Improving Management of Sclerotinia Stem Rot (White Mold) in Soybeans

Michael Wunsch, Michael Schaefer, Suanne Kallis, and Billy Kraft

The Carrington Research Extension Center is leading a multi-location research effort to improve the management of Sclerotinia stem rot (white mold) in soybeans, with an emphasis on improving our understanding of the impacts of seeding rate and row spacing on disease and yield and on optimizing fungicide usage.

Impact of row spacing and seeding rate on Sclerotinia

Producers concerned about Sclerotinia often plant soybeans to wide (30-inch) rows. However, while the use of wide row spacing reduces Sclerotinia, it also has undesirable agronomic impacts: canopy closure is delayed, which reduces yield potential and increases pressure from weeds.

For producers wanting to balance concerns about Sclerotinia with other agronomic priorities, an intermediate row spacing is often adopted. It is generally assumed that the use of an intermediate row spacing confers a moderate risk of Sclerotinia and that disease risk increases as row spacing is narrowed, with highest risk of Sclerotinia found when soybeans are solid-seeded. University studies evaluating the impact of row spacing on Sclerotinia in soybeans have given support to this perceived relationship between row spacing and risk of Sclerotinia, but the studies did not hold seeding rate constant as row spacing changed. As row spacing decreased, seeding rates were sharply increased, thereby reducing the impact that changes in row spacing have on the distance between plants within a row.

When row spacing has been tested while holding seeding rate constant, the impact on Sclerotinia and on soybean yield under Sclerotinia pressure has often been surprising. In a study conducted in Michigan in the late 1990s in which soybeans were planted at 174,000 seeds/ac, soybeans seeded to 7.5-inch rows produced better yields than soybeans seeded to 30-inch rows under high Sclerotinia pressure. In trials conducted in Carrington, ND, in 2013 and 2014 in which 14 soybean varieties were seeded to rows 7, 14, 21, and 28 inches apart and seeding rate was held constant at 165,000 viable seeds/ac, Sclerotinia levels were consistently lowest in soybeans seeded to 28-inch rows but disease levels were similar or even declined as row spacing decreased from 21 to 7 inches. Yields were optimized with narrow row spacing in 2013 and with wide row spacing in 2014 (Table 1).

Table 1 : Average Sclerotinia incidence and grain yield across 14 soybean varieties seeded to rows 7, 14, 21, and 28 inches apart in Carrington in 2013 and 2014. Within-column means followed by different letters are significantly different ($P < 0.05$).

Location:	Carrington		Carrington	
Year:	2013		2014	
Varieties assessed:	*14 varieties*		*14 varieties*	
	Sclerotinia Incidence	Yield	Sclerotinia Incidence	Yield
	percent	bu/ac	percent	bu/ac
7-inch row spacing	48 b	43 a	68 b	28 b
14-inch row spacing	53 c	42 a	74 b	26 b
21-inch row spacing	53 c	42 a	70 b	29 b
28-inch row spacing	42 a	40 b	55 a	33 a
F:	23.03	9.30	17.10	11.36
P>F:	< 0.0001	< 0.0001	< 0.0001	0.0004
CV:	8.5	4.0	13.9	15.5

To rigorously assess the impact of row spacing on Sclerotinia, multi-location research was initiated in 2015 to develop recommendations for maximizing soybean yield under Sclerotinia disease pressure. Testing was conducted at three seeding rates (132,000 pure live seeds/ac; 165,000 pls/ac; and 198,000 pls/ac) representing the full range of seeding rates commonly employed in North Dakota. Seed yield and quality results are still being assessed for many of the trials, but preliminary results parallel findings from 2013 and 2014. Seeding soybeans to rows 28 inches apart consistently minimized Sclerotinia and resulted in the lowest levels of contamination of the grain with sclerotia (fungal resting structures) but, even under high Sclerotinia pressure, yields were optimized in soybeans seeded to rows 14 or 21 inches apart (Tables 2 and 3). Increasing the seeding rate increased Sclerotinia disease severity and contamination of harvested grain with sclerotia but had little impact on yield. However, additional research is required before rigorous conclusions can be reached. Additional results from 2015 will be available later this winter, and more testing is planned for 2016.

Stem sclerotia on soybean.

Table 2: Impact of seeding rate and row spacing on the performance of the 0.4-maturity soybean variety Mycogen '5B040R2' under conditions favoring Sclerotinia early, intermediate, and late in crop development; Carrington, ND (2015). Early, intermediate, and late Sclerotinia disease development was facilitated by differential timing of supplemental irrigation. Within-column means followed by different letters are significantly different ($P < 0.05$).

