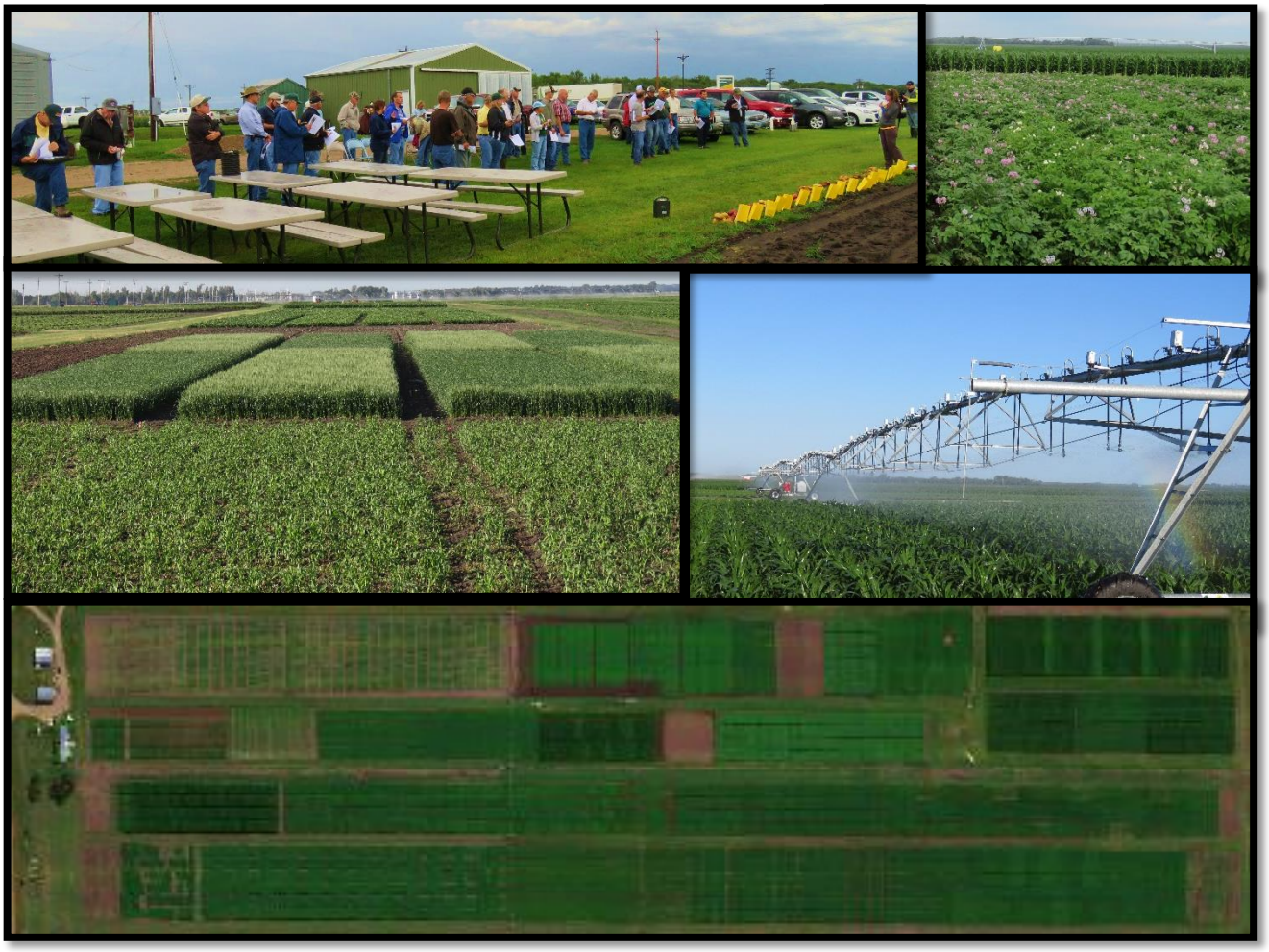
Oakes Irrigation Research Site

Robert Titus Research Farm

Carrington Research Extension Center

North Dakota State University

Garrison Diversion Conservancy District



2016 ANNUAL REPORT

Blaine Schatz	Director/Agronomist
Kelly Cooper	Research Agronomist
Leonard Besemann	Research Specialist
Heidi Eslinger	Research Technician

NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

In addition to the major sponsors: Garrison Diversion Conservancy District and North Dakota State University; we would like to acknowledge and thank the following people and companies for their support of the Oakes Irrigation Research Site.

Companies that have provided financial sponsorship, grants or gifts:

James Valley Grain

USDA National Sclerotinia Initiative

North Dakota Corn Growers Association

North Dakota Soybean Council

Wheat Growers

Companies and individuals that donated seed, chemicals, supplies or equipment:

BASF
Bayer CropScience
Bejo
CCSP – Forman
Charnell Haak
County 14 Seed
Domine Seed Farms
Dow AgroSciences
DuPont
GRG Farms
Norman Haak
Robert Titus
Tom Rodine

Summer help – Christine Halvorson

Annual reports for 1996-2016 are available at www.ag.ndsu.nodak.edu/oakes/oakes.htm

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Oakes Irrigation Research Site - Updates

Kelly Cooper

I must first thank all of the people involved in making the Oakes Irrigation Research Site Robert Titus Research Farm a success and focal point for advancing agriculture efficiency and productivity in our region. Robert and Elsie Titus have secured a future where students, industry, researchers and the general public can be assured of access to land where crops are grown under irrigation in southeast North Dakota. This was our first year with the expanded site of nearly 40 acres. To cover the new land, a new irrigation system was installed with a new water supply. The lateral irrigation system, sometimes called "linear move" is state of the art. The irrigation system, known as "Variable Rate Irrigation" or VRI, can control each nozzle individually and has the capability of delivering separate amounts of water to individual plots. This gives the site the unique ability to more readily manage various types of crops, and look at the effects of different watering regimes. This can be done to study disease management, water application efficiency and yield outcomes. The new water supply, a horizontal well, performed without issues and delivered ample, sand-free water throughout the irrigation season. The North Dakota State Water Commission is planning on installing monitoring wells so we can learn more about how these relatively new wells function throughout the year. This type of well was a good choice for our area due to the shallow aquifer and lack of silt or clay in the zone of installation.

This was also my first year here, and as the Research Agronomist, I must say it was a privilege to work with the well trained and organized staff both here at Oakes and Carrington. I also very much enjoyed meeting and working with the researchers, educators, farmers, students, and industry professionals who were involved with our site. I look forward to a new year and stretching our capabilities into new areas of irrigation research and soil health.

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RESEARCH PROGRAM

Data on irrigated crop production have been collected for the past 46 years on approximately 20 acres at the Oakes Irrigation Research Site located on the Robert Titus farm. In 2016 the site increased in size to about 40 acres due to the foresight and generosity of Robert Titus. The site is located 4.5 miles south of Oakes adjacent to North Dakota State Highway 1. The objectives of these studies are to:

1. Provide irrigators with information that results in efficient crop production.

2. Develop and refine Best Management Practices that are producer acceptable.

3. Promote irrigation development in North Dakota.

4. Determine alternate and specialty crops to be grown under irrigation in North Dakota and develop agronomic practices for their successful adaptation.

A cooperative agreement between North Dakota State University and the Garrison Diversion Conservancy District makes this research effort possible. The University provides technical staff: Kelly Cooper, research agronomist; Leonard Besemann, research specialist; and Heidi Eslinger, research technician. The Garrison Diversion Conservancy District provides most of the financial support. North Dakota State University faculty and staff from the departments of Soil Science, Plant Science, Agricultural and Biosystems Engineering, Plant Pathology, and the Agricultural Experiment Station participate in conducting experiments at the site.

WEATHER 2016

The winter of 2015 - 2016 was non-eventful. Temperatures followed a typical winter in North Dakota with warm and cool temperatures through the winter months with no extremes. The amount of snow received for the winter was less than the long-term average. Most field work and planting dates were near seasonal averages. The last frost in the spring was on May 17. The maximum temperature equaled or exceeded 90°F fifteen times; five times in June, seven times in July and three times in August. The high temperature was 97°F on July 20. Precipitation was about 1½ to 2 inches below the long-term average in May, June and September. Precipitation was above the long-term average in April, July, August and September. The months of July and August nearly doubled the long-term average for those months. The total rainfall for the season was about 2.75 inches above long-term average (April to October). The mean daily temperatures were two to four degrees above of the long-term averages for the season except for April, which was near the long-term average. The first frost was October 6 with the first hard frost (≤ 28°F) October 7. All crops reached maturity before frost. Growing degree units in 2016 were above the long-term average.

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Table 1. Precipitation and temperature at the Oakes Irrigation Research Site.

	Precipitation			Average daily temperatures		
Month	2016	15-year average	25-year average	2016	15-year average	25-year average
	----------inches----------			----------°F----------		
April	2.87	1.56	1.54	43	44	43
May	2.02	3.41	3.11	58	56	56
June	2.58	4.70	4.23	70	67	66
July	5.52	2.85	3.27	73	71	71
August	5.06	2.52	2.28	71	69	69
September	1.02	2.43	2.70	63	61	60
October	3.15	2.13	2.21	50	46	46

Table 2. Growing degree units[1] at the Oakes Irrigation Research Site.

Month	2016	10-year average	15-year average	25-year average
May	366	312	298	306
June	579	512	511	500
July	683	654	654	632
August	640	586	580	581
September	433	389	388	375
Total	2699	2453	2432	2395

[1]Growing degree units = (Tempmax + Tempmin)/2 - 50. If Tempmax is greater than 86, then Tempmax = 86. If Tempmin is less than 50, then Tempmin = 50. Temperature is in degrees F.

Table 3. Dates of last and first frosts.

	2016	10-year average	15-year average	25-year average
Last frost in Spring				
32 °F or less	17-May	8-May	8-May	5-May
28 °F or less	14-May	25-Apr	28-Apr	27-Apr
First frost in Fall				
32 °F or less	6-Oct	6-Oct	3-Oct	2-Oct
28 °F or less	7-Oct	12-Oct	9-Oct	8-Oct
Frost free period (days)	142	150	148	149

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Table 4. Irrigation water applied, 2016.

Study	Irrigation water applied
	inches
Dry edible bean variety trials	9.9
Field corn hybrid performance trial	12.9
Onion hybrid performance trial	11.7
Onion weed control study	12.5
Optimum corn stover removal for biofuel	
corn on corn	12.2
corn on soybean	12.9
soybean on corn	12.2
Potato trials	13.7
Sorghum	11.9
Soybean Sclerotinia study	15.9
Soybean studies	11.4
Soybean variety performance trials	12.9
Soybean studies - Mosaic/Summit	12.2
Strip-till	
corn on corn	12.2
corn on soybean	11.4
soybean on corn	12.2
Sunflower oilseed headrot study*	6.2
Sunflower fungicide drop nozzle study*	6.2
Wheat	3.0

*Received additional irrigation via the misting system.

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Dry Edible Bean Variety Trials

K. Cooper, L. Besemann and H. Eslinger

Dry edible beans play a significant role in irrigated rotations in southeastern North Dakota. As universities and private companies develop new varieties it is important to test them upon their release. Twenty-three edible bean varieties were tested: ten miscellaneous, four navy, and eight pinto.

MATERIALS AND METHODS

Soil:	Embden sandy loam; pH = 6.8; 2.7% organic matter; soil N was 25 lbs/acre; soil P and soil K were very high and soil S was very low.
Previous crop:	2015 - spring wheat
Seedbed preparation:	Spring conventional tillage.
Planting:	May 27 in 30-inch rows.
Plots:	Plots were 25 ft long by 5 ft (2 rows) wide. The study had four replications.
Fertilizer:	Broadcast 19 lbs N/acre, 50 lbs P_2O_5/acre, 45 lbs K_2O/acre and 10 lbs S/acre as 9-24-21-5 April 20.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Spartan Elite 22 oz/acre (May 24), Select Max 12 oz/acre + NIS 1 pt/100 gal + Interlock 4 oz/acre (June 13) for weed control. Endura 5.5 oz/acre (July 15) for disease control.
Harvest:	Hand harvested bean varieties August 29 to September 6 as they matured. Harvest area for all bean varieties was five feet (two rows wide) by approximately 21 feet. Beans were threshed with a stationary plot thresher September 1 to September 6.

RESULTS

The three classes of dry edible beans all had fair yields for the 2016 season. The mean yield of the miscellaneous beans was 2899 lbs/acre. Merlot (small red) had the highest yield of the miscellaneous beans yielding 3472 lbs/acre. The mean yield of the navy beans was 2848 lbs/acre. T9905 had the highest yield of the navy bean yielding 3134 lbs/acre. The mean yield of the pinto beans was 3240 lbs/acre. Windbreaker had the highest pinto bean yield at 3830 lbs/acre.

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Table 1. Misc Bean Variety Trial at the Oakes Irrigation Research Site in 2016.

Variety	Market Class	Days to PM	Seeds/ Pound	Seed Weight	Test Weight	Seed Yield 2016	Seed Yield 3-yr. Avg.
				grams/100	lb/bu	----- lb/ac -----	
Eclipse	Black Bean	83.3	2497	18.2	63.9	3130	3114
Merlot	Small Red	89.0	1295	35.1	60.3	3472	3295
Loreto	Black Bean	88.5	2543	17.9	63.1	2734	3051
Zorro	Black Bean	83.5	2536	17.9	63.9	2844	--
Rosie	Light Red Kidney	93.5	994	45.7	56.9	2616	--
Talon	Dark Red Kidney	89.8	1032	44.1	58.7	2754	--
Montcalm	Dark Red Kidney	89.3	964	47.2	57.2	2650	2645
Pink Panther	Light Red Kidney	87.3	876	51.9	56.7	2868	2634
Rosetta	Pink	85.5	1410	32.2	62.6	3222	--
Knight Rider	Black Bean	88.5	2570	17.8	62.9	2705	--
Mean		87.8	1672	32.8	60.6	2899	--
C.V. (%)		2.0	5.1	5.0	1.9	12.4	--
LSD 0.10		2.1	102	2.0	1.4	431	--
LSD 0.05		2.6	123	2.4	1.7	520	--

Planting date = May 24; Harvest date = August 29 - September 6; Previous crop = Spring wheat

Table 2. Navy Bean Variety Trial at the Oakes Irrigation Research Site in 2016.

