigorously tested when fungicides are applied over the top of the canopy



### Methods – Susceptibility of sunflowers to head rot during and after bloom

PLOTS: Minimum 21 to 29 feet of row per plot

**DESIGN:** Completely randomized split-plot or split-split-plot with minimum 4 replicates

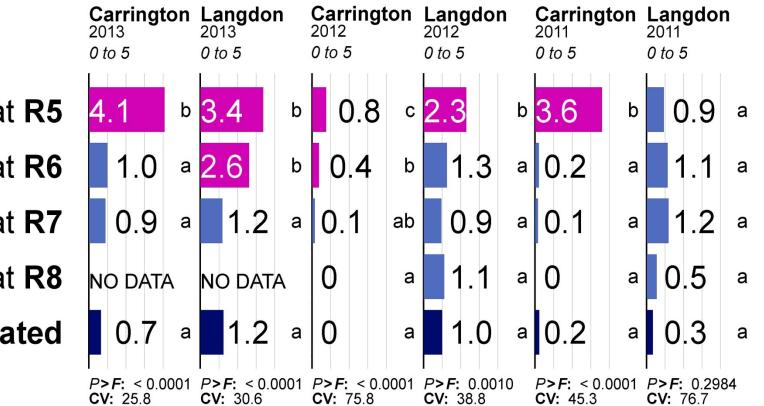
**2013:** 6 to 16 replicates **2012:** 6 to 7 replicates **2011:** 4 to 6 replicates

**INOCULATION:** approx. 15,000 ascospores of *S. sclerotiorum* applied to the <u>front</u> and <u>back</u> of heads on two different days

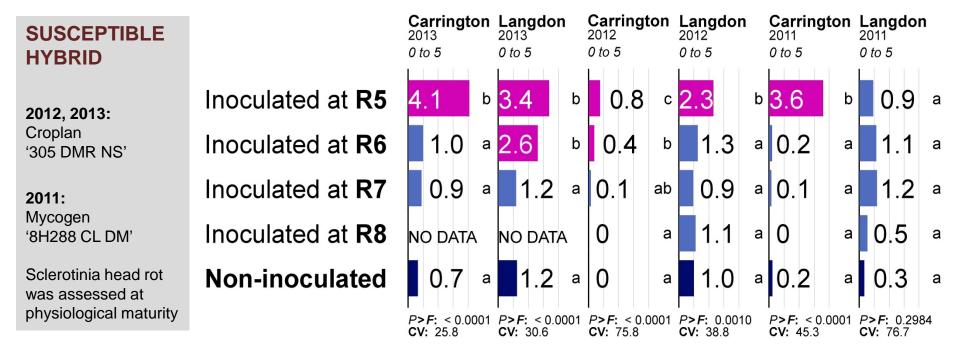


### SUSCEPTIBLE HYBRID

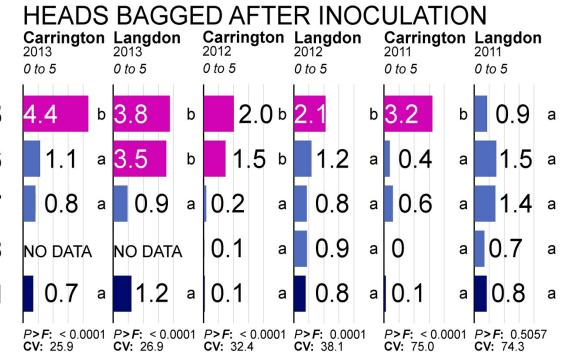
**2012, 2013:** Croplan '305 DMR NS'**2011:** Mycogen '8H288 CL DM'Sclerotinia head rot severity (0 to 5) was assessed at physiological maturity.



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



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



## SUSCEPTIBLE HYBRID

**2013:** Croplan '305 DMR NS'; 145 sq ft plots

Sclerotinia head rot was assessed at physiological maturity.



### **RESISTANT HYBRID**

**2012, 2013:** Croplan '343 DMR HO' **2011:** ProSeed 'E8' Sclerotinia head rot severity (0 to 5) was assessed at physiological maturity.