Irrigation timing:	Supplemental irrigation: July 22-Aug. 3 (R2-R4 growth stage)					Supplemental irrigation: Aug. 8-31 (R4-R7 growth stage)					Supplemental irrigation: Aug. 16-31 (R5-R7 growth stage)				
	Canopy closure	Sclerotinia incidence	Sclerotinia severity	Contamination of grain with sclerotia	Yield	Canopy closure	Sclerotinia incidence	Sclerotinia severity	Contamination of grain with sclerotia	Yield	Canopy closure	Sclerotinia incidence	Sclerotinia severity	Contamination of grain with sclerotia	Yield
	days after bloom initiation	*%*	*1 to 3*	*% by weight*	*bu/ac*	*days after bloom initiation*	*%*	*1 to 3*	*% by weight*	*bu/ac*	*days after bloom initiation*	*%*	*1 to 3*	*% by weight*	*bu/ac*
Row spacing (combined results across all three seeding rates)															
7-inch row spacing	5 a	37 b	2.83 a	1.25 a	40 ab	4 a	31 b	2.57 a	0.77 a	51 ab	4 a	23 b	2.45 a	0.53 a	49 bc
14-inch row spacing	6 a	38 b	2.84 a	1.42 a	43 ab	5 a	33 b	2.65 a	0.72 a	54 a	6 a	24 b	2.51 a	0.42 a	53 a
21-inch row spacing	14 b	35 ab	2.82 a	1.26 a	44 a	14 b	28 ab	2.49 a	0.57 a	51 ab	12 b	19 ab	2.38 a	0.42 a	52 ab
28-inch row spacing	19 c	29 a	2.85 a	1.02 a	39 b	21 c	23 a	2.47 a	0.51 a	48 b	23 c	15 a	2.32 a	0.36 a	47 c
Seeding rate (combined results across all four row spacings)															
132,000 viable seeds/ac	11 b	32 a	2.79 a	0.95 a	42 a	11 a	30 a	2.47 a	0.60 a	50 a	12 a	21 a	2.27 a	0.37 a	50 a
198,000 viable seeds/ac	11 a	37 a	2.88 a	1.53 b	41 a	11 a	27 a	2.62 b	0.68 a	51 a	11 a	20 a	2.56 b	0.50 a	51 a
CV:	17.9	22.0	3.0	10.0	33.8	18.6	19.8	8.1	32.1	6.2	19.8	25.3	7.8	34.1	6.0

Table 3: Impact of seeding rate and row spacing on the performance of three soybean varieties under high Sclerotinia disease pressure; Langdon, ND (2015). Research conducted by Venkata Chapara and Amanda Arens of the NDSU Langdon Research Extension Center. Within-column means followed by different letters are significantly different ($P < 0.05$).

Soybean variety:	Dairyland 'C506/R2Y' (0.05 maturity)					Dairyland 'C905/R2Y' (0.09 maturity)					Dairyland 'C918/R2Y' (0.09 maturity)				
	Canopy closure	Sclerotinia incidence	Sclerotinia severity	Contamination of grain with sclerotia	Yield	Canopy closure	Sclerotinia incidence	Sclerotinia severity	Contamination of grain with sclerotia	Yield	Canopy closure	Sclerotinia incidence	Sclerotinia severity	Contamination of grain with sclerotia	Yield
	days before/after bloom initiation	*%*	*1 to 3*	*% by weight*	*bu/ac*	*days before/after bloom initiation*	*%*	*1 to 3*	*% by weight*	*bu/ac*	*days before/after bloom initiation*	*%*	*1 to 3*	*% by weight*	*bu/ac*
Row spacing (combined results across all three seeding rates)															
7-inch row spacing	-8 a	24 b	2.65 a	0.10 ab	40 bc	-9 a	25 a	2.70 ab	0.12 a	40 ab	-9 a	37 b	2.72 a	0.12 a	39 b
14-inch row spacing	-7 a	27 b	2.54 a	0.12 b	41 ab	-8 a	30 ab	2.64 a	0.16 ab	42 a	-7 a	38 b	2.59 a	0.13 ab	41 ab
21-inch row spacing	4 b	23 ab	2.49 a	0.09 ab	44 a	5 b	33 b	2.81 b	0.22 b	38 ab	3 b	39 b	2.59 a	0.24 b	45 a
28-inch row spacing	8 c	17 a	2.55 a	0.03 a	37 c	8 c	29 ab	2.79 ab	0.14 ab	36 b	7 c	29 a	2.65 a	0.15 ab	41 b
Seeding rate (combined results across all four row spacings)															
132,000 viable seeds/ac	0 a	22 a	2.51 a	0.09 a	40 a	-1 a	27 a	2.60 a	0.16 a	40 a	-1 a	35 a	2.58 a	0.15 a	42 a
165,000 viable seeds/ac	-2 a	24 a	2.51 a	0.08 a	41 a	-1 a	28 a	2.80 b	0.14 a	39 a	-1 a	31 a	2.63 a	0.13 a	43 a
198,000 viable seeds/ac	-1 a	22 a	2.66 a	0.08 a	41 a	-1 a	32 a	2.80 b	0.17 a	39 a	-2 a	41 a	2.70 a	0.20 a	41 a
CV:	27.7	36.2	7.2	82.2	8.0	17.6	21.8	5.9	52.8	10.1	28.4	18.6	7.5	79.9	12.5