Variety	Days to PM	Seeds/ Pound	Seed Weight	Test Weight	Seed Yield 2016	Seed Yield 3-yr. Avg.
			grams/100	lb/bu	----- lb/ac -----	
HMS Medalist	89.8	2609	17.5	65.3	2389	2959
Ensign	87.0	2307	19.7	64.9	3050	3110
Vista	89.3	2664	17.1	65.6	2819	2978
T9905	88.5	2221	20.5	64.6	3134	3300
Mean	88.7	2450	18.7	65.1	2848	--
C.V. (%)	2.9	5.2	5.3	0.42	13.7	--
LSD 0.10	3.3	166	1.3	0.35	507	--
LSD 0.05	4.0	205	1.6	0.43	626	--

Planting date = May 24; Harvest date = August 29 - August 30; Previous crop = Spring wheat

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Table 3. Pinto Bean Variety Trial at the Oakes Irrigation Research Site in 2016.

Variety	Days to PM	Seeds/ Pound	Seed Weight	Test Weight	Seed Yield 2016	Seed Yield 3-yr. Avg.
			grams/100	lb/bu	----- lb/ac -----	
LaPaz	87.3	1388	32.8	61.4	3407	3348
Lariat	90.3	1215	37.5	58.8	2829	3490
Stampede	84.8	1262	36.1	60.2	3438	3347
Maverick	86.8	1219	37.3	59.1	3301	3204
ND-307	89.3	1108	41.0	57.0	3534	--
Windbreaker	84.8	1181	38.5	59.6	3830	3709
Palomino	91.0	1155	39.3	55.2	2633	--
Monterrey	88.3	1305	34.9	61.3	2947	--
Mean	87.8	1229	37.2	59.1	3240	
C.V. (%)	2.1	4.0	3.8	1.6	9.8	
LSD 0.10	2.3	59	1.7	1.1	385	
LSD 0.05	2.8	71	2.1	1.4	465	

Planting date = May 24; Harvest date = August 29 - September 6; Previous crop = Spring wheat

Dry edible bean (misc) trial.

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Corn Hybrid Performance Trial - Irrigated

K. Cooper, L. Besemann and H. Eslinger

Corn for grain commands the most irrigated acres of all crops in North Dakota. The fact that significant differences in the accumulation of growing degree units for corn and other weather-related issues exist across the state, it is vital that corn hybrids be tested in specific locations and regions. It is the goal of this trial to provide yield and other agronomic parameters for corn growers in southeastern North Dakota. This trial tested 55 hybrids.

MATERIALS AND METHODS

Soil:	Embden loam, Gardena loam; pH = 6.7; 3.4% organic matter; soil N was 17 lbs/acre; soil P and soil K were very high soil S was low.
Previous crop:	2015 - spring wheat
Seedbed preparation:	Spring conventional tillage.
Planting:	Planted May 12 in 30-inch rows. Thinned to 36,900 plants/acre.
Fertilizer:	Broadcast 19 lbs N/acre, 50 lbs P_2O_5/acre, 45 lbs K_2O/acre and 10 lbs S/acre as 9-24-21-5 April 20. Stream bar 50 lbs N/acre May 16 as 28-0-0. Sidedress 145 lbs N/acre June 17 as 28-0-0.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest Control:	Harness (2 pt/acre) May 5, Laudis (3 oz/acre) + AAtrex 9-O (0.5 lb ai/acre) + Destiny (0.05% v/v) + Interlock (4 oz/acre) May 23.
Harvest:	October 28 with a plot combine. Harvest area was two rows 21 feet long.

RESULTS

The overall mean of 248.8 bu/acre was almost the same as 2015 (249.0 bu/acre). Yields ranged from 204.1 bu/acre to 277.5 bu/acre.

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Table 1. Corn hybrid performance trial at the Oakes Irrigation Research Site in 2016.

Brand	Hybrid	RM	Hybrid Traits[1]	Days to Silk	Ear Ht.	Plant Ht.	Root Lodging	Grain Protein	Content Starch	Content Oil	Moist.	Test Weight	Grain Yield 2016	Grain Yield 2 yr. Avg.
					inch	inch		%	%	%	%	lb/bu	bu/ac	bu/ac
Channel	193-53 VT2PRIB	93	VT2PRIB	68.3	47.8	98.2	0.1	8.7	73.5	3.4	19.2	56.1	244.6	--
Channel	194-14 VT2PRIB	94	VT2PRIB	69.5	48.9	102.6	0.4	8.9	73.3	3.2	18.6	55.9	235.3	246.3
Channel	195-18 VT2PRIB	95	VT2PRIB	69.5	47.7	97.4	0.0	9.3	72.7	3.7	20.3	57.2	265.5	--
Channel	197-50 VT2PRIB	97	VT2PRIB	69.3	48.0	102.8	0.0	8.9	73.0	3.3	19.9	55.8	258.4	261.7
Dairyland Seed	DS-9487SSX	87	SSX	66.0	47.3	93.9	0.0	9.2	73.1	2.9	18.3	55.5	204.1	--
Dairyland Seed	DS-7294	94	3110	69.8	57.3	106.8	0.5	10.0	72.7	3.0	19.5	56.6	270.2	--
Dairyland Seed	DS-9599	99	300GT	70.8	53.2	105.8	0.1	9.2	73.1	3.3	20.9	54.5	256.6	--
Dairyland Seed	DS-9802		SSX	69.0	50.7	97.1	0.4	8.5	73.0	3.5	20.9	53.6	234.7	--
Dairyland Seed	DS-9198RA	98	SSX	70.0	48.7	98.3	0.0	9.4	72.4	3.6	20.3	52.7	234.1	233.6
Dairyland Seed	DS-9701RA	101	SSX	70.0	46.5	96.8	0.0	8.9	72.4	3.6	21.2	53.4	242.8	246.2
Innotech	IC4453-3110	94	Agrisure Viptera 3110	70.3	54.0	105.2	0.3	9.9	72.7	3.1	18.6	57.0	239.6	248.8
Innotech	IC4688-3010	96	Agrisure 3010	70.3	53.2	104.3	0.0	8.8	73.6	3.3	20.0	54.6	266.7	--
Innotech	IC4730-3010	97	Agrisure 3010	69.0	49.8	102.5	0.5	9.2	73.6	2.9	19.8	56.0	238.9	--
Integra	5151			71.8	53.4	102.4	0.0	9.1	73.0	3.4	20.9	55.2	248.9	--
Latham	LH4454	94	VT2Pro	69.8	48.9	99.3	0.0	9.1	72.8	3.5	19.2	56.7	244.5	--
Latham	LH4727	97	VT2Pro	70.5	50.0	102.5	0.0	9.0	72.6	3.5	19.9	55.3	275.6	--
Latham	LH4955	99	VT2Pro	70.0	51.5	100.7	0.0	9.1	72.6	3.5	20.1	54.9	262.9	--
Latham	LH5095	100	VT2Pro	70.0	49.3	97.7	0.0	9.1	72.5	3.6	21.3	55.3	266.0	--
Latham	LH5215		VT2Pro	70.3	49.5	102.4	0.9	8.8	72.4	4.0	22.5	54.3	256.6	265.6
	MEAN			69.6	50.1	100.8	0.2	9.1	72.9	3.4	19.8	55.6	248.8	--
	C.V. (%)			0.8	3.7	2.2	210.9	2.4	0.6	6.8	3.9	1.1	5.7	--
	LSD 0.10			0.7	2.2	2.6	0.6	0.3	0.5	0.3	0.9	0.7	16.7	--
	LSD 0.05			0.8	2.6	3.1	0.7	0.3	0.6	0.3	1.1	0.9	19.9	--

Planting date = May 12; Harvest date = October 28; Previous crop = Spring wheat

Table 1. Corn hybrid performance trial at the Oakes Irrigation Research Site in 2016.

Brand	Hybrid	RM	Hybrid Traits[1]	Days to Silk	Ear Ht.	Plant Ht.	Root Lodging	Grain Protein	Content Starch	Content Oil	Moist.	Test Weight	Grain Yield 2016	Grain Yield 2 yr. Avg.
					inch	inch		%	%	%	%	lb/bu	bu/ac	bu/ac
Legacy Seeds	L-3115 VT2PRO	92	VT2PRO	70.0	50.1	97.9	0.0	9.2	72.7	3.5	18.6	55.7	226.4	234.5
Legacy Seeds	L-3043 VT2PRO	93	VT2PRO	69.3	46.3	96.4	0.4	8.3	73.4	3.4	18.8	56.7	231.4	233.7
Legacy Seeds	L-3416 VT2PRO	94	VT2PRO	68.8	47.2	100.1	1.6	8.8	73.5	3.6	20.2	54.9	233.0	--
Legacy Seeds	L-3712 VT3PRO	96	VT3PRO	70.3	47.2	99.2	0.0	9.0	72.8	3.5	19.7	56.0	268.3	257.4
Legacy Seeds	L-3715 GENSS	96	GENSS	69.0	50.4	97.2	0.1	8.9	73.4	3.2	19.8	56.1	252.5	--
NuTech	5B-293	93	GT/CB/LL	69.8	55.0	105.0	0.5	9.9	72.7	3.2	19.9	57.3	245.8	--
NuTech	X5N-9901	99	3000GT	70.0	53.5	107.0	1.3	9.7	73.0	3.0	19.7	56.0	246.4	--
NuTech/G2 Genetics	5F-198	98	Optimum AcreMax	70.3	53.9	105.3	0.1	8.8	72.4	3.7	19.7	52.6	277.5	268.0
NuTech/G2 Genetics	5F-196	96	Optimum AcreMax	69.3	51.0	103.7	0.1	8.6	73.1	3.1	20.7	53.4	267.5	252.9
NuTech/G2 Genetics	5F-894	94	Optimum AcreMax	68.0	48.3	97.4	0.0	8.9	73.2	3.4	19.1	53.9	257.6	251.8
NuTech/G2 Genetics	X5Y-9902	99	Optimum Intrasect Xtra	67.5	49.3	99.9	0.0	9.5	72.4	3.5	19.7	55.4	268.5	--
PFS	PFS76S92 VT2PRO	92	VT2PRO	69.8	45.7	96.6	0.0	8.7	72.9	3.6	18.9	56.5	239.3	233.8
PFS	PFS81W95 VT2PRO	95	VT2PRO	69.3	50.1	101.4	0.0	9.1	73.0	3.5	19.9	55.1	258.9	260.2
PFS	PFS77P94 VT2PRO	94	VT2PRO	68.5	48.8	103.3	1.6	9.0	73.0	3.4	19.8	55.6	230.9	--
Proseed	1295 SS RIB	95	VT2P	69.5	48.0	99.7	0.6	9.2	72.7	3.6	21.0	56.3	239.9	--
Proseed	1193 VT2P	93	VT2P	68.3	45.8	100.0	1.3	9.1	73.2	3.3	19.3	57.7	225.7	--
Proseed	PX695 VIP 3	95	VIP 3	69.3	56.4	105.7	0.1	9.9	73.0	2.9	18.9	57.1	260.0	--
Proseed	1495 SS	95		70.0	49.5	100.1	0.0	9.2	72.4	3.7	20.2	55.5	249.5	255.5
Proseed	1496SS VT2PRO	96	VT2P	71.0	49.4	99.4	0.0	9.2	72.7	3.2	21.4	55.6	242.9	242.0
	MEAN			69.6	50.1	100.8	0.2	9.1	72.9	3.4	19.8	55.6	248.8	--
	C.V. (%)			0.8	3.7	2.2	210.9	2.4	0.6	6.8	3.9	1.1	5.7	--
	LSD 0.10			0.7	2.2	2.6	0.6	0.3	0.5	0.3	0.9	0.7	16.7	--
	LSD 0.05			0.8	2.6	3.1	0.7	0.3	0.6	0.3	1.1	0.9	19.9	--

Planting date = May 12; Harvest date = October 28; Previous crop = Spring wheat

Table 1. Corn hybrid performance trial at the Oakes Irrigation Research Site in 2016.

Brand	Hybrid	RM	Hybrid Traits[1]	Days to Silk	Ear Ht.	Plant Ht.	Root Lodging	Grain Protein	Content Starch	Content Oil	Moist.	Test Weight	Grain Yield 2016	Grain Yield 2 yr. Avg.
					inch	inch		%	%	%	%	lb/bu	bu/ac	bu/ac
REA Hybrids	4B931-RIB	93	RR2, Bt	68.8	49.2	101.0	0.0	8.8	73.1	3.5	19.8	55.3	247.5	--
REA Hybrids	4B953-RIB	95	RR2, Bt	70.0	50.1	102.9	0.1	8.9	73.2	3.4	18.4	56.6	246.3	250.0
REA Hybrids	4A962-RIB	96	RR2, Bt, CRW	69.8	49.4	103.2	0.0	9.3	73.1	3.1	21.0	56.0	255.1	255.2
REA Hybrids	5A982-RIB	98	RR2, Bt, CRW	71.3	49.8	103.2	0.1	8.7	72.8	3.7	20.4	56.1	237.7	--
Renk	RK522SSTX	94	SSTX	70.0	48.7	99.6	0.0	9.1	72.9	3.4	20.2	55.3	245.0	247.1
Renk	RK566SSTX	94	SSTX	69.3	50.3	97.7	0.6	8.8	73.1	3.3	20.4	55.1	242.1	--
Renk	RK568VT3P	95	VT3P	69.8	47.4	98.2	0.0	9.1	72.8	3.4	19.1	56.6	254.6	253.2
Rob-See-Co	RC4343-3110A	93	Agrisure Viptera 3110A	69.3	57.2	106.5	0.4	9.8	73.2	3.0	19.0	57.1	255.3	--
Rob-See-Co	RC5112-3011A	101	Agrisure Artesian 3011A	70.8	51.4	104.1	0.0	9.3	72.8	3.2	20.3	56.2	253.0	--
Thunder	6791 VT2P	91	VT2P	69.0	48.8	98.3	0.0	9.0	72.7	3.7	18.2	55.6	257.8	--
Thunder	7993 VT2P	93	VT2P	69.5	45.3	96.3	0.0	8.7	73.1	3.7	19.4	56.5	238.8	242.9
Thunder	7396 VT2P	96	VT2P	70.0	52.6	101.7	0.0	9.5	72.8	3.6	19.7	55.4	240.8	248.1
Wensman	W80972VT2PRO	97	VT2PRO	69.5	46.9	95.4	0.0	8.6	73.4	3.2	19.4	55.5	251.8	--
Wensman	W90941STXRIB	94	STXRIB	69.0	50.2	98.5	0.0	9.0	72.6	3.5	19.3	55.5	259.1	--
Wensman	W90962STXRIB	96	STXRIB	69.3	52.2	101.8	0.0	9.2	72.7	3.6	20.0	55.1	238.8	257.2
Wensman	W90979STXRIB	97	STXRIB	69.8	51.2	97.5	0.4	8.7	73.5	3.1	20.4	56.7	242.5	255.9
Wensman	W90994STX RIB	99	STXRIB	70.8	53.5	104.8	0.3	9.3	72.5	3.6	20.4	54.3	251.9	249.8
	MEAN			69.6	50.1	100.8	0.2	9.1	72.9	3.4	19.8	55.6	248.8	--
	C.V. (%)			0.8	3.7	2.2	210.9	2.4	0.6	6.8	3.9	1.1	5.7	--
	LSD 0.10			0.7	2.2	2.6	0.6	0.3	0.5	0.3	0.9	0.7	16.7	--
	LSD 0.05			0.8	2.6	3.1	0.7	0.3	0.6	0.3	1.1	0.9	19.9	--

Planting date = May 12; Harvest date = October 28; Previous crop = Spring wheat

[1]Hybrid traits as reported by seed company when hybrids submitted for evaluation.