**Carrington Langdon** 

Carrington Langdon

CV: 101.9

**Carrington Langdon** 

b

а

а

а

а

CV: 70.7

2011

0 to 5

0.4

0.3

0.3

0

0

CV: 135.5

а

а

а

а

а

2013 2013 2012 2012 2011 0 to 5 0.9 2.5 0.8 b 2.9 Inoculated at **R5** 0. С b а 0.1 0.1 Inoculated at R6 1.5 0.1 b 0.1 a a а 0.1 Inoculated at R7 0.3 0.2 0 0 а а а а Inoculated at R8 0 0. 1 0 **NO DATA** NO DATA а а 0.2 **Non-inoculated** 0.5 0  $\mathbf{O}$ 0. а а а а *P*>*F*: < 0.0001 *P*>*F*: < 0.0001 *P*>*F*: < 0.0001 *P*>*F*: 0.0777 *P*>*F*: < 0.0001 *P*>*F*: 0.3349 CV: 93.2

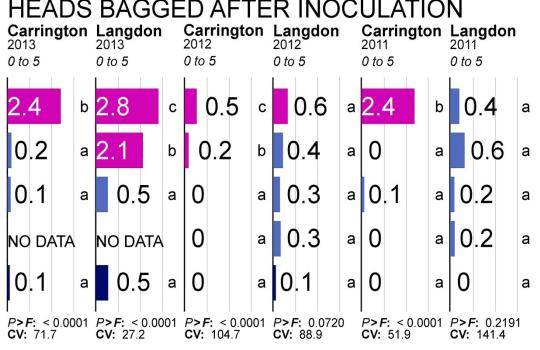
CV: 56.0

**CV**: 24.2

RESISTANT HYBRID		<b>Ca</b> 201 0 to	13	ngto		<b>La</b> 201 <i>0 tc</i>	3	don		<b>Cai</b> 2012 0 to	2	gtor	20	<b>ang</b> 012 <i>to 5</i>	don		<b>Car</b> 2011 <i>0 to</i> 3		gtor	20	ang 011 to 5	gdon ₅	1
2012, 2013:	Inoculated at <b>R5</b>	2.	5		b	2.	9		с		0.	9	b	0.4	4	а		<b>3</b> .0	3 1	b	0.	.4	а
Croplan '343 DMR HO'	Inoculated at R6	0	). 1		а	1.	5		b	0	.1	á	a	0.1		а	0	.1	1	a	0.	.3	а
2011:	Inoculated at R7	0	). 1		а	(	0.3	3	а	0		á	a	0.2		а	0		1	a	0.	.3	а
ProSeed 'E8'	Inoculated at R8	NC	ם כ	)ATA	•	NC	D D	ATA		0		á	a	0.1		а	0		1	a (	0		а
Sclerotinia head rot was assessed at	Non-inoculated	0	).2	2	а		0.	5	а	0		á	a	0.1		а	0		í	a (	0.	1	а
physiological maturity		•	F: 24	< 0.00 1.2			<b>F:</b> <	0.00 0			: < ( 93.2	0.000		> <i>F</i> : ( V: 10			P>F CV:		0.000			0.3349 135.5	Э

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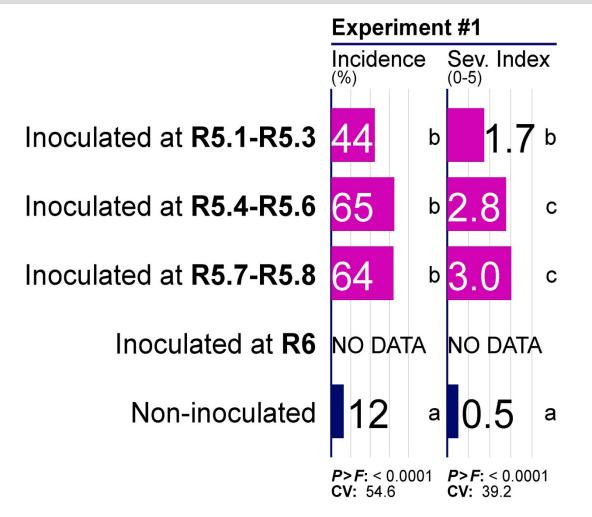
Inoculated at **R5** Inoculated at R6 Inoculated at R7 Inoculated at **R8 Non-inoculated** 



# SUSCEPTIBLE HYBRID

2013: Croplan '305 DMR NS'

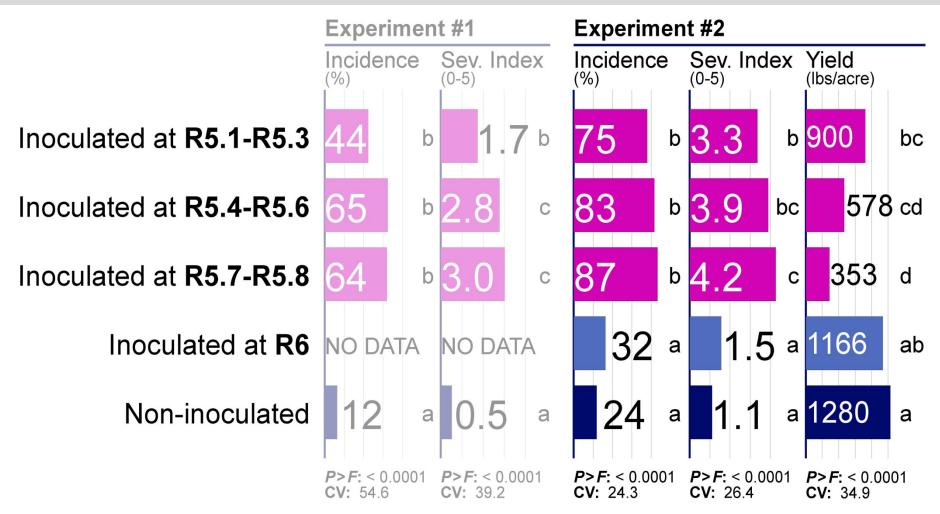
Sclerotinia head rot severity (0 to 5) was assessed at physiological maturity.