Optimizing fungicide usage

Multi-location research conducted or coordinated by the Carrington Research Extension Center strongly suggests that the current recommendation of applying fungicides at bloom initiation (R1 growth stage) when targeting Sclerotinia stem rot may not be optimal. Across seven trials conducted on soybeans seeded to narrow rows (7 to 15 inches) and four trials conducted on soybeans seeded to wide rows (21 to 30 inches), delaying applications of the fungicide Endura (5.5 or 8.0 oz/ac) until 80 to 90 percent of plants have reached the R2 growth stage (soybeans seeded to narrow rows) or until 100 percent of plants have reached the R2 growth stage (soybeans seeded to wide rows) maximized Sclerotinia control and yield. Under high Sclerotinia pressure, applications at bloom initiation (80 to 90% of plants at R1) resulted in an average yield gain of 5 bu/ac, while applications at early to full R2 resulted in an average yield gain of 8 bu/ac (Table 4). Applications of Endura (5.5 or 8.0 oz/ac) at the R1 growth stage did not optimize Sclerotinia control or soybean yield in any of the trials (Tables 5 and 6). Additional testing is planned for 2016, and final conclusions will be reached after next season. The fungicide tested in these trials was Endura (active ingredient, boscalid), and producers are cautioned that the optimal application timing of other fungicides could be different.

Table 4. Impact of fungicide application timing on Sclerotinia disease control and yield in soybeans seeded to rows 7 to 15 and 21 to 28 inches wide in Carrington, Langdon, and Oakes, ND, in 2014-15. Results are average values across seven trials planted to narrow rows and four trials planted to wide rows. Within-column means followed by different letters are significantly different ($P < 0.05$).

	Fungicide (application timing)	Sclerotinia Incidence %	Yield bu/ac
Soybeans seeded to rows 7 to 15 inches wide			
1	Non-treated check	**61**	**35**
2	Endura 5.5 or 8.0 oz/ac (80-90% at R1 growth stage)	**49**	**40**
3	Endura 5.5 or 8.0 oz/ac (80-90% at R2 growth stage)	**34**	**43**
Soybeans seeded to rows 21 to 28 inches wide			
1	Non-treated check	**54**	**38**
2	Endura 70WG 8 oz/ac (80-90% at R1 growth stage)	**42**	**43**
3	Endura 70WG 8 oz/ac (80-90% at R2 growth stage)	**33**	**44**
4	Endura 70WG 8 oz/ac (100% R2; 1-2 days after treatment 3)	**30**	**46**
5	Endura 70WG 8 oz/ac (R2; 3-4 days after treatment 3)	**30**	**46**

Table 5. Impact of fungicide timing on Sclerotinia control and yield in soybeans seeded to rows 21 to 28 inches apart; Carrington and Oakes, ND (2014-15). In 2014, Endura was applied at 8.0 oz/ac; in 2015, Endura was applied at 5.5 oz/ac. Leonard Besemann and Heidi Eslinger conducted the trial in Oakes. Within-column means followed by different letters are significantly different ($P < 0.05$).