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Corn Hybrid Performance Trial – Dryland

K. Cooper, L. Besemann and H. Eslinger

A dryland corn hybrid performance trial was initiated in 2011 to provide information for corn producers in southeast and south central North Dakota. This study is conducted on Barnes-Svea soils that dominate the dryland farming in the area. This trial tested 63 hybrids.

MATERIALS AND METHODS

Soil:	Barnes-Svea; pH = 5.9; 3.1% organic matter; soil N was 20 lbs/acre; soil P was medium; soil K was very high; soil S was very low.
Previous crop:	2015 - soybean.
Seedbed preparation:	Spring conventional tillage.
Planting:	Planted May 11 in 30-inch rows. Thinned to 33,200 plants/acre.
Fertilizer:	Broadcast 19 lbs N/acre, 50 lbs P_2O_5/acre, 45 lbs K_2O/acre and 10 lbs S/acre as 9-24-21-5 April 21. Stream bar 50 lbs N/acre as 28-0-0 May 15. Sidedress 145 lbs N/acre June 17 as 28-0-0.
Pest control:	Harness (2 pt/acre) May 8, Laudis (3 oz/acre) + AAtrex 9-O (0.5 lb ai/acre) + Destiny (0.05% v/v) + Interlock (4 oz/acre) May 23.
Harvest:	October 20 and October 21 with a plot combine. Harvest area was two rows 21 feet long.

RESULTS

Overall yields were high with a mean of 225.0 bu/ac compared to the 182.7 bu/acre mean in 2015. Yields ranged from 181.8 bu/acre to 260.3 bu/acre.

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Table 2. Corn hybrid performance trial (dryland) Dickey County - Oakes Irrigation Research Site 2016.

Brand	Hybrid	RM	Hybrid Traits[1]	Days to Silk	Ear Ht.	Plant Ht.	Grain Protein	Starch Content	Oil Content	Harvest Moist.	Test Weight	Grain Yield 2016	Grain Yield 2 yr. Avg.
					inch	inch	%	%	%	%	lb/bu	bu/ac	bu/ac
Channel	193-53 VT2PRIB	93	VT2PRIB	69.3	43.7	92.3	9.2	72.8	3.2	19.2	54.0	233.9	--
Channel	194-14 VT2PRIB	94	VT2PRIB	70.5	45.3	94.8	9.3	72.7	3.2	18.5	54.0	241.6	220.3
Channel	195-18 VT2PRIB	95	VT2PRIB	71.3	43.0	89.8	9.6	72.0	3.9	21.1	55.5	227.7	--
Channel	197-50 VT2PRIB	97	VT2PRIB	71.0	46.3	96.3	9.3	72.5	3.2	20.9	52.9	240.6	--
Dairyland Seed	DS-9487SSX	87	SSX	67.5	44.2	88.7	9.8	72.4	3.0	18.3	53.3	216.9	195.3
Dairyland Seed	DS-7294	94	3110	71.0	53.8	99.5	10.4	72.3	3.0	19.1	54.6	233.9	--
Dairyland Seed	DS-9599	99	300GT	72.3	49.2	97.5	9.8	72.3	3.5	22.5	52.1	218.0	191.7
Dairyland Seed	DS-9802		SSX	71.3	47.0	91.4	8.8	72.7	3.9	22.4	50.4	193.5	--
Frontiersman	91-E3 VT2ProRIB	91	VT2ProRIB	69.5	44.7	90.8	9.5	72.8	3.2	18.2	54.8	197.5	197.6
Frontiersman	91-C6 VT2ProRIB	91	VT2ProRIB	71.3	45.4	91.0	9.6	72.2	3.6	18.0	55.0	238.9	--
Frontiersman	93-H6 GTCBLL	93	GTCBLL	71.0	51.3	95.9	10.6	72.1	3.1	18.7	54.6	201.7	--
Frontiersman	92-E5 VT2ProRIB	92	VT2ProRIB	71.3	43.1	93.3	9.3	72.1	3.7	19.7	54.3	222.4	207.1
Frontiersman	90-H33220 EZRefuge VIP	90	EZRefuge Viptera	72.3	53.0	98.8	10.4	72.3	2.8	19.3	53.0	190.4	--
Innotech	IC4453-3110	94	Agrisure Viptera 3110	71.0	52.3	95.1	10.9	72.7	2.5	18.2	55.4	228.5	198.1
Innotech	IC4688-3010	96	Agrisure 3010	71.5	48.3	96.3	9.2	73.1	3.1	20.3	53.7	247.8	--
Innotech	IC4730-3010	97	Agrisure 3010	71.0	47.0	97.8	9.3	73.6	3.2	21.9	52.9	213.7	--
Innotech	IC4173-3110A	91	Agrisure Viptera 3110A	69.8	49.2	95.2	10.3	72.0	3.4	19.0	55.5	223.6	--
Integra	4652			69.5	45.4	88.1	9.6	72.7	3.0	20.7	53.6	244.5	--
Latham	LH4454	94	VT2Pro	71.3	43.4	92.5	9.5	72.4	3.2	20.1	54.6	228.1	--
Latham	LH4727	97	VT2Pro	72.0	45.9	95.2	9.5	71.8	3.5	20.6	52.9	243.1	--
Latham	LH4955	99	VT2Pro	71.8	46.2	92.4	9.5	71.9	3.5	20.9	52.0	227.8	--
	MEAN			70.8	45.6	92.8	9.6	72.5	3.3	19.3	54.0	225.0	--
	C.V. (%)			0.8	3.7	3.4	2.6	0.7	6.9	6.3	1.5	9.1	--
	LSD 0.10			0.7	1.9	3.7	0.29	0.6	0.26	1.4	0.9	24.0	--
	LSD 0.05			0.8	2.3	4.4	0.35	0.7	0.31	1.7	1.1	28.7	--

Planting date = May 11; Harvest date = October 21; Previous crop = Soybean

Table 2. Corn hybrid performance trial (dryland) Dickey County - Oakes Irrigation Research Site 2016.

Brand	Hybrid	RM	Hybrid Traits[1]	Days to Silk	Ear Ht.	Plant Ht.	Grain Protein	Starch Content	Oil Content	Harvest Moist.	Test Weight	Grain Yield 2016	Grain Yield 2 yr. Avg.
					inch	inch	%	%	%	%	lb/bu	bu/ac	bu/ac
Latham	LH4242	92	VT2Pro	71.3	43.4	90.3	9.4	72.6	3.3	18.2	55.2	204.9	198.4
Latham	LH4437	94	VT2Pro	69.3	42.9	92.6	9.2	72.7	3.2	19.8	53.6	235.5	--
Legacy Seeds	L-3115 VT2PRO	92	VT2PRO	70.5	44.7	89.2	9.6	72.3	3.5	17.0	54.9	221.0	205.3
Legacy Seeds	L-3043 VT2PRO	93	VT2PRO	70.8	44.8	91.3	9.5	72.6	3.3	17.8	54.9	234.2	213.0
Legacy Seeds	L-3416 VT2PRO	94	VT2PRO	69.5	43.7	95.4	9.4	72.8	3.2	19.3	54.2	228.4	--
Legacy Seeds	L-3712 VT3PRO	96	VT3PRO	71.5	41.6	88.4	10.0	72.1	3.3	19.3	55.3	231.9	200.5
Legacy Seeds	L-3715 GENSS	96	GENSS	71.3	45.0	91.4	9.2	72.8	3.1	20.1	53.5	210.4	--
Legend	LR 97A89		VIP 3011	67.5	45.1	93.3	9.4	73.0	3.1	18.6	55.7	224.2	--
Legend	LR 9691		VT2PRIB	71.0	45.1	94.4	9.3	72.3	3.5	18.5	55.0	260.3	--
Legend	LR 9697		VT2PRIB	72.8	45.7	93.0	9.5	71.8	3.8	21.1	51.5	231.1	--
Legend	LR 9497		VT2PRIB	71.8	43.0	89.9	9.7	72.6	3.0	19.4	53.7	203.1	187.1
NorthStar	NS 91-591 VT2P RIB	91	VT2P	69.5	43.9	91.0	9.1	73.1	3.1	18.4	54.4	228.2	208.8
NorthStar	NS 94-125 GenSS RIB	94	SmartStax	71.5	46.6	92.2	9.4	72.5	3.4	18.6	55.0	210.5	--
NorthStar	NS 95-135 VT2P	95	VT2P	69.8	44.8	92.1	9.4	73.0	3.2	20.4	56.4	243.1	--
NorthStar	NS 96-578	96	VT3P	71.5	42.7	90.7	9.5	72.6	3.3	19.7	54.0	232.9	--
NuTech	5B-293	93	GT/CB/LL	70.8	51.5	97.0	10.3	72.8	3.1	19.0	54.8	207.2	--
NuTech/G2 Genetics	5F-198	98	Optimum AcreMax	71.3	47.0	95.2	8.8	72.2	3.6	20.8	50.1	244.9	217.7
NuTech/G2 Genetics	5F-196	96	Optimum AcreMax	70.3	45.2	91.4	9.0	72.6	3.2	20.3	52.3	241.6	220.5
NuTech/G2 Genetics	5F-894	94	Optimum AcreMax	69.5	44.5	86.1	9.6	72.8	2.9	17.9	52.2	236.0	236
PFS	PFS76S92	92	VT2PRO	71.3	43.5	92.6	9.4	72.7	3.3	18.7	54.8	224.3	203.9
PFS	PFS81W95	95	VT2PRO	70.5	43.9	95.0	9.7	72.3	3.2	19.0	53.9	220.9	210.2
	MEAN			70.8	45.6	92.8	9.6	72.5	3.3	19.3	54.0	225.0	--
	C.V. (%)			0.8	3.7	3.4	2.6	0.7	6.9	6.3	1.5	9.1	--
	LSD 0.10			0.7	1.9	3.7	0.29	0.6	0.26	1.4	0.9	24.0	--
	LSD 0.05			0.8	2.3	4.4	0.35	0.7	0.31	1.7	1.1	28.7	--

Planting date = May 11; Harvest date = October 21; Previous crop = Soybean

Table 2. Corn hybrid performance trial (dryland) Dickey County - Oakes Irrigation Research Site 2016.

Brand	Hybrid	RM	Hybrid Traits[1]	Days to Silk	Ear Ht.	Plant Ht.	Grain Protein	Starch Content	Oil Content	Harvest Moist.	Test Weight	Grain Yield 2016	Grain Yield 2 yr. Avg.
					inch	inch	%	%	%	%	lb/bu	bu/ac	bu/ac
PFS	PFS77P94	94	VT2PRO	69.3	41.8	92.2	9.2	72.7	3.2	19.5	53.9	243.0	--
Proseed	1295 SS RIB	95	VT2P	71.0	45.0	92.2	9.6	72.4	3.3	18.7	55.0	200.7	--
Proseed	1193 VT2P	93	VT2P	69.3	42.7	92.6	9.5	72.5	3.4	18.4	55.9	217.5	--
Proseed	PX695	95	VIP 3	71.3	51.9	96.0	10.7	72.6	2.7	14.9	54.9	212.6	--
Proseed	1495 SS	95		71.8	43.5	92.3	9.4	72.1	3.6	20.6	53.4	206.3	200.3
Proseed	1496SS	96	VT2P	71.5	44.2	92.0	9.8	72.7	3.0	20.3	53.1	181.8	187.8
REA Hybrids	4B931-RIB	93	RR2, Bt	69.8	46.1	96.0	9.3	72.6	3.3	20.1	53.6	231.2	213.8
REA Hybrids	4B953-RIB	95	RR2, Bt	71.5	45.7	94.8	9.5	72.6	3.2	18.8	54.7	241.6	218.5
REA Hybrids	3A922-RIB	92	RR2, Bt, CRW	70.5	42.0	86.9	9.5	72.8	3.2	17.5	56.2	205.8	--
Renk	RK522SSTX	94	SSTX	70.5	44.7	96.4	9.7	72.2	3.4	18.9	53.9	214.9	200.5
Renk	RK566SSTX	94	SSTX	70.8	44.3	87.9	9.4	72.6	3.2	18.8	54.1	190.2	--
Renk	RK568VT3P	95	VT3P	71.0	43.2	91.1	9.7	72.1	3.4	20.4	54.5	230.4	202.9
Rob-See-Co	RC4343-3110A	93	Agrisure Viptera 3110A	71.3	53.1	98.2	10.7	72.4	2.8	18.9	55.0	239.8	--
Thunder	6791 VT2P	91	VT2P	71.3	45.2	92.9	9.5	72.2	3.5	18.4	54.6	247.4	--
Thunder	7993 VT2P	93	VT2P	71.5	45.1	93.0	9.4	72.4	3.5	19.6	54.1	226.4	202.5
Thunder	7396 VT2P	96	VT2P	71.0	45.3	91.8	9.5	72.8	3.2	18.6	53.6	247.2	213.1
Wensman	W80972VT2PRO	97	VT2PRO	70.5	41.4	91.3	9.2	72.6	3.3	20.2	53.1	229.8	--
Wensman	W90941STXRIB	94	STXRIB	70.3	43.9	89.7	9.3	72.5	3.2	18.6	52.9	243.3	216.7
Wensman	W90962STXRIB	96	STXRIB	70.8	46.6	95.4	9.8	72.5	3.1	18.4	53.3	223.4	206.4
Wensman	W90979STXRIB	97	STXRIB	71.0	46.3	87.2	9.3	73.2	2.9	19.1	53.9	226.1	212.6
Wensman	W80928VT2RIB	92	VT2RIB	71.3	45.2	90.0	10.0	71.8	3.4	17.5	55.1	225.8	--
	MEAN			70.8	45.6	92.8	9.6	72.5	3.3	19.3	54.0	225.0	--
	C.V. (%)			0.8	3.7	3.4	2.6	0.7	6.9	6.3	1.5	9.1	--
	LSD 0.10			0.7	1.9	3.7	0.29	0.6	0.26	1.4	0.9	24.0	--
	LSD 0.05			0.8	2.3	4.4	0.35	0.7	0.31	1.7	1.1	28.7	--

Planting date = May 11; Harvest date = October 21; Previous crop = Soybean

[1]Hybrid traits as reported by seed company when hybrids submitted for evaluation.