# SUSCEPTIBLE HYBRID

2013: Croplan '305 DMR NS'

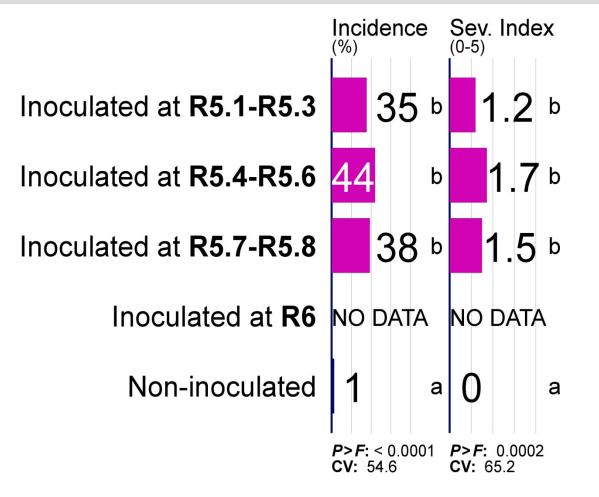
Sclerotinia head rot severity (0 to 5) was assessed at physiological maturity.



# **RESISTANT HYBRID**

2013: Croplan '343 DMR HO'

Sclerotinia head rot severity (0 to 5) was assessed at physiological maturity.



### HEAD ROT RESISTANCE SCREENING NURSERIES:

To produce replicable, unbiased results,

inoculations must be **conducted over multiple dates** such that all heads across all entries are inoculated at the same growth stage.

# **USING FUNGICIDES TO CONTROL HEAD ROT:**

To maximize disease control with foliar fungicides, fungicides must be applied such that sunflower heads are protected during bloom.



### Methods – Resistance screening nurseries

# PLOTS: Minimum 17 feet of row per plot

**DESIGN:** Completely randomized block, minimum 4 replicates

**2013:** 4 to 9 replicates **2012:** 4 to 6 replicates **2011:** 4 replicates

**INOCULATION:** approx. 15,000 ascospores of *S. sclerotiorum* applied to the <u>front</u> of heads at R5.4 to R5.6 and again 2 to 3 days later



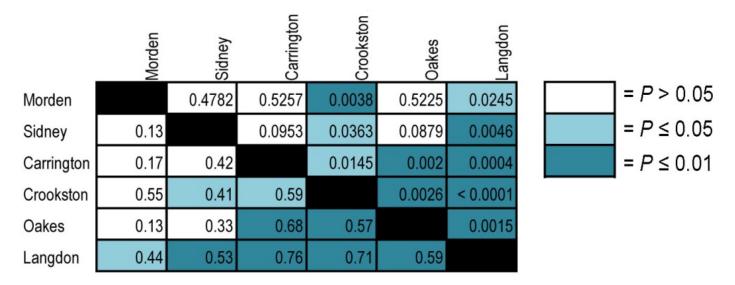
## Multi-location screening nurseries, 2011:

			OAKES, NORTH DAKO		۱.	M Dise	ROOKS INNESC ease Sever	AT		ple size	LANGE NORTH Disease Ser	DAK	ΟΤΑ	Sample size	SIDNEY, MONTANA Disease Severity	Index		CARRINGTON NORTH DAKOT Disease Severity Index	A	iple size	MORDEN, MANITOBA isease Severity Ind	dex
			0 to 51	-					-	S	0 to 51				0 to 5 <sup>1</sup>		ŝ	0 to 5 <sup>1</sup>	-	S	o 4 <sup>2</sup>	
			0 1 2 3 4	5		0	1 2 3	4 5			0 1 2	2 3	4		0 1 2 3	4 5		0 1 2 3 4	5	0	0.2 0.4 0.6	0.8
Croplan	343 DMR HO	60	1.5	1	а-е	108 1.3	3		ab	87	0.5		а	53	0.8	а	23	2.2	a	52 0	)	а
Seeds2000	X9856	60	0.2		ab	114 1.1			a	84	0.6		а	55	3.4	e-h	47	2.3	a	24 0		а
Genosys	8064	58	0.7		abc	104 1.7	7		ab	72	0.6		а	47	1.7	a-d	15	3.1	abc	36 0	.3	а
Pioneer	63N82	60	0.1		a	113 2.2	2		a-d	72	0.5		а	62	2.3	a-f	28	2.6	abc	59 0	.2	а
Mycogen	DAS 10-1	60	1.1		а-е	104 2.6	6		a-d	74	1.1		ab	57	1.0	ab	7	NO DATA (hail damage) 4		44 0	.7	a
Pioneer	63ME70	59	0.4		abc	108 2.3	3		a-d	75	1.1		ab	42	1.9	a-e	28	2.3	ab	58 0	.5	а
Nidera	EXP97-11	58	1.5		a-e	92 2.8	3		a-d	58	0.7		ab	50	1.4	abc	17	2.2	abc	22 0	.2	а
Syngenta	4596 HO/DM	52	0.6		abc	<b>107</b> 3.0	)		a-d	81	1.5		abc	54	1.8	a-e	12	NO DATA (hail damage) 4		52 0	.7	а
Syngenta	4651 NS/DM	60	0.7		abc	106 2.2	2		a-d	80	1.8		a-d	63	1.9	a-e	12	4.2	abc	60 0	.2	а
Genosys	9008	59	2.0		а-е	103 1.8	3		ab	74	1.3		ab	53	2.4	a-f	5	NO DATA (hail damage) 4		55 0	.3	а
Triumph	EX61706	58	1.4		а-е	105 2.8	3		a-d	86	1.6		abc	42	NO DATA <sup>3</sup>		7	NO DATA (hail damage) 4		32 0	.1	а
Pioneer	64HE01	60	0.8		a-d	110 2.4			a-d	84	0.8		ab	60	3.3	d-h	23	3.3	abc	43	0.1	а
Seeds2000	X9814	60	0.9		а-е	108 2.0	)		abc	71	1.3		ab	66	3.2	d-h	23	NO DATA (hail damage) 4		52 0	.2	а
Genosys	9319	60	1.5		а-е	100 1.7	7		ab	70	1.8		a-d	45	2.5	b-f	16	3.7	abc	33	0.1	а
Seeds2000	X49464	58	2.1		a-f	112 2.6	6		a-d	77	0.9		ab	63	NO DATA <sup>3</sup>		33	2.9	abc	57 0	.6	а
Genosys	8037	60	1.6		a-e	109 1.9	)		abc	74	2.1		a-d	59	2.2	a-e	16	3.9	abc	58 0	.3	а
Pannar	PEX 7813NS	59	1.9		а-е	110 3.2	2		a-d	73	1.0		ab	60	2.3	a-f	20	3.7	abc	37 0	.3	а
Genosys	7163	60	1.4		а-е	111 3.4	1		a-d	87	3.2		cd	64	2.5	b-f	0	NO DATA (hail damage) 4		30 0	.6	а
Triumph	EX62212	60	3.1		ef	108 2.2	2		a-d	79	0.8		ab	53	NO DATA <sup>3</sup>		28	4.6	bc	58	0.1	а
Seeds2000	X4437=Jaguar XL	60	1.9		а-е	85 4.0	)		a-d	78	2.1		a-d	45	2.6	b-f	17	4.0	abc	58 0	.4	а
Mycogen	8N270CLDM	59	1.5		a-e	<mark>107</mark> 3.2	2		a-d	78	1.8		a-d	68	4.2	gh	23	3.6	abc	<u>58</u> 0	.7	а
Croplan	305 DMR NS	60	2.7		c-f	107 2.3	3		a-d	83	2.3		bcd	64	2.8	c-g	11	NO DATA (hail damage) 4		50 0	.3	а
Triumph	TRX8343	59	2.4		b-f	<b>107</b> 3.6	6		bcd	81	2.5		bcd	59	2.7	b-g	16	4.7	abc	26 N	O DATA (poor emerger	nce) 5
CHS	HRT 10-4	54	3.0		def	116 4.1			cd	86	3.4		d	57	3.9	fgh	10	NO DATA (hail damage) 4		45 0	.7	а
Seeds2000	X5913	60	4.4	1	f	110 4.6	6		d	86	3.5		d	78	4.8	h	16	4.9	c	45 0	.4	а
			F: 5.70 P > F: < 0.0001 CV: 53.8				3.94 F: < 0.000 33.1	1			F: <b>8.21</b> P > F: < 0.0 CV: 40.5	001			F: 11.71 P > F: < 0.0001 CV: 19.8			F: 4.01 P > F: 0.0010 CV: 24.4		Р	1.43 > F∶ 0.1529 √: 109.7	