	Fungicide (application timing)	Carrington 2014 21-inch May 27 Dairyland 'DSR0404' Sept. 1	Carrington 2014 28-inch May 27 Dairyland 'DSR0404' Sept. 1	Oakes 2014 28-inch May 26 Dairyland 'DSR0404' Sept. 11	Carrington 2015 28-inch May 8 Dairyland 'DSR0404' Aug. 31
Sclerotinia incidence (%)					
1	Non-treated check	**80** c*	**60** b*	**55** b*	**23** b*
2	Endura 5.5 or 8.0 oz/ac (80-90% at R1 growth stage)	**63** b	**46** ab	**47** ab	**11** a
3	Endura 5.5 or 8.0 oz/ac (80-90% at R2 growth stage)	**54** ab	**34** a	**36** a	**8** a
4	Endura 5.5 or 8.0 oz/ac (100% R2; 1-2 days after treatment 3)	**43** a	**32** a	**34** a	**12** ab
5	Endura 5.5 or 8.0 oz/ac (R2; 3-4 days after treatment 3)	**46** a	**31** a	**34** a	**10** a
6	Endura 5.5 or 8.0 oz/ac (R2 to R3; 7-8 days after treatment 3)	**52** ab	**39** a	No data	**12** ab
Soybean yield (bu/ac)					
1	Non-treated check	**23** c*	**30** b*	**51** b*	**47** a*
2	Endura 5.5 or 8.0 oz/ac (80-90% at R1 growth stage)	**31** bc	**35** ab	**57** ab	**49** a
3	Endura 5.5 or 8.0 oz/ac (80-90% at R2 growth stage)	**33** a	**37** ab	**59** a	**48** a
4	Endura 5.5 or 8.0 oz/ac (100% R2; 1-2 days after treatment 3)	**34** a	**40** a	**59** a	**50** a
5	Endura 5.5 or 8.0 oz/ac (R2; 3-4 days after treatment 3)	**36** a	**39** a	**59** a	**50** a
6	Endura 5.5 or 8.0 oz/ac (R2 to R3; 7-8 days after treatment 3)	**34** ab	**37** ab	No data	**49** a
	F:	32.98	3.84	4.63	1.55
	P > *F*:	< 0.0001	0.0082	0.0083	0.2115
	CV:	6.8	13.1	6.8	4.8

Table 6. Impact of fungicide timing on Sclerotinia control and yield in soybeans seeded to rows 7 to 15 inches apart; Carrington, Langdon, and Oakes, ND (2014-15). In 2014, Endura was applied at 8.0 oz/ac; in 2015, Endura was applied at 5.5 oz/ac. Leonard Besemann and Heidi Eslinger conducted the trial in Oakes, and Pravin Gautam and Amanda Arens conducted the trial in Langdon. Within-column means followed by different letters are significantly different ($P < 0.05$).

	Fungicide (application timing)	Carrington 2014 7-inch May 27 Dairyland 'DSR0404' Sept. 1	Carrington 2014 14-inch May 27 Dairyland 'DSR0404' Sept. 1	Langdon 2014 15-inch May 29 Mycogen '5B005' Sept. 6	Oakes 2014 14-inch May 26 Dairyland 'DSR0404' Sept. 11	Carrington 2015 14-inch May 8 Dairyland 'DSR0404' Aug. 31	Carrington 2015 14-inch May 21 Dairyland 'DSR0404' Sept. 7	Carrington 2015 14-inch May 21 Dairyland 'DSR0305' Sept. 6-7
Sclerotinia incidence (%)								
1	Non-treated check	**73** b*	**85** c*	**82** b*	**64** a*	**34** b*	**37** b*	**48** b*
2	Endura 5.5 or 8.0 oz/ac (80-90% at R1 growth stag	**60** b	**68** b	**72** b	**56** a	**28** ab	**26** ab	**30** ab
3	Endura 5.5 or 8.0 oz/ac (80-90% at R2 growth stag	**44** a	**51** a	**25** a	**54** a	**18** a	**16** a	**28** a
4	Endura 5.5 or 8.0 oz/ac (100% at R2 growth stage)					**16** a	**19** a	**22** a
Soybean yield (bu/ac)								
1	Non-treated check	**25** c*	**25** b*	**26** b*	**46** b*	**45** b*	**37** b*	**42** a*
2	Endura 5.5 or 8.0 oz/ac (80-90% R1 growth stage)	**32** b	**30** a	**30** b	**55** a	**48** ab	**41** ab	**47** a
3	Endura 5.5 or 8.0 oz/ac (80-90% R2 growth stage)	**37** a	**31** a	**39** a	**54** a	**51** a	**44** a	**47** a
4	Endura 5.5 or 8.0 oz/ac (100% R2 growth stage)					**50** ab	**43** a	**49** a
	CV:	9.0	9.2	9.8	8.3	6.8	6.8	11.2