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Onion Hybrid Performance Trial

K. Cooper, L. Besemann and H. Eslinger

Onions have done well under irrigation in North Dakota. Yellow sweet Spanish is the predominate type grown. This study tested 21 varieties: sixteen sweet Spanish hybrids, two red hybrids and three white hybrids.

MATERIALS AND METHODS

Soil:	Embden loam; pH = 6.7; 3.4% organic matter; soil N 17 lbs/acre; soil P and soil K were very high; soil S was low.
Previous crop:	2015 - spring wheat
Seedbed preparation:	Spring conventional tillage.
Planting:	Direct seeded onions (250,000 seeds/acre) April 29 with a Monosem precision planter. Onions were planted 2 lines per row with 2.5 inches between lines.
Plots:	Plots were three ft (two rows) wide by 25 ft long. The study had four replications.
Fertilizer:	Broadcast 19 lbs N/acre, 50 lbs P_2O_5/acre, 45 lbs K_2O/acre and 10 lbs S/acre as 9-24-21-5 April 19. Stream bar 50 lbs N/acre May 30, June 30 and July 1 as 28-0-0.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Moxy 2E (6 oz/acre) May 23, Section 2EC (8 oz/acre) June 3, Moxy 2E (12 oz/acre) + Goal Tender (5 oz/acre) June 10, Prowl (1.5 pt/acre) June 23, Moxy 2E (8 oz/acre) + Goal Tender (4 oz/acre) June 28, Select Max (12 oz/acre) + NIS (1 pt/acre) July 8, Select Max (12 oz/acre) August 2 and hand weeding for weed control.
Harvest:	Pulled all onions September 9 and left to field dry/cure. Onions were bagged September 19 and September 20, then graded November 22 to December 2.

RESULTS

Delgado had the highest yield in the onions with diameters of 3 to 4 inches and the highest overall yield. The onions were doing well until two wind/rain events occurred a week apart. The most severe storm occurred August 10. The heavy rain (one inch per hour) and small hail resulted in 3.2 inches of precipitation which was accompanied by winds in excess of 45 MPH. A substantial number of tops/leaves on many plants were broken. The damage allowed disease (bacterial blight) to infect the damaged leaves which we believe greatly diminished further increases in bulb size.

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Table 1. Onion hybrid performance trial at the Oakes Irrigation Research Site in 2016.

Hybrid	Seed Source	Maturity Days[2]	Half down	>4"	3 to 4"	2¼ to 3"	1 to 2¼"	Total	Culls	Single Center	Total Bulbs
				----------cwt----------						%	/ac
Calibra	Bejo	115	22-Aug	0	79	86	20	186	122	45	101316
Crockett	Bejo	118	24-Aug	0	82	156	38	277	146	70	143126
Dawson	Bejo[1]	115	22-Aug	0	71	51	22	143	101	70	82842
Delgado	Bejo	115	25-Aug	5	202	126	28	361	154	65	130291
Gunnison	Bejo	110	15-Aug	0	165	113	25	304	62	75	105594
Hamilton (BGS 167)	Bejo	118	24-Aug	0	161	139	30	329	150	75	138070
Mondella	Bejo	110	18-Aug	0	112	145	27	284	104	85	123485
Red Angel	Bejo[1]	110	22-Aug	0	67	59	21	147	63	25	82842
Red Bull	Bejo	115	18-Aug	0	89	100	26	214	122	65	111623
Sedona	Bejo	120	22-Aug	0	93	54	10	157	129	90	70202
Commendable	Seminis	115	26-Aug	0	57	64	13	133	138	85	85370
SV4643NT	Seminis	110	16-Aug	0	166	140	28	334	129	45	136125
SV6646NW	Seminis	120	23-Aug	0	157	89	19	265	201	90	129513
SV6672NW	Seminis	116	17-Aug	0	129	112	24	265	174	100	134958
Tucannon	Seminis	118	20-Aug	0	160	140	27	327	161	100	135736
SS-1108	Solar Seed	106	15-Aug	0	65	176	45	286	34	70	119596
Mean			21-Aug	0	116	109	25	251	124	72	114418
C.V.(%)			14.1	477.1	46.7	35.1	42.1	34.1	31.3	29.8	25.8
LSD 0.10			3.2	NS	64	46	13	101	46	25.5	35108
LSD 0.05			3.9	NS	77	55	15	122	55	30.6	42104

Planting date = April 29; Pulled/harvested = September 9; Previous crop = Spring wheat

Fertilizer lbs/acre; 170 N, 50 P, 45 K, 10 S; Irrigation = 11.70 inches.

[1]Supplied by Barry Vculek.

[2]Maturity given by seed supplier.

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Soybean Variety Trial

K. Cooper, L. Besemann and H. Eslinger

Three soybean variety trials were conducted at the Oakes Irrigation Research Site; a Roundup Ready® trial, a Liberty Link trial and conventional soybean trial. Results for the Roundup Ready trial are listed in Table 1. Results for the Liberty Link trial are listed in Table 2. Results for the conventional trial are listed in Table 3. There were 37 varieties in the Roundup Ready trial, 11 varieties in the Liberty Link trial and eight varieties in the conventional trial.

MATERIALS AND METHODS

Soil:	Embden sandy loam and Hecla sandy loam; pH = 6.8; 2.3% organic matter; soil N was 28 lbs/acre; soil P and soil K were very high; soil S was low.
Previous crop:	2015 - spring wheat
Seedbed preparation:	Spring conventional tillage.
Planting:	Planted May 17 in 30-inch rows.
Plots:	Plots were 25 ft long by 5 ft (2 rows) wide. The study had four replications.
Fertilizer:	Broadcast 19 lbs N/acre, 50 lbs P_2O_5/acre, 45 lbs K_2O/acre and 10 lbs S/acre as 9-24-21-5 April 20.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Weed control: Liberty Link, Roundup Ready, and conventional soybeans received Spartan Elite (22 oz/acre) May 19, Select Max (12 oz/acre) + NIS (1 pt/100gal) June 13. Disease control: Endura (5.5 oz/acre) July 15.
Harvest:	September 30, October 1 and October 3 with a plot combine.

RESULTS

Yields averaged 54.4 bu/acre in the Roundup Ready trial, 55.4 bu/acre in the Liberty Link trial and 46.5 bu/acre in the conventional trial. Most plots were lodged with the plants laying inbetween the rows. The drive wheel of the combine caused extensive shatter loss during harvest resulting in reduction in recorded yield.

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Table 1. Soybean variety trial (Roundup Ready®) at the Oakes Irrigation Research Site 2016.

Brand	Variety	Mat Group[1]	Days to PM	Plant Ht.	Plant Lodge[2]	Seeds/ Pound	Seed Oil	Seed Protein	Test Wt.	Seed Yield 2016	Seed Yield 2-yr. Ave.
				inch	0 to 9		%	%	lb/bu	---bu/ac---	
REA Hybrids	R0815	0.8	123.8	22.8	6.0	2693	18.8	33.2	55.2	51.4	65.0
REA Hybrids	69G14	0.9	124.5	24.0	6.0	2504	19.0	33.0	56.0	55.4	68.2
NuTech	6097R2	0.9	123.3	21.8	7.0	2297	20.5	30.6	55.7	52.4	63.5
NuTech	7127R2	1.2	125.8	28.5	5.5	2436	18.2	33.8	56.4	53.2	--
Peterson Farms Seed	16X12N	1.2	126.0	25.0	6.8	2648	18.3	34.1	55.2	48.6	--
Peterson Farms Seed	17X13	1.3	123.8	22.0	5.8	2483	18.9	33.5	55.0	61.9	--
Dairyland Seed	DSR-0711/R2Y	0.7	123.8	22.8	5.8	2451	19.2	33.0	55.2	49.4	62.2
Dairyland Seed	DSR-0807/R2Y	0.8	123.3	22.5	5.3	2392	18.3	34.5	55.3	53.5	--
Dairyland Seed	DSR-0988/R2Y	0.9	125.8	24.5	7.3	2661	18.6	32.6	55.7	49.1	--
Dairyland Seed	DSR-1120/R2Y	1.1	127.3	25.5	7.5	2214	19.5	33.1	55.1	48.6	62.4
Dairyland Seed	DSR-1313/R2Y	1.3	127.3	25.3	7.0	2589	19.0	33.0	55.1	59.7	--
Proseed	XT607	0.7	119.8	24.3	5.8	2543	19.0	33.1	56.1	42.1	--
Proseed	XT610	1.0	123.8	25.3	4.3	2596	18.2	34.5	55.8	54.3	--
Integra	20775N	0.7	123.8	22.0	6.0	2713	18.7	33.4	55.5	54.4	--
Integra	20915N	0.9	124.8	24.0	6.8	2629	18.5	33.0	56.2	57.1	69.8
Prairie Brand	PB-0777R2	0.7	124.5	20.8	7.0	2549	18.6	33.4	56.2	53.1	65.9
Prairie Brand	PB-0987R2	0.8	124.8	26.0	7.0	2631	18.6	33.1	55.4	52.7	--
Prairie Brand	PB-1257R2	1.2	128.3	22.3	8.5	2773	18.7	32.3	55.6	57.3	--
Legacy Seed	LS-0836N RR2	0.8	125.0	24.8	6.3	2673	18.6	32.7	55.5	54.0	--
Legacy Seed	LS-0833N RR2	0.8	124.0	24.0	5.3	2659	18.7	33.3	55.9	56.3	66.9
Legacy Seed	LS-0935N RR2	0.9	125.3	23.3	6.5	2486	18.8	33.1	55.7	56.0	67.6
Legacy Seed	LS-1134N RR2	1.1	127.0	21.5	8.5	2620	19.3	33.4	55.9	51.6	63.3
Legacy Seed	LS-1335N RR2	1.3	126.0	25.0	6.8	2582	19.0	32.9	55.6	55.9	70.1
Dyna-Gro	S07RY45	0.7	122.8	22.0	6.0	2690	18.9	33.1	55.2	56.4	--
Dyna-Gro	S09RY64	0.9	125.3	21.5	7.3	2615	18.6	33.0	55.5	57.6	69.1
Dyna-Gro	S12RY44	1.2	124.5	23.3	5.0	2528	18.4	34.5	56.0	54.3	66.5
Wensman	W1106NRX	1.0	124.5	24.0	4.3	2622	18.1	34.4	56.5	54.1	--
Wensman	W1129NRX	1.2	125.3	23.0	6.8	2545	18.8	33.3	55.4	58.2	--
Wensman	W3080NR2	0.8	123.3	24.0	6.0	2738	18.8	33.1	55.2	55.7	67.7
Wensman	W3100NR2	1.0	125.5	21.3	7.8	2434	18.7	32.8	55.6	54.1	66.3
Wensman	W3143NR2	1.4	126.8	24.0	5.8	2539	18.9	33.3	55.9	58.5	71.9
NorthStar	NS 0941NR2	0.9	124.3	23.8	5.3	2592	19.0	33.0	55.2	59.0	68.3
NorthStar	NS 1040NR2	1.1	126.8	22.3	8.3	2661	19.2	33.6	56.3	55.8	66.4
NorthStar	NS 1390NR2	1.3	127.0	25.5	7.3	2281	18.4	34.6	56.9	53.2	67.8
Thunder	3614N	1.4	126.0	24.5	6.8	2549	19.1	32.9	56.1	59.8	71.1
Thunder	SB8710N	1.0	124.5	24.3	6.0	2681	18.4	34.4	55.7	49.3	--
Thunder	SB8713N	1.3	125.3	20.5	8.0	2518	18.8	33.4	55.8	57.4	--
	Mean		125.0	23.6	6.5	2562	18.8	33.3	55.7	54.4	--
	C.V (%)		0.7	10.1	20.6	2.5	0.7	0.8	1.2	6.7	--
	LSD 0.10		1.0	2.8	1.6	76	0.2	0.3	0.8	4.3	--
	LSD 0.05		1.2	3.3	1.9	91	0.2	0.4	0.9	5.1	--

Planting date = May 17; Harvest date = September 30 and October 1; Previous crop = Spring wheat

[1]Maturity group based on data provided by seed company.

[2]Plant lodge: 0 = no lodging; 9 = plants lying flat.

Table 2. Soybean variety trial (Liberty Link) at the Oakes Irrigation Research Site 2016.