#### CORRELATION, DISEASE SEVERITY INDEX

Multi-location head rot resistance screening nurseries, 2011

Below axis: Pearson correlation coefficient Above axis: P-value associated with correlation



#### Morden:

Inoculations conducted on fixed dates with some entries at R5, others at R6

#### Sidney:

Inoculations conducted on fixed dates with some entries at mid-bloom, others at early bloom

#### Other sites:

Inoculations conducted on multiple dates such that all entries were at mid- to late bloom

Results – Screening commercial		Carrington, ND Trial #1 (6 replicates) Oct. 17 & 19, 2012	Carrington, ND Trial #2 (4 replicates) Oct. 19, 2012	Langdon, ND (4 replicates) Sept. 28, 2012	<b>Oakes, ND</b> (4 replicates) Sept. 10 & 14, 2012
sunflower hybrids and	Syngenta '3990 NS/CL/DM'	0.04 a *	0.24 a*	0.02 a *	0.50 a*
breeding lines for	Syngenta 'NX24122'	0.06 ab	<b>0.25</b>	0.13 ab	<b>0</b> .37 a
resistance	<b>Mycogen</b> 'E101321'	0.21 abc	0.12 a	0.00 a	0.13 a
	Seeds 2000 'Camaro II'	0.18 abc	0.50 ab	0.18 abc	1.65 abc
Multi-location	Syngenta 'NX24123'	0.26 a-d	<b>0.55</b> abc	0.04 a	<b>0.28</b> a
	Croplan '343 DMR HO' (resistant check)	0.27 a-d	0.51 abc	0.22 abc	<b>0.25</b> a
nurseries,	Seeds 2000 'X2793'	0.38 a-d	0.39 ab	1.45 bc	0.57 abc
2012	Seeds 2000 'Cobalt II'	0.33 a-d	0.59 abc	0.54 abc	0.69 abc
2012	Seeds 2000 'X3293'	0.50 a-e	<b>0.46</b> ab	0.49 abc	0.21 a
	Seeds 2000 'Cobalt'	0.56 a-d	0.54 abc	0.03 a	0.22 a
	Genosys 'M12-213R'	0.46 a-d	0.74 a-e	1.45 ∘	<b>0.4</b> 6 a
	Genosys '12GCF05'	0.80 a-f	0.42 ab	0.00 a	1.10 abc
	Seeds 2000 'X2193'	0.80 a-f	0.39 ab	0.77 abc	0.38 a
	<b>Mycogen</b> 'E411501'	0.80 a-f	0.51 ab	0.31 abc	0.48 <sup>ab</sup>
	Genosys 'M12-193R'	0.99 a-f	0.64 a-d	0.30 abc	0.39 a
	Syngenta 'NX24121'	0.98 a-f	0.98 a-f	0.18 abc	0.73 abc
	Genosys 'M12-187R'	1.25 c-f	1.09 a-f	0.50 abc	2.81 ℃
	<b>Mycogen</b> 'E101163'	1.12 c-f	1.47 b-f	0.30 abc	0.45 ab
	Genosys 'M12-203R'	1.07 b-f	1.69 b-f	1.18 abc	1.01 abc
	Genosys '12GCF09'	1.23 c-f	1.94 c-f	0.55 abc	1.38 abc
	Genosys 'M12-223R'	1.41 def	1.62 b-f	1.52 abc	2.48 bc
	Genosys '12GCF07'	2.09 f	1.66 b-f	1.01 abc	2.61 ℃
	Mycogen '8N270CLDM' (susceptible check)	1.96 f	2.15 def	0.23 abc	1.09 abc
	Genosys 'M12-217R'	2.10 f	2.20 ef	0.64 abc	2.36 bc
	Croplan '305 DMR NS' (susceptible check)	1.83 0 1.0 2.0	2.66 f 0 1.5 3.0	1.57 c 0 1.0 2.0	1.15 abc 0 1.5 3.0

Sclerotinia head rot severity index (0 to 5)

#### CORRELATION, DISEASE SEVERITY INDEX

Multi-location head rot resistance screening nurseries, 2012

Below axis: Pearson correlation coefficient Above axis: P-value associated with correlation

Carrington, Oakes: Inoculations conducted on multiple dates such that all entries were at mid- to late bloom Langdon: Inoculations conducted on fixed dat		<b>Carrington</b> - trial 1	<b>Carrington</b> - trial 2	Oakes	Langdon
with <u>some entries at mid-bloom</u> , others at early bloom	Carrington - trial 1		<0.0001	0.0002	0.0527
	Carrington - trial 2	0.8866		0.0024	0.0167
	Oakes	0.6704	0.5794		0.0839
	Langdon	0.3917	0.4739	0.3526	