Brand	Variety	Mat Group[1]	Days to PM	Plant Ht.	Plant Lodge[2]	Seeds/ Pound	Seed Oil	Seed Protein	Test Wt	Seed Yield 2016	Seed Yield 2-yr. Ave.
				inch	0 to 9		%	%	lb/bu		
Credenz	0525	0.5	120.0	22.0	3.8	2309	19.1	34.6	56.7	57.6	66.1
Credenz	0601		120.0	25.0	4.0	2203	18.4	33.0	57.0	52.7	--
Credenz	1201		127.5	24.8	8.3	2179	18.3	34.4	57.0	56.4	--
Credenz	1332	1.3	125.3	23.0	6.0	2289	17.7	34.6	56.6	55.0	69.1
NuTech	2086L	0.8	124.5	27.8	5.5	2491	18.5	34.3	55.8	48.3	61.0
NuTech	3115L	1.1	127.3	24.3	7.0	2187	18.3	34.5	57.2	61.7	--
Rob-See-Co	RS0828-LL	0.8	123.5	26.5	3.3	2472	18.5	34.6	55.9	50.3	--
Rob-See-Co	RS1231-LL	1.2	126.5	24.5	7.5	2193	18.5	34.2	56.8	59.0	--
Rob-See-Co	RS1452-LL	1.4	129.0	27.0	7.0	2071	18.3	33.5	56.7	66.0	--
Thunder	5411LLN	1.1	123.0	22.3	5.8	2430	19.3	34.0	55.9	50.4	62.0
Thunder	5615LLN	1.5	128.5	27.3	7.5	2723	18.6	33.2	56.4	51.6	--
	Mean		125.0	25.0	6.0	2322	18.5	34.1	56.5	55.4	--
	C.V (%)		0.5	10.6	20.4	2.4	0.7	0.7	1.1	5.1	--
	LSD 0.10		0.70	3.2	1.5	67.9	0.2	0.3	0.7	3.4	--
	LSD 0.05		0.9	3.8	1.8	81.7	0.2	0.4	0.9	4.1	--

Planting date = May 17; Harvest date = October 1; Previous crop = Spring wheat

[1]Maturity group based on data provided by seed company.

[2]Plant lodge: 0 = no lodging; 9 = plants lying flat.

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Table 3. Soybean variety trial (conventional varieties) at the Oakes Irrigation Research Site 2016.

Brand	Variety	Mat Group[1]	Days to Mat.	Plant Ht.	Plant Lodge[2]	Seeds/ Pound	Seed Oil	Seed Protein	Test Wt	Seed Yield
				inch	0 to 9		%	%	lb/bu	bu/ac
Richland IFC	MK0603	0.6	122.0	18.0	8.5	5378	16.6	35.2	57.3	41.1
Richland IFC	MK0508	0.8	122.3	18.5	8.3	5328	17.2	33.6	57.6	41.3
Richland IFC	MK1016	1.0	121.5	20.0	7.8	5114	17.1	35.2	57.9	45.4
Richland IFC	MK9101	1.0	124.0	28.0	6.3	2149	20.2	34.8	56.7	48.1
Richland IFC	MK42	0.7	119.5	21.0	5.8	2236	17.7	36.2	55.9	44.2
Richland IFC	MK41	1.1	125.8	30.0	5.3	2288	17.3	35.9	57.7	56.4
Richland IFC	MK9404CN	0.6	120.0	20.5	5.8	2604	21.5	34.9	56.6	48.3
Richland IFC	MK808CN	0.8	119.8	20.5	5.8	3098	19.1	33.1	57.0	46.9
	Mean		121.9	22.1	6.7	3524	18.3	34.9	57.1	46.5
	C.V (%)		1.1	9.4	16.1	4.05	2.2	1.6	1.2	12.1
	LSD 0.10		1.70	2.5	1.3	174.1	0.5	0.70	0.9	6.9
	LSD 0.05		2.0	3.0	1.5	210.5	0.6	0.8	1.0	8.4

Planting date = May 17; Harvest date = October 3; Previous crop = Spring wheat

[1]Maturity group based on data provided by seed company.

[2]Plant lodge: 0 = no lodging; 9 = plants lying flat.

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Mosaic Soybean Study

K. Mann, K. Cooper, L. Besemann and H. Eslinger

MATERIALS AND METHODS

Soil:	Embden loam and Gardena loam; pH = 6.9; 2.8% organic matter; soil N was 77 lbs/acre; soil P and soil K were very high; soil S was medium.
Previous crop:	2015 - field corn
Seedbed preparation:	Spring conventional tillage.
Hybrid:	Northrup King S10P9
Planting:	May 19 in 30-inch rows.
Plots:	Plots were 25 ft long by 10 ft (4 rows) wide. The study had four replications.
Fertilizer:	Broadcast and incorporated treatments (see Table 1) May 18.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Spartan Elite (22 oz/acre) May 20, Select Max (12 oz/acre) + NIS (1 pt/100 gal) + Interlock (4 oz/acre) June 13 controlled weeds. Endura (5.5 oz/acre) July 15, controlled disease.
Harvest:	October 3 with a plot combine. Harvest area was the center two rows, approximately 21 feet long.

Mosaic soybean study.

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Table 1. Specific details associated with treatments within the Mosaic soybean study.

Entry No.	Treatment	Formulation	Product	Formulation
				lb nutrient/acre
1	MAP	52% P2O5	11-52-0	40
2	MAP	52% P2O5	11-52-0	40
2	MOP	60% K2O	0-0-60	60
3	MAP	52% P2O5	11-52-0	40
3	Aspire	58% K2O	0-0-58-0.5B	60
4	MAP	52% P2O5	11-52-0	40
4	MOP	60% K2O	0-0-60	60
4	Granubor Preplant	14.3%	0-0-0-14.3B	0.5
5	MAP	52% P2O5	11-52-0	40
5	MOP	60% K2O	0-0-60	60
5	Granubor Preplant	14.3%	0-0-0-14.3B	1.0
6	MAP	52% P2O5	11-52-0	40
6	MOP	60% K2O	0-0-60	60
6	Granubor Preplant	14.3%	0-0-0-14.3B	2.0
7	MESZ	40% P2O5	12-40-0-10S-1Zn	40
7	MOP	60% K2O	0-0-60	60
8	MESZ	40% P2O5	12-40-0-10S-1Zn	40
8	Aspire	58% K2O	0-0-58-0.5B	60

Table 2. Agronomic data for the Mosaic soybean study at the Oakes Irrigation Research Site

Treatment	Moisture	Plant Lodge[1]	Test Wt.	Yield 2016	Population
	%	0 to 9	lb/bu	bu/ac	plants/ac
MAP	10.7	5.3	55.2	71.3	128774
MAP + MOP	11.0	5.0	55.1	71.1	130136
MAP + Aspire	11.2	5.0	54.9	70.4	127958
MAP + MOP + Granubor Pre 0.5	10.9	5.0	55.7	68.2	125235
MAP + MOP + Granubor Pre 1	10.8	5.0	54.7	67.3	133947
MAP + MOP + Granubor Pre 2	10.9	4.8	54.0	65.4	136397
MESZ + MOP	10.8	4.8	54.3	68.0	125507
MESZ + Aspire	10.8	5.3	54.2	69.3	130408
Mean	10.9	5.0	54.7	68.9	129795
C.V. (%)	2.7	10.0	1.8	8.5	6.3
LSD 0.10	NS	NS	NS	NS	NS
LSD 0.05	NS	NS	NS	NS	NS

Planting date = May 19; Harvest date = October 3; Previous crop = Field corn

[1]Plant lodge: 0 = no lodging; 9 = plants lying flat.

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Evaluation of Plant Populations and Row Spacing for Management of Sclerotinia in Soybeans

M. Wunsch, M. Schaefer, B. Kraft, S. Kallis, K. Cooper, L. Besemann and H. Eslinger

METHODS

General Agronomics: The study was on a Maddock sandy loam soil type. The previous crop was spring wheat. The tillage operation consisted of cultivation with a soil finisher (May 2). The maintenance herbicide application was a PRE-EMERGENCE application of Spartan Elite (sulfentrazone, 0.7 lb ai/gal, and s-metolachlor, 6.3 lb ai/gal; FMC Corp., Philadelphia, PA) applied at 22 fl oz/ac on May 19 and a POST-EMERGENCE application of Roundup PowerMax (5.5 lbs/gal of the a.i. glyphosate = 4.5 lbs/gal of the acid equivalent; Monsanto Corp., St. Louis, MO) applied June 13 at 32 fl oz/ac with 1 lb AMS/10 gal and 0.125% v/v NIS.

Experimental design: A completely randomized split-split block design. Main factor = variety, sub-factor = seeding rate (132,000 pure live seeds/ac; 165,000 pls/ac; or 198,000 pls/ac), sub-sub-factor = row spacing (7-inch, 14-inch, 21-inch, or 28-inch row spacing). The seeded plot size was 5 feet (center to center) by 25 feet long. The harvested plot size was 5 feet (center to center) and approximately 20 feet long.

To maintain a consistent gap from each outermost row of plots with 7-inch, 14-inch, and 21-inch row spacing and the outermost rows of adjacent plots, unharvested filler plots seeded to 14-inch rows were established on both sides of plots with 28-inch row spacing. The use of these filler plots resulted in a consistent 18-inch gap between the outermost rows in plots seeded to rows 7, 14, and 21 inches apart and the outermost rows of adjacent plots. The outermost rows of plots with 28-inch row spacing were 25 inches from the outermost rows of adjacent plots.

Planting details: The study was planted on May 16, 2016. Seed treatments used were Apron Maxx RTA (5.0 fl oz/100 lbs seed) + Imidacloprid 4ST (3 fl oz/100 lbs seed). Imidacloprid 4ST (Willowood) contains 4 lbs/gal thiamethoxam; Apron Maxx RTA (Syngenta) contains 0.096 lb/gal mefenoxam and 0.064 lb/gal fludioxonil.

Plant establishment: Soybean establishment was assessed on June 16 when soybeans were at the V2 growth stage and on Sept. 8-12 at the R7 growth stage by counting all plants along the full length of the plot in rows 2, 3, 5, and 6 of each 7-row plot (7-in. row spacing), rows 2 and 3 of each 4-row plot (14-in. row spacing), row 2 of each 3-row plot (21-in. row spacing) and the northern row of each 2-row plot (28-in. row spacing).

Bloom initiation: Bloom initiation, defined as 80 to 90% of plants at the R1 growth stage, was assessed three times a week as soon as the soybeans first began entering bloom and until the last variety reached 80-90% of plants with an open blossom. Ten sequential plants within a row were evaluated at an arbitrarily selected location in each of six arbitrarily selected plots within each 12-plot main-factor block of each variety.

Canopy closure and height: The percent canopy closure was assessed three times a week as soon as the canopy began to close in the first plots until the canopy reached full closure in all plots. The height of the canopy at bloom initiation was assessed at one location per plot in all 12 plots of each main-factor (soybean variety) block when 80-90% of plants within that block, as assessed in bloom initiation notes, reached the R1 growth stage.

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Disease severity: Sclerotinia incidence and severity were assessed on September 8-12 at the R7 growth stage using the 0 to 3 scale developed by Craig Grau (Grau and Radke 1984; Plant Disease 68: 56-58): 0 = no symptoms, 1 = lesions on lateral branches only, 2 = lesions on main stem, no wilt, and normal pod development, 3 = lesions on main stem resulting in wilting, poor pod fill, and plant death. All plants were assessed along the full length of the plot in rows 2, 3, 5, and 6 of each 7-row plot (7-in. row spacing), rows 2 and 3 of each 4-row plot (14-in. row spacing), row 2 of each 3-row plot (21-in. row spacing) and the northern row of each 2-row plot (28-in. row spacing). An average of 133 plants and minimum of 60 plants were assessed in each plot.

Disease establishment and irrigation: This trial was established on a site with a prior history of Sclerotinia epidemics, and all pathogen inoculum originated from ambient disease pressure. Supplemental irrigation was applied from mid-vegetative growth through mid-pod-fill as needed to maintain soil moisture an inch below the surface.

Harvest, seed yield and quality assessment: The soybeans were harvested September 26. Yields were calculated on the basis of a 5-ft plot width and the measured plot length. Seed yield was adjusted to correct for sclerotia remaining in the mechanically cleaned grain. Sclerotia contamination in the harvested grain (% by weight) was assessed on a 400-gram subsample of grain from each plot by manually removing sclerotia. Sclerotia contamination in the mechanically cleaned grain was not assessed due to very low levels of sclerotia remaining in the grain after cleaning.

Test weight: Test weight was evaluated by evaluating the weight of the grain that filled a dry pint. Test weights were calculated on grain that was mechanically and manually cleaned; grain was cleaned on a mechanical shaker, and test weights were assessed on a subsample of the mechanically cleaned grain from which all remaining contaminants (including sclerotia) were manually removed.

Management of Sclerotinia in Soybeans.

Partial funding for this project was provided by the North Dakota Soybean Council.

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Evaluation of plant populations and row spacing for management of Sclerotinia in soybeans at Oakes, ND (2016)

Dairyland 'DSR 0711/R2Y'

	Seeding rate	Row spacing	Plant population [z] June 16 | V2 plants/ac	Plant population [z] Sept. 8-12 | R7 plants/ac	Bloom to canopy closure Days	Plant height [x] R1 growth stage cm	Sclerotinia incidence (%) [v] September 8-12 | R7 growth stage %	Sclerotinia severity (1-3) September 8-12 | R7 growth stage 1 to 3	Sclerotinia sev. Index (0-3) [t] September 8-12 | R7 growth stage 0 to 3	Yield 13% moisture bu/ac	Test weight 13% moisture lbs/bu	Sclerotia in harvested grain [s] % by weight
1	**132,000 pls/ac**	**7-inch**	**96210**	**87504**	**3** a*	**41** b*	**3** a*	**1.86** a*	**0.05** a*	**59** bc*	**58.7** a*	**0.01** a*
2	**132,000 pls/ac**	**14-inch**	**102373**	**89372**	**6** b	**43** ab	**3** a	**1.96** a	**0.06** a	**63** ab	**58.8** a	**0.02** a
3	**132,000 pls/ac**	**21-inch**	**88677**	**84528**	**13** c	**43** ab	**1** a	**3.00** a	**0.04** a	**66** a	**58.5** a	**0.01** a
4	**132,000 pls/ac**	**28-inch**	**110885**	**102665**	**18** d	**45** a	**1** a	**2.75** a	**0.02** a	**54** c	**58.6** a	**0.01** a
		F:			220.95	2.86	1.94	3.32	0.71	11.72	0.45	2.50
		P>F:			< 0.0001	0.0721	0.1661	0.0864	0.5633	0.0003	0.7237	0.0989
		CV:			11.1	5.9	96.0	26.0	110.3	6.2	0.9	74.2
1	**165,000 pls/ac**	**7-inch**	**137373**	**128136**	**1** a*	**41** b*	**2** a*	**2.61** a*	**0.05** a*	**62** a*	**58.7** a*	**0.02** a*
2	**165,000 pls/ac**	**14-inch**	**132279**	**117097**	**5** b	**44** ab	**3** a	**2.10** a	**0.06** a	**60** a	**58.6** a	**0.02** a
3	**165,000 pls/ac**	**21-inch**	**132923**	**122923**	**9** c	**45** ab	**2** a	**2.56** a	**0.04** a	**65** a	**58.2** a	**0.02** a
4	**165,000 pls/ac**	**28-inch**	**142156**	**128829**	**17** d	**46** a	**2** a	**2.67** a	**0.05** a	**55** b	**58.2** a	**0.02** a
		F:			185.49	3.43	0.26	2.07	0.22	14.57	1.38	0.03
		P>F:			< 0.0001	0.0445	0.8513	0.1924	0.8833	0.0001	0.2875	0.9938
		CV:			16.2	5.5	113.9	18.8	112.0	4.5	0.9	143.1
1	**198,000 pls/ac**	**7-inch**	**154502**	**140730**	**0** a*	**42** a*	**1** a*	**1.70** a*	**0.02** a*	**65** a*	**58.5** a*	**0.00** a*
2	**198,000 pls/ac**	**14-inch**	**163959**	**152061**	**3** a	**43** a	**3** a	**2.51** a	**0.07** a	**66** a	**58.6** a	**0.03** a
3	**198,000 pls/ac**	**21-inch**	**184125**	**164202**	**9** b	**44** a	**2** a	**2.73** a	**0.05** a	**65** ab	**58.8** a	**0.01** a
4	**198,000 pls/ac**	**28-inch**	**165264**	**155724**	**16** c	**46** a	**1** a	**2.08** a	**0.03** a	**58** b	**58.4** a	**0.01** a
		F:			96.05	1.86	2.63	2.65	2.79	4.94	0.42	3.03
		P>F:			< 0.0001	0.1794	0.0884	0.1199	0.0764	0.0140	0.7391	0.0623
		CV:			24.8	5.9	80.4	24.7	90.5	6.5	1.1	116.2
1	**AVERAGE**	**7-inch**	**129362**	**118790**	**1** a*	**41** b*	**2** ab*‡	**2.06** a*	**0.04** a*	**62** a*	**58.6** a*	**0.01** a*
2	**AVERAGE**	**14-inch**	**132870**	**119510**	**4** b	**43** ab	**3** b	**2.19** a	**0.06** a	**63** a	**58.7** a	**0.02** a
3	**AVERAGE**	**21-inch**	**135242**	**123885**	**10** c	**44** a	**2** ab	**2.76** b	**0.04** a	**65** a	**58.5** a	**0.01** a
4	**AVERAGE**	**28-inch**	**139435**	**129073**	**17** d	**45** a	**1** a	**2.50** ab	**0.03** a	**55** b	**58.4** a	**0.01** a
		F:			435.20	7.55	2.81	4.25	1.46	24.34	0.94	1.35
		P>F:			< 0.0001	0.0003	0.0498	0.0164	0.2376	< 0.0001	0.4281	0.2690
		CV:			17.0	5.8	77.2	23.2	106.6	5.8	1.0	130.6
1	**132,000 pls/ac**	**AVERAGE**	**99536**	**91018**	**10** b*	**43** a*	**2** a*‡	**2.39** a*	**0.04** a*	**60** b*	**58.7** a*	**0.01** a*
2	**165,000 pls/ac**	**AVERAGE**	**136182**	**124246**	**8** a	**44** a	**2** a	**2.48** a	**0.05** a	**60** b	**58.4** a	**0.02** a
3	**198,000 pls/ac**	**AVERAGE**	**166962**	**153179**	**7** a	**44** a	**2** a	**2.26** a	**0.04** a	**64** a	**58.6** a	**0.01** a
		F:			21.32	2.24	0.12	2.34	0.22	12.85	0.76	4.80
		P>F:			0.0002	0.1569	0.8850	0.1464	0.8030	0.0017	0.4948	0.0506
		CV:			17.0	5.8	77.2	23.2	106.6	5.8	1.0	130.6

Pioneer 'P07T50R'

	Seeding rate	Row spacing	Plant population [z] June 16 | V2 plants/ac	Plant population [z] Sept. 8-12 | R7 plants/ac	Bloom to canopy closure Days	Plant height [x] R1 growth stage cm	Sclerotinia incidence (%) [v] September 8-12 | R7 growth stage %	Sclerotinia severity (1-3) September 8-12 | R7 growth stage 1 to 3	Sclerotinia sev. Index (0-3) [t] September 8-12 | R7 growth stage 0 to 3	Yield 13% moisture bu/ac	Test weight 13% moisture lbs/bu	Sclerotia in harvested grain [s] % by weight
1	**132,000 pls/ac**	**7-inch**	**110740**	**104274**	**-4** a*†	**55** a*	**13** a*	**2.52** a*	**0.33** a*	**56** a*	**58.5** a*	**0.11** a*
2	**132,000 pls/ac**	**14-inch**	**119368**	**110002**	**-3** a	**57** a	**17** a	**2.65** a	**0.45** a	**55** a	**58.3** a	**0.22** a
3	**132,000 pls/ac**	**21-inch**	**117104**	**110262**	**2** b	**55** a	**12** a	**2.68** a	**0.32** a	**57** a	**58.6** a	**0.17** a
4	**132,000 pls/ac**	**28-inch**	**119691**	**114086**	**9** c	**55** a	**15** a	**2.74** a	**0.41** a	**47** b	**58.1** a	**0.21** a
		F:			159.08	1.41	0.58	0.77	0.69	9.08	1.61	1.03
		P>F:			< 0.0001	0.2797	0.6369	0.5305	0.5723	0.0011	0.2287	0.4073
		CV:			14.8	4.1	48.4	9.8	50.6	6.6	0.8	70.1
1	**165,000 pls/ac**	**7-inch**	**131462**	**128247**	**-6** a*†	**57** a*	**6** a*	**2.64** a*	**0.17** a*	**61** a*	**58.3** a*	**0.09** a*
2	**165,000 pls/ac**	**14-inch**	**135531**	**128170**	**-4** b	**56** a	**9** a	**2.62** a	**0.24** a	**61** a	**58.8** a	**0.15** a
3	**165,000 pls/ac**	**21-inch**	**138329**	**134193**	**1** c	**58** a	**10** a	**2.78** a	**0.28** a	**59** a	**58.5** a	**0.15** a
4	**165,000 pls/ac**	**28-inch**	**140924**	**131544**	**9** d	**58** a	**9** a	**2.70** a	**0.26** a	**53** b	**58.1** a	**0.10** a
		F:			278.94	0.48	1.67	0.57	1.76	10.16	1.69	1.23
		P>F:			< 0.0001	0.7033	0.2149	0.6454	0.1987	0.0007	0.2114	0.3340
		CV:			14.2	5.8	35.4	9.0	36.9	4.9	1.0	58.6
1	**198,000 pls/ac**	**7-inch**	**163910**	**160177**	**-7** a*†	**58** a*	**9** a*	**2.65** a*	**0.26** a*	**60** a*	**58.2** a*	**0.13** a*
2	**198,000 pls/ac**	**14-inch**	**177151**	**163868**	**-5** b	**59** a	**8** a	**2.69** a	**0.23** a	**61** a	**58.8** a	**0.14** a
3	**198,000 pls/ac**	**21-inch**	**165225**	**161610**	**0** c	**59** a	**11** a	**2.76** a	**0.28** a	**60** a	**58.7** a	**0.16** a
4	**198,000 pls/ac**	**28-inch**	**180983**	**165578**	**8** d	**59** a	**11** a	**2.91** a	**0.32** a	**52** b	**58.6** a	**0.18** a
		F:			179.20	0.33	0.38	0.87	0.48	6.69	2.90	0.49
		P>F:			< 0.0001	0.8014	0.7713	0.4779	0.7036	0.0044	0.0697	0.6931
		CV:			15.6	5.3	51.4	10.7	51.9	7.0	0.7	54.3
1	**AVERAGE**	**7-inch**	**135371**	**130899**	**-6** a*†	**56** a*	**10** a*‡	**2.60** a*	**0.25** a*	**59** a*	**58.3** ab*	**0.11** a*
2	**AVERAGE**	**14-inch**	**144017**	**134014**	**-4** b	**57** a	**11** a	**2.65** a	**0.31** a	**59** a	**58.6** a	**0.17** a
3	**AVERAGE**	**21-inch**	**140219**	**135355**	**1** c	**57** a	**11** a	**2.74** a	**0.30** a	**59** a	**58.6** ab	**0.16** a
4	**AVERAGE**	**28-inch**	**147199**	**137069**	**9** d	**58** a	**12** a	**2.78** a	**0.33** a	**51** b	**58.2** b	**0.16** a
		F:			588.37	0.56	1.91	1.70	0.86	23.96	2.87	1.60
		P>F:			< 0.0001	0.6414	0.1420	0.1801	0.4705	< 0.0001	0.0466	0.2018
		CV:			15.0	5.2	22.0	9.9	49.5	6.2	0.8	63.4
1	**132,000 pls/ac**	**AVERAGE**	**116726**	**109656**	**1** a*†	**56** b*	**14** a*‡	**2.65** a*	**0.38** a*	**54** b*	**58.4** a*	**0.18** a*
2	**165,000 pls/ac**	**AVERAGE**	**136562**	**130539**	**0** a	**57** ab	**9** a	**2.69** a	**0.24** a	**58** a	**58.4** a	**0.12** a
3	**198,000 pls/ac**	**AVERAGE**	**171817**	**162808**	**-1** a	**59** a	**10** a	**2.75** a	**0.27** a	**58** a	**58.5** a	**0.15** a
		F:			2.07	4.71	1.21	0.67	1.09	8.43	0.89	0.60
		P>F:			0.1768	0.0363	0.3389	0.5345	0.3741	0.0072	0.4418	0.5669
		CV:			15.0	5.2	22.0	9.9	49.5	6.2	0.8	63.4

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Pioneer '90M80' (0.8 maturity)

	Seeding rate	Row spacing	Plant population [z] June 16 | V2 plants/ac	Plant population [z] Sept. 8-12 | R7 plants/ac	Bloom to canopy closure Days	Plant height [x] R1 growth stage cm	Sclerotinia incidence (%) [v] September 8-12 | R7 growth stage %	Sclerotinia severity (1-3) September 8-12 | R7 growth stage 1 to 3	Sclerotinia sev. Index (0-3) [t] September 8-12 | R7 growth stage 0 to 3	Yield 13% moisture bu/ac	Test weight 13% moisture lbs/bu	Sclerotia in harvested grain [s] % by weight
1	**132,000 pls/ac**	**7-inch**	**114067**	**99520**	**5** a*	**38** ab*	**15** a*	**2.54** a*	**0.37** a*	**56** a*	**58.8** a*	**0.15** a*
2	**132,000 pls/ac**	**14-inch**	**114994**	**104251**	**6** a	**37** a	**13** a	**2.58** a	**0.34** a	**57** a	**58.7** a	**0.23** a
3	**132,000 pls/ac**	**21-inch**	**123690**	**107468**	**11** b	**41** b	**22** a	**2.73** a	**0.59** a	**54** a	**58.7** a	**0.31** a
4	**132,000 pls/ac**	**28-inch**	**109798**	**100531**	**18** c	**38** ab	**16** a	**2.61** a	**0.42** a	**46** b	**58.7** a	**0.22** a
		F:			85.89	3.41	1.17	0.64	1.60	12.18	0.09	1.19
		P>F:			< 0.0001	0.0452	0.3551	0.6034	0.2316	0.0003	0.9645	0.3453
		CV:			16.2	5.7	50.5	9.4	49.0	6.4	1.1	62.8
1	**165,000 pls/ac**	**7-inch**	**138239**	**126100**	**4** a*	**39** b*	**24** a*	**2.69** a*	**0.65** a*	**53** a*	**58.8** a*	**0.23** a*
2	**165,000 pls/ac**	**14-inch**	**146402**	**132977**	**5** a	**39** ab	**21** a	**2.68** a	**0.57** a	**54** a	**58.8** a	**0.24** a
3	**165,000 pls/ac**	**21-inch**	**150561**	**133765**	**10** b	**42** ab	**25** a	**2.89** a	**0.72** a	**54** a	**58.9** a	**0.27** a
4	**165,000 pls/ac**	**28-inch**	**151507**	**136629**	**15** c	**42** a	**20** a	**2.80** a	**0.55** a	**45** b	**59.2** a	**0.33** a
		F:			47.14	3.39	2.66	1.70	0.55	10.48	0.80	0.85
		P>F:			< 0.0001	0.0459	0.0862	0.2107	0.6545	0.0006	0.5112	0.4856
		CV:			23.5	5.2	33.6	6.6	40.9	6.7	0.8	47.5
1	**198,000 pls/ac**	**7-inch**	**171369**	**150511**	**3** a*	**38** b*	**22** a*	**2.86** a*	**0.64** a*	**54** ab*	**58.9** a*	**0.30** a*
2	**198,000 pls/ac**	**14-inch**	**183022**	**159082**	**4** a	**39** ab	**26** a	**2.84** a	**0.74** a	**57** a	**59.3** a	**0.33** a
3	**198,000 pls/ac**	**21-inch**	**165178**	**148267**	**10** b	**41** ab	**33** a	**2.78** a	**0.94** a	**50** bc	**59.2** a	**0.41** a
4	**198,000 pls/ac**	**28-inch**	**189928**	**173093**	**14** c	**41** a	**20** a	**2.87** a	**0.58** a	**44** c	**58.7** a	**0.24** a
		F:			47.14	3.39	2.66	0.62	2.43	11.69	3.07	1.66
		P>F:			< 0.0001	0.0459	0.0862	0.6100	0.1058	0.0003	0.0599	0.2186
		CV:			23.5	5.2	33.6	4.5	34.5	7.9	0.7	0.6
1	**AVERAGE**	**7-inch**	**141225**	**125377**	**4** a*	**38** c*	**20** ab*	**2.69** a*	**0.55** ab*	**55** ab*	**58.8** a*	**0.23** a*‡
2	**AVERAGE**	**14-inch**	**148139**	**132103**	**5** a	**38** bc	**20** ab	**2.70** a	**0.55** ab	**56** a	**58.9** a	**0.27** a
3	**AVERAGE**	**21-inch**	**146476**	**129833**	**10** b*	**41** a	**27** b	**2.80** a	**0.75** b	**53** bc	**58.9** a	**0.33** a
4	**AVERAGE**	**28-inch**	**150411**	**136751**	**16** c	**41** ab	**18** a	**2.76** a	**0.52** a	**45** c	**58.9** a	**0.27** a
		F:			202.85	5.67	3.21	1.16	3.54	32.86	0.16	1.86
		P>F:			< 0.0001	0.0022	0.0318	0.3366	0.0220	< 0.0001	0.9247	0.1495
		CV:			18.7	6.9	39.5	7.0	40.4	7.0	0.9	43.8
1	**132,000 pls/ac**	**AVERAGE**	**115637**	**102942**	**10** b*	**38** a*	**16** a*	**2.62** a*	**0.43** a*	**53** a*	**58.7** b*	**0.23** a*‡
2	**165,000 pls/ac**	**AVERAGE**	**146677**	**132367**	**8** ab	**41** a	**22** a	**2.76** ab	**0.62** a	**51** a	**58.9** ab	**0.27** a
3	**198,000 pls/ac**	**AVERAGE**	**177374**	**157738**	**8** a	**40** a	**25** a	**2.83** b	**0.73** a	**52** a	**59.0** a	**0.32** a
		F:			5.27	3.67	2.79	7.55	3.35	1.26	7.49	1.18
		P>F:			0.0273	0.0637	0.1090	0.0100	0.0771	0.3239	0.0103	0.3477
		CV:			18.7	6.9	39.5	7.0	40.4	7.0	0.9	43.8