Company	Entry	Туре	Status	9 REPLICATES R9 growth stage 0 to 5		4 REPLICATES R9 growth stage 0 to 5		4 REPLICATES R9 growth stage 0 to 5	
NuSeed Global	NHW11915	Confection	experimental	0.8	ab	1.6	ab		1
lycogen	246321	Oil	experimental	0.5	а	1.7	ab	2.3	
luSeed Global	NHW11917	Confection	experimental	1.1	a-d	1.7	ab	2.5	
lycogen	101321	Oil	experimental	1.0	abc	2.4	а-е	2.0	
Croplan	343 DRM HO	Oil	resistant check	1.9	b-h	2.2	a-d	1.5	
NuSeed Global	NHW12706	Confection	experimental	1.7	a-f	1.1	а	3.1	
NuSeed Global	NHW12806	Confection	experimental	1.9	b-h	1.7	ab	2.3	
NuSeed / Seeds 2000	NLK12M008	Oil	experimental	1.4	а-е	2.0	abc	2.6	
Genosys	12GCF05	Confection	commercially available	1.4	а-е	2.0	abc	3.0	
NuSeed / Seeds 2000	NHK12S076	Oil	experimental	1.7	a-g	NOT TESTED		NOT TESTED	
Genosys	12G20	Oil	commercially available	2.0	b-i	NOT TESTED		NOT TESTED	
Mycogen	303321	Oil	experimental	3.0	g-n	2.6	а-е	2.9	
Genosys	12GCF18	Confection	commercially available	2.9	f-m	2.6	a-f	3.1	
Genosys	12GCF07	Confection	commercially available	2.4	d-k	2.9	a-f	3.5	
NuSeed / Seeds 2000	NHK12M010	Oil	experimental	2.3	c-i	3.4	b-f	3.7	
Genosys	11G08	Oil	commercially available	2.3	c-i	NOT TESTED		NOT TESTED	
NuSeed Global	NHW11929	Confection	experimental	2.5	e-l	NOT TESTED		NOT TESTED	
Croplan	305 DMR NS	Oil	susceptible check	3.1	h-o	4.6	ef	2.0	
Genosys	12GCF12	Confection	commercially available	3.7	k-o	2.7	a-f	3.4	
NuSeed / Seeds 2000	NHK12S075	Oil	experimental	2.5	e-l	3.5	b-f	4.0	
NuSeed / Seeds 2000	NHK12S029	Oil	experimental	3.2	i-o	NOT TESTED		NOT TESTED	I
NuSeed / Seeds 2000	Camaro II	Oil	commercially available	3.5	j-o	3.3	a-f	3.4	
NuSeed / Seeds 2000	Cobalt II	Oil	commercially available	3.6	k-o	3.9	c-f	3.2	
Mycogen	8N270CLDM	Oil	susceptible check	4.1	mno	4.0	c-f	3.1	
NuSeed / Seeds 2000	NLK12S069	Oil	experimental	3.5	j-o	4.3	def	3.6	
NuSeed / Seeds 2000	NSK13M305	Confection	experimental	4.1	mno	3.8	b-f	3.4	
NuSeed / Seeds 2000	NSK13M302	Confection	experimental	3.7	k-o	4.1	c-f	4.0	
NuSeed / Seeds 2000	X4216	Oil	experimental	3.7	l-o	NOT TESTED		NOT TESTED	
NuSeed / Seeds 2000	NSK13M301	Confection	experimental	4.1	mno	4.0	c-f	4.4	
NuSeed / Seeds 2000	NSK13M304	Confection	experimental	3.9	mno	4.4	def	4.3	
Genosys	12GCF15	Confection	commercially available	4.3	no	4.8	f	3.7	
NuSeed / Seeds 2000	NLK12S070	Oil	experimental	3.9	mno	4.5	def	4.5	
NuSeed / Seeds 2000	NSK13M303	Confection	experimental	4.4	o	NOT TESTED		NOT TESTED	
				<b>P&gt;F:</b> < 0.0001	C *	<b>P&gt;F:</b> < 0.0001		<b>P&gt;F:</b> < 0.0001	

### Results – Multi-location screening nurseries, 2013

#### CORRELATION, DISEASE SEVERITY INDEX

Multi-location head rot resistance screening nurseries, **2013** 

Below axis: Pearson correlation coefficient Above axis: P-value associated with correlation

### All sites:

Inoculations conducted on multiple dates such that <u>all entries were at mid- to late bloom.</u>

	Carrington	Oakes	Langdon
Carrington		<0.0001	<0.0001
Oakes	0.8542		0.0006
Langdon	0.6998	0.6288	

## **TO PRODUCE REPLICABLE, UNBIASED RESULTS:**

inoculations must be **conducted over multiple dates** such that all heads across all entries are inoculated at the same growth stage.



# PLOT SIZE:

**2012, 2013:** 127.5-130 sq ft (Oakes, Langdon), 145-150 sq ft (Carrington, Scottsbluff) **2011:** 55 sq ft (Langdon), 100 sq ft (Carrington)

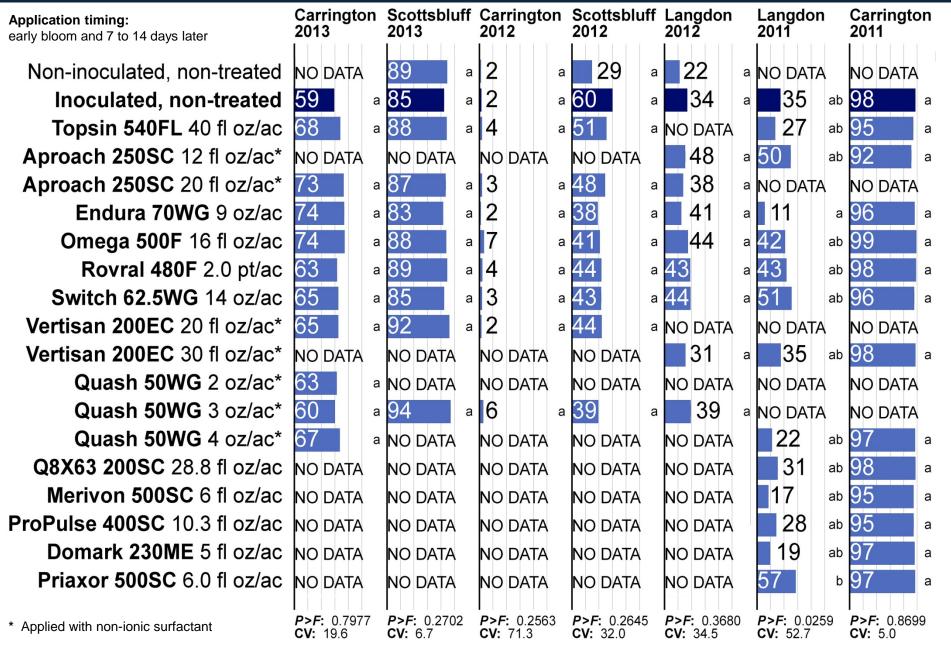
# **DESIGN:** Completely randomized block with 4 replicates

**INOCULATION:** approx. 15,000 ascospores of *S. sclerotiorum* applied to the <u>front</u> of heads two to three times during bloom

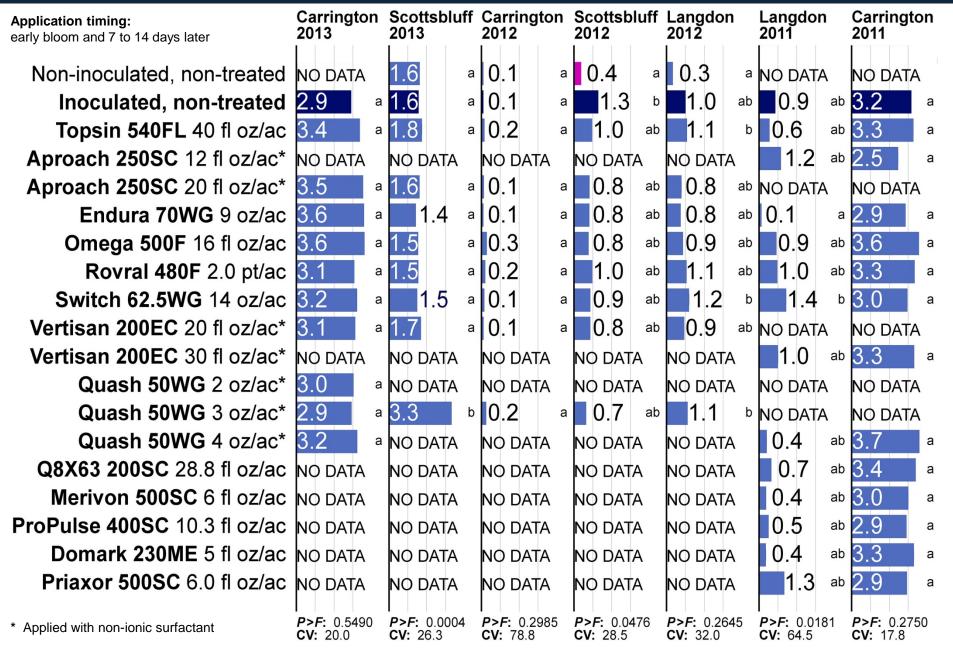
FUNGICIDE APPLICATIONS: - Flat-fan 8001 or 8002 nozzles - Minimum 14.5 gallons of water/ac - Generally 30 or 35 psi