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Pioneer 'P08T36R' (0.8 maturity)

	Seeding rate	Row spacing	Plant population [z] June 16 | V2 plants/ac	Plant population [z] Sept. 8-12 | R7 plants/ac	Bloom to canopy closure Days	Plant height [x] R1 growth stage cm	Sclerotinia incidence (%) [v] September 8-12 | R7 growth stage %	Sclerotinia severity (1-3) September 8-12 | R7 growth stage 1 to 3	Sclerotinia sev. Index (0-3) [t] September 8-12 | R7 growth stage 0 to 3	Yield 13% moisture bu/ac	Test weight 13% moisture lbs/bu	Sclerotia in harvested grain [s] % by weight
1	**132,000 pls/ac**	**7-inch**	**103498**	**96100**	**-1** a*†	**50** b*	**5** a*	**2.49** a*	**0.14** a*	**62** a*	**58.5** a*	**0.04** a*
2	**132,000 pls/ac**	**14-inch**	**121098**	**101908**	**2** a	**55** a	**4** a	**2.44** a	**0.10** a	**62** a	**58.6** a	**0.06** a
3	**132,000 pls/ac**	**21-inch**	**118821**	**110362**	**6** b	**57** a	**4** a	**2.42** a	**0.10** a	**62** a	**58.3** a	**0.05** a
4	**132,000 pls/ac**	**28-inch**	**126702**	**105544**	**14** c	**58** a	**6** a	**2.56** a	**0.14** a	**51** b	**58.9** a	**0.07** a
		F:			56.41	7.44	0.35	0.20	0.44	19.20	1.94	0.51
		P>F:			< 0.0001	0.0028	0.7912	0.8942	0.7253	< 0.0001	0.1667	0.6797
		CV:			25.4	5.3	73.0	17.1	76.8	5.3	0.9	72.4
1	**165,000 pls/ac**	**7-inch**	**131084**	**126333**	**-3** a*†	**54** b*	**7** a*	**2.50** a*	**0.16** a*	**62** a*	**58.6** a*	**0.07** a*
2	**165,000 pls/ac**	**14-inch**	**140804**	**129907**	**0** a	**55** b	**6** a	**2.48** a	**0.15** a	**62** a	**58.7** a	**0.07** a
3	**165,000 pls/ac**	**21-inch**	**138469**	**124504**	**5** b	**57** ab	**6** a	**2.80** b	**0.16** a	**62** a	**58.6** a	**0.11** a
4	**165,000 pls/ac**	**28-inch**	**143242**	**134699**	**12** c	**60** a	**4** a	**2.58** ab	**0.11** a	**52** b	**58.6** a	**0.08** a
		F:			82.18	5.51	0.38	4.37	0.29	20.60	0.17	0.41
		P>F:			< 0.0001	0.0094	0.7707	0.0294	0.8337	< 0.0001	0.9150	0.7451
		CV:			26.6	5.1	73.9	8.4	75.6	4.4	0.8	83.1
1	**198,000 pls/ac**	**7-inch**	**159978**	**149744**	**-2** a*†	**52** c*	**4** a*	**2.34** a*	**0.09** a*	**64** a*	**58.5** a*	**0.03** a*
2	**198,000 pls/ac**	**14-inch**	**164795**	**168599**	**-2** a	**55** bc	**10** a	**2.70** a	**0.27** b	**66** a	**58.6** a	**0.08** a
3	**198,000 pls/ac**	**21-inch**	**169662**	**153664**	**7** b	**60** ab	**9** a	**2.80** a	**0.26** ab	**63** a	**58.6** a	**0.14** a
4	**198,000 pls/ac**	**28-inch**	**179291**	**160831**	**12** c	**63** a	**5** a	**2.88** a	**0.14** ab	**55** b	**58.5** a	**0.11** a
		F:			65.65	7.23	3.05	2.29	3.30	10.14	0.15	2.37
		P>F:			< 0.0001	0.0032	0.0614	0.1201	0.0489	0.0007	0.9248	0.1142
		CV:			24.4	7.4	63.3	14.4	63.4	5.9	0.7	80.2
1	**AVERAGE**	**7-inch**	**131520**	**124059**	**-2** a*†	**52** c*	**5** a*‡	**2.44** a*	**0.13** a*	**63** a*	**58.5** a*	**0.05** a*
2	**AVERAGE**	**14-inch**	**142232**	**133471**	**0** a	**55** bc	**7** a	**2.54** a	**0.17** a	**63** a	**58.6** a	**0.07** a
3	**AVERAGE**	**21-inch**	**142317**	**129510**	**6** a	**58** ab	**6** a	**2.67** a	**0.17** a	**62** a	**58.5** a	**0.10** a
4	**AVERAGE**	**28-inch**	**149745**	**133691**	**13** a	**60** a	**5** a	**2.67** a	**0.13** a	**53** b	**58.7** a	**0.09** a
		F:			197.74	18.55	0.55	2.00	0.94	45.22	0.65	2.44
		P>F:			< 0.0001	< 0.0001	0.6485	0.1315	0.4294	< 0.0001	0.5878	0.0773
		CV:			25.5	6.0	46.7	13.7	71.2	5.3	0.8	81.8
1	**132,000 pls/ac**	**AVERAGE**	**117530**	**103479**	**5** a*†	**55** a*	**5** a*‡	**2.48** a*	**0.12** a*	**59** a*	**58.6** a*	**0.05** a*
2	**165,000 pls/ac**	**AVERAGE**	**138400**	**128861**	**4** a	**57** a	**6** a	**2.59** a	**0.14** a	**60** a	**58.6** a	**0.08** a
3	**198,000 pls/ac**	**AVERAGE**	**168431**	**158209**	**3** a	**57** a	**7** a	**2.68** a	**0.19** a	**62** a	**58.5** a	**0.09** a
		F:			2.93	2.55	1.16	2.37	1.04	2.97	0.15	1.05
		P>F:			0.0995	0.1276	0.3530	0.1441	0.3883	0.0971	0.8603	0.3844
		CV:			25.5	6.0	46.7	13.7	71.2	5.3	0.8	81.8

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[z] **Plant population:** assessed on June 16 when soybeans were at the V2 growth stage and again near maturity on Sept. 8-12 at the R7 growth stage by counting all plants along the full length of the plot in rows 2, 3, 5, and 6 of each 7-row plot (7-in. row spacing), rows 2 and 3 of each 4-row plot (14-in. row spacing), row 2 of each 3-row plot (21-in. row spacing) and the northern row of each 2-row plot (28-in. row spacing).

[y] **Days from bloom to canopy closure:** Number of days between bloom initiation (80-90% of the plants with an open blossom) and canopy closure (canopy fully covered ground between the rows).

[x] **Canopy height:** Height of the canopy when 80 to 90% of plants had at least one open blossom; assessed at one location per plot.

[v] **Sclerotinia stem rot incidence**: assessed on Sept. 8-12 at the R7 growth stage by evaluating all plants along the full length of the plot in rows 2, 3, 5, and 6 of each 7-row plot (7-in. row spacing), rows 2 and 3 of each 4-row plot (14-in. row spacing), row 2 of each 3-row plot (21-in. row spacing) and the northern row of each 2-row plot (28-in. row spacing). An average of 133 plants and minimum of 60 plants were assessed in each plot.

[u] **Sclerotinia severity:** Average disease severity among plants expressing Sclerotinia stem rot. Assessed on Sept. 8-12 at the R7 growth stage using the 1 to 3 scale developed by Craig Grau (Grau and Radke 1984; Plant Disease 68: 56-58): 1 = lesions on lateral branches only, 2 = lesions on main stem, no wilt, and normal pod development, 3 = lesions on main stem resulting in wilting, poor pod fill, and plant death. All plants were assessed along the full length of the plot in rows 2, 3, 5, and 6 of each 7-row plot (7-in. row spacing), rows 2 and 3 of each 4-row plot (14-in. row spacing), row 2 of each 3-row plot (21-in. row spacing) and the northern row of each 2-row plot (28-in. row spacing). An average of 133 plants and minimum of 60 plants were assessed in each plot.

[t] **Sclerotinia disease severity index:** Average disease severity across all plants, including those without any disease. Assessed on Sept. 8-12 at the R7 growth stage using the 0 to 3 scale developed by Craig Grau (Grau and Radke 1984; Plant Disease 68: 56-58): 0 = no symptoms, 1 = lesions on lateral branches only, 2 = lesions on main stem, no wilt, and normal pod development, 3 = lesions on main stem resulting in wilting, poor pod fill, and plant death. All plants were assessed along the full length of the plot in rows 2, 3, 5, and 6 of each 7-row plot (7-in. row spacing), rows 2 and 3 of each 4-row plot (14-in. row spacing), row 2 of each 3-row plot (21-in. row spacing) and the northern row of each 2-row plot (28-in. row spacing). An average of 133 plants and minimum of 60 plants were assessed in each plot.

[s] **Sclerotia in harvested grain:** Percent sclerotia contaminants (by weight) in the harvested grain; assessed on an approx. 400-gram subsample of grain from each plot by manually removing sclerotia.

*** Within-column means followed by different letters are significantly different (***P* < 0.05; Tukey multiple comparison procedure).

‡ **To meet model assumptions of homoskedasticity and normality,** analysis of variance was conducted on data subjected to a systematic natural-log transformation. For ease of interpretation, treatment means are presented for the untransformed data.

† **To permit accurate assessment of the coefficient of variation,** analysis of variance was conducted on data subjected to a systematic transformation in which all values were increased by a fixed integer such that the smallest value equaled zero. This transformation had no impact on the F or P values but permitted accurate assessment of the CV. For ease of interpretation, treatment means are presented for the untransformed data.

	Seeding rate	Row spacing	Plant population [z]	Plant population [z]	Bloom to canopy closure	Plant height [x]	Sclerotinia incidence (%) [v]	Sclerotinia severity (1-3)	Sclerotinia sev. Index (0-3) [t]	Yield	Test weight	Sclerotia in harvested grain [s]
				Sept. 8-12 | R7		R1 growth stage	September 8-12 | R7 growth stage			13% moisture		
			plants/ac	plants/ac	Days	cm	%	1 to 3	0 to 3	bu/ac	lbs/bu	% by weight
SUMMARY		AVERAGE ACROSS ALL VARIETIES										
1	**AVERAGE**	**7-inch**	**134369**	**124781**	**-1** a*†	**47** c*	**9** a*‡	**2.45** a*	**0.24** a*‡	**60** a*	**58.6** a*	**0.10** a*
2	**AVERAGE**	**14-inch**	**141815**	**129775**	**1** b	**49** b	**10** a	**2.52** a	**0.27** ab	**60** a	**58.7** a	**0.13** ab
3	**AVERAGE**	**21-inch**	**141064**	**129646**	**7** c	**50** a	**11** a	**2.74** b	**0.31** b	**60** a	**58.6** a	**0.15** b
4	**AVERAGE**	**28-inch**	**146698**	**134146**	**13** d	**51** a	**9** a	**2.68** b	**0.25** ab	**51** b	**58.5** a	**0.13** ab
		F:			signif interaction:	signif interaction:	2.52	signif interaction:	signif interaction:	signif interaction:	1.77	4.44
		P>F:			variety x row sp	variety x row sp	0.0592	variety x row sp	variety x row sp	variety x row sp	0.1546	0.0049
		CV:			17.9	5.9	30.8	12.5	47.8	6.0	0.9	69.6
1	**AVERAGE**	**14-inch**	**112357**	**101774**	**6** b*†	**48** b*	**9** a*‡	**2.53** a*	**0.24** a*‡	**57** a*	**58.6** a*	**0.12** a*
2	**AVERAGE**	**21-inch**	**139455**	**129003**	**5** a	**50** a	**10** a	**2.63** b	**0.26** a	**58** ab	**58.6** a	**0.12** a
3	**AVERAGE**	**28-inch**	**171146**	**157984**	**4** a	**50** a	**11** a	**2.63** ab	**0.31** a	**59** b	**58.7** a	**0.14** a
		F:			25.32	11.35	0.42	4.10	1.13	6.38	0.78	0.89
		P>F:			< 0.0001	0.0001	0.6582	0.0241	0.3324	0.0039	0.4669	0.4187
		CV:			17.9	5.9	30.8	12.5	47.8	6.0	0.9	69.6

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Optimizing Fungicide Application Timing for Sclerotinia Control in Soybeans

M. Wunsch, M. Schaefer, B. Kraft, S. Kallis, K. Cooper, L. Besemann and H. Eslinger

METHODS

General Agronomics: The study was on a Maddock sandy loam soil type. The previous crop was spring wheat and the tillage operation consisted of field cultivation May 2. The maintenance herbicide applications were: PRE-EMERGENCE Spartan Elite (sulfentrazone, 0.7 lb ai/gal, and s-metolachlor, 6.3 lb ai/gal; FMC Corp., Philadelphia, PA) was applied at 22 fl oz/acre on May 19 and POST-EMERGENCE Roundup PowerMax (5.5 lbs/gal of the a.i. glyphosate = 4.5 lbs/gal of the acid equivalent; Monsanto Corp., St. Louis, MO) was applied June 13 at 32 fl oz/acre with 1 lb AMS/10 gal and 0.125% v/v NIS.