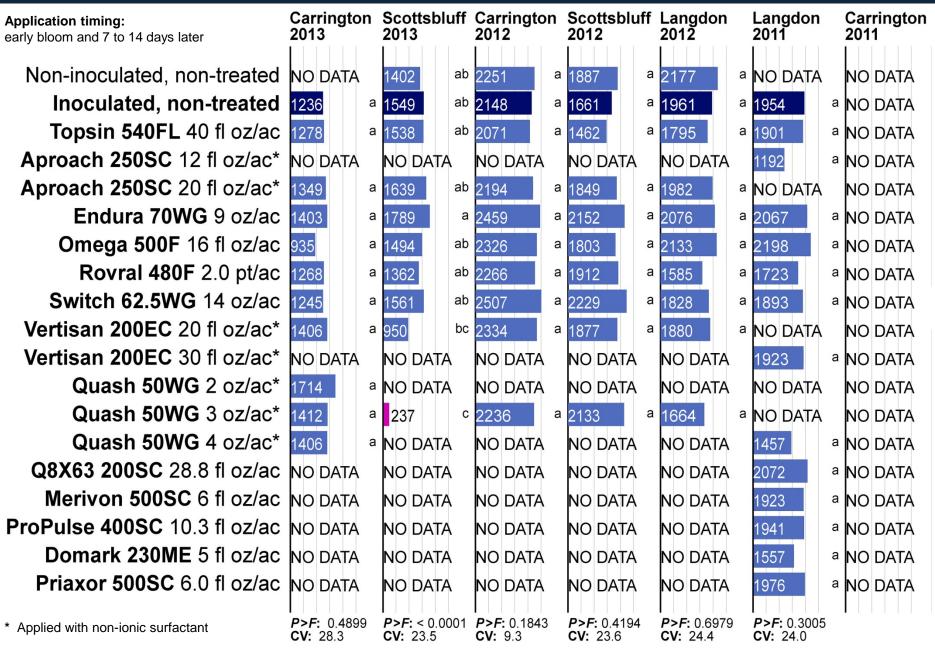
### SCLEROTINIA HEAD ROT INCIDENCE (%)



SCLEROTINIA HEAD ROT SEVERITY INDEX (0-5)



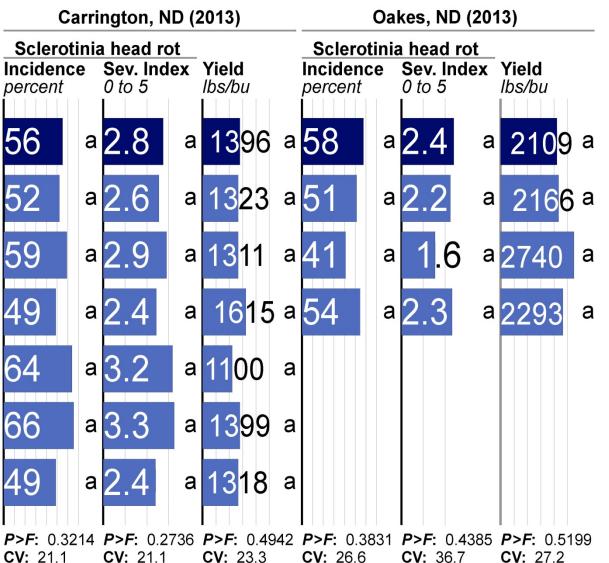
#### YIELD (pounds/acre)



### ONE vs. TWO vs. THREE APPLICATIONS

#### **Application timing:**

- (A): early bloom
- (B): 10-12 days after application A
- (C): 8-10 days after application B
- Non-treated check (A) water
- Endura 70WG 9 oz/ac (A) boscalid 441 g ai/Ha
- Endura 70WG 9 oz/ac (A,B) boscalid 441 g ai/Ha
- Endura 70WG 9 oz/ac (A,B,C) boscalid 441 g ai/Ha
- Omega 500F 16 fl oz/ac (A) fluazinam 585 g ai/Ha
- Omega 500F 16 fl oz/ac (A,B) fluazinam 585 g ai/Ha
- Omega 500F 16 fl oz/ac (A,B,C) 49 fluazinam 585 g ai/Ha



# WHEN APPLIED ACROSS THE TOP OF THE CANOPY, FOLIAR FUNGICIDES EXHIBIT LITTLE OR NO EFFICACY AGAINST SCLEROTINIA HEAD ROT

The poor efficacy is likely due to the difficulty of achieving satisfactory fungicide coverage.



# Thank you!



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