Experimental design: A completely randomized block design with six replicates, with fungicide timing evaluated within each row spacing as a separate experiment. The seeded plot size was 5 feet (center to center) by 25 feet long. The harvested plot size was 5 feet (center to center) and approximately 22 feet long. Every treatment plot was separated by a non-harvested buffer plot.

Planting details: Pioneer 'P07T50R' (0.7 maturity) was seeded at 165,000 pure live seeds/acre. The study was planted on May 17, 2016. Seed treatments used were Apron Maxx RTA (5.0 fl oz/100 lbs seed) + Imidacloprid 4ST (3 fl oz/100 lbs seed). Imidacloprid 4ST (Willowood) contains 4 lbs/gal thiamethoxam; Apron Maxx RTA (Syngenta) contains 0.096 lb/gal mefenoxam and 0.064 lb/gal fludioxonil. Rhizobium inoculant: BYSI-N granular inoculant for soybeans (100 million Bradyrhizobium japonicum per gram; Lallemand Specialties Canada, Saskatoon, SK) was applied in-furrow with the seed at a rate of 10.3 lbs/acre.

Fungicide applications:
Application details: Fungicides were applied with a 60-inch hand boom equipped with four equally spaced TeeJet 80015VS flat-fan nozzles at a spray volume of 15 gal water/A operated at 40 psi.
Application A: 07/08/2016; 47% of plants at the R1 growth stage (at least one open blossom); 90-100% canopy closure in the 14-inch rows and 50% canopy closure in the 28-inch rows. Wind speed - 3 MPH, Temperature 79°F, R Humidity 53%.
Application B: 07/15/2016; 100% of plants at the R2 growth stage (an open blossom at one of the top two nodes; could not spray earlier because the wind speed was too high.); 100% canopy closure in the narrow (14-inch) rows and 75-90% canopy closure in the wide (28-inch rows); Wind speed - 2 MPH, Temperature 75°F, R Humidity 48%.
Application C: 07/18/2016; 100% of plants at the R2 growth stage; 100% canopy closure in the narrow (14-inch) rows and 90-100% canopy closure in the wide (28-inch) rows. Wind speed - 5 MPH, Temperature 76°F, R Humidity 69%.
Application D: 07/20/2016; 90-100% of plants at the R3 growth stage (a pod at least 3/16" long at one of the top two nodes); 100% canopy closure in the narrow (14-inch) rows and 95-100% canopy closure in the wide (28-inch) rows. Wind speed - 5 MPH, Temperature 80°F, R Humidity 87%.

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Notes and disease establishment: The trial was established on a site with a previous history of Sclerotinia epidemics. To sustain the soil moisture necessary for apothecia development, the trial was irrigated aggressively to create conditions favorable for apothecia production and Sclerotinia infection. Sclerotinia incidence and severity were assessed on September 14 at the late R7 growth stage using the 0 to 3 scale developed by Craig Grau (Grau and Radke 1984; Plant Disease 68: 56-58): 0 = no symptoms, 1 = lesions on lateral branches only, 2 = lesions on main stem, no wilt, and normal pod development, 3 = lesions on main stem resulting in wilting, poor pod fill, and plant death. All plants were assessed in the middle two rows of four-row plots (14-inch row spacing) and in one of two rows of two-row plots (28-inch row spacing).

Harvest, seed yield and quality assessment: The trial was harvested on September 26. To facilitate accurate yield assessment, plot lengths were measured shortly before harvest. Yields were calculated on the basis of a 5-ft plot width and the measured plot length. Seed moisture was assessed after the grain was cleaned. Seed yield and quality results were adjusted from the grain actual moisture to a standard 13% moisture level.

Partial funding for this project was provided by the North Dakota Soybean Council.

Optimizing Fungicide Application Timing Soybean; four-row plots top photo and two row plots bottom photo.

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Evaluation of fungicide application timing for management of Sclerotinia in soybeans

NARROW (14-INCH) ROWS

		Sclerotinia stem rot			Yield	Test Weight	Kernel Weight	Sclerotia in harvested grain
		Incidence	Severity	Severity Index	13% moisture			
	Fungicide application timing (Endura 70WG 5.5 oz/ac)	- Sept. 14 | R7 growth stage -			bu/ac	lbs/bu	seeds/lb	% by weight
1	Non-treated	**7** a*‡	2.8 a*	**0.20** a*	**62** a*	57.7 a*	**2593** a*	**0.16** b*
2	**July 8:** 47% of plants at R1; 90-100% canopy closure	**6** a	2.7 a	**0.18** a	**63** a	57.8 a	**2605** a	**0.05** a
3	**July 15:** 100% of plants at R2; 100% canopy closure	**4** a	2.5 a	**0.11** a	**64** a	57.6 a	**2529** a	**0.06** ab
4	**July 18:** 100% of plants at R2; 100% canopy closure	**4** a	2.6 a	**0.12** a	**65** a	58.0 a	**2591** a	**0.04** a
5	**July 20:** 90-100% of plants at R3; 100% canopy closure	**4** a	2.7 a	**0.10** a	**63** a	57.7 a	**2622** a	**0.05** a
	F:	1.49	1.04	2.09	0.82	0.46	0.71	3.88
	P>F:	0.2438	0.4156	0.1207	0.5264	0.7642	0.5952	0.0172
	CV:	28.7	9.4	52.1	4.7	1.0	4.0	86.5

WIDE (28-INCH) ROWS

		Sclerotinia stem rot			Yield	Test Weight	Kernel Weight	Sclerotia in harvested grain
		Incidence	Severity	Severity Index	13% moisture			
	Fungicide application timing (Endura 70WG 5.5 oz/ac)	- Sept. 14 | R7 growth stage -			bu/ac	lbs/bu	seeds/lb	% by weight
1	Non-treated	**5** a*‡	2.6 a*	**0.13** a*	**58** a*	58.1 a*	**2659** a*	**0.04** a*
2	**July 8:** 47% of plants at R1; 50% canopy closure	**4** a	2.8 a	**0.12** a	**60** a	58.0 a	**2618** a	**0.02** a
3	**July 15:** 100% of plants at R2; 75-90% canopy closure	**5** a	2.8 a	**0.14** a	**59** a	58.1 a	**2615** a	**0.08** a
4	**July 18:** 100% of plants at R2; 90-100% canopy closure	**4** a	2.3 a	**0.11** a	**59** a	58.3 a	**2587** a	**0.05** a
5	**July 20:** 90-100% of plants at R3; 95-100% canopy closure	**5** a	2.8 a	**0.15** a	**59** a	58.2 a	**2603** a	**0.05** a
	F:	0.03	1.29	0.11	0.68	0.36	0.58	1.12
	P>F:	0.9975	0.3162	0.9786	0.6120	0.8366	0.6830	0.3733
	CV:	56.5	16.0	95.8	2.9	0.6	3.3	97.1

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Strip-Till, Corn on Corn, Nitrogen Rate Study

L. Besemann and H. Eslinger

Conventional grown continuous corn requires extensive tillage with high fuel use. Continuous corn requires about 40 lb more N/acre than corn grown on soybean ground.

The objectives of this study are to grow continuous corn in a strip-till system that eliminates full width tillage and to find efficient nitrogen rates.

MATERIALS AND METHODS

Soil:	Embden sandy loam and Hecla sandy loam; pH = 7.3; 2.5% organic matter; soil N average was 28 lbs/acre; soil P and soil K were very high; soil S was low.
Previous crop:	2015 - field corn.
Seedbed preparation:	Strip-till May 5 with an Orthman strip-till machine.
Hybrid:	Wensman W8184VT2RIB.
Planting:	Planted May 6 in 30-inch rows @ 26,000 seeds/acre.
Plots:	Plots were 120 ft long by 20 ft (8 rows) wide. There were four replications.
Fertilizer:	All plots received 12 lbs N/acre plus 40 lbs P_2O_5/acre stream-barred as 10-34-0 and, 13 lbs N/acre and 18 lbs S/acre stream-barred as 15-0-0-20 May 9. Stream-barred 79 lbs N/acre as 28-0-0 to the 100 and 150 lb treatments and 44 lbs N/acre as 28-0-0 to the 150d and 200 lb treatments May 20. Sidedress N treatments as 28-0-0 (three inches deep) June 16; the 150 lb treatment received 47 lbs N/acre, the 150d treatment received 83 lbs N/acre and the 200 lb treatment received 132 lbs N/acre.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Roundup (40 oz/acre) + Harness (2 pt/acre) + AMS (1 lb/10 gal) + NIS (1.6 oz/gal) May 10, Laudis (3 oz/acre) + Roundup (32 oz/acre) + NIS (1 pt/100 gal) + AMS (1 lbs/10 gal) + Interlock (4 oz/acre) June 20.
Remote sensing:	Sensing was achieved with an Opti-Sciences CCM 200 Plus chlorophyll meter.
Harvest:	October 17 with a JD 4400 combine. Harvest area was the middle four rows of each plot, 120 feet long.

RESULTS

Determining nitrogen sufficiency in time is important to achieve N efficiency. Remote sensing utilized an Opti-Science CCM 200 chlorophyll meter to measure N sufficiency. Increasing nitrogen rates (N) increased grain yield and chlorophyll meter readings. Remote sensing with the chlorophyll meter did well in predicting corn N status.

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Table 1. Strip-till, corn on corn nitrogen rate study at the Oakes Irrigation Research Site in 2016.

Fertilizer N Rate	Grain Yield[1]	Grain Yield 2009-16	Harvest Moisture	Test Weight	Chlorophyll Meter Reading[2]	Nitrate-N Stalk	Nitrate-N Fall Soil	Seed Protein	Seed Starch	Seed Oil	Emerge Date	Silk Date
lb/acre	bu/ac		%	lb/bu	4-Aug	ppm	lbs/ac	----------%----------				
22	108.3	86.9	17.7	54.7	12.2	12	11	7.0	73.3	3.7	21-May	22-Jul
100	190.4	171.3	18.0	56.9	47.1	20	14	8.3	73.0	3.5	21-May	19-Jul
150	207.8	191.4	18.3	57.1	53.3	30	18	9.2	72.3	3.6	21-May	20-Jul
150d	208.9	199.8	18.4	57.1	54.9	198	15	9.3	72.1	3.7	22-May	20-Jul
200	218.8	210.6	17.1	57.5	58.1	352	25	9.4	72.1	3.6	21-May	19-Jul
Mean	186.8	--	17.9	56.6	45.1	122	17	8.6	72.5	3.6	21-May	20-Jul
C.V. (%)	1.9	--	1.7	1.17	5.6	135.8	19.8	6.2	0.8	5.1	0	0
LSD 0.10	4.3	--	0.4	0.8	3.2	209	4	0.7	0.7	0.2	NS	0.7
LSD 0.05	5.3	--	0.5	1.0	3.9	256	5	0.8	0.9	NS	NS	0.8

Planting date = May 6; Harvest date = October 24; Previous crop = Field corn

[1]Yield adjusted to 15.5% moisture.

[2]Opti-Science CCM 200.

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Strip-Till, Corn on Soybean, Nitrogen Rate Study

L. Besemann and H. Eslinger

The objectives of this study were to compare corn yields of a corn/soybean rotation to those in a companion corn/corn rotation and to find differences in N response and other agronomic measurements in no-till rotations, utilizing strip-till.

MATERIALS AND METHODS

Soil:	Embden loam and Gardena loam; pH = 7.4; 2.1% organic matter; Soil N average was 32 lbs/acre; soil P was very high; soil K was high; soil S was low.
Previous crop:	2015 - soybean.
Seedbed preparation:	Strip-till May 5 with an Orthman strip-till machine.
Hybrid:	Wensman W8184VT2RIB
Planting:	Planted May 6 @ 26,000 seeds per acre in 30-inch rows.
Plots:	Plots were 37 ft long by 15 ft (6 rows) wide. There were four replications.
Fertilizer:	All plots received 12 lbs N/acre plus 40 lbs P_2O_5/acre stream-barred as 10-34-0 and 13 lbs N/acre and 18 lbs S/acre stream-barred as 15-0-0-20 May 9. Stream-barred 79 lbs N/acre as 28-0-0 to the 100 lb treatment and 44 lbs N/acre as 28-0-0 to the 100d, 150 and 200 lb treatments May 20. Sidedress N treatments as 28-0-0 (three inches deep) June 16; the 100d treatment received 32 lbs N/acre, the 150 lb treatment received 81 lbs N/acre and 200 lb treatment received 131 lbs N/acre.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Roundup (40 oz/acre) + Harness (2 pt/acre) + AMS (1 lb/10gal) + NIS (1.6 oz/10 gal) May 10 and Laudis (3 oz/acre) + Roundup (32 oz/acre) + NIS (1 pt/100 gal) + AMS (1 lb/10 gal) + Interlock (4 oz/acre) June 20.
Remote sensing:	Opti-Sciences CCM 200 Plus chlorophyll meter.
Harvest:	Hand harvested October 19. Harvest area was the two center rows from each plot (72 feet of total row).

RESULTS

Determining nitrogen sufficiency in time is important to achieve N efficiency. Remote sensing utilized an Opti-Science CCM 200 chlorophyll meter to determine N sufficiency. Increasing nitrogen rates (N) increased grain yield and chlorophyll meter readings. Remote sensing with the chlorophyll meter did well in predicting corn N status.

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Table 1. Strip-till, corn on soybean nitrogen rate study at the Oakes Irrigation Research Site in 2016.

Fertilizer N Rate	Grain Yield[1]	Grain Yield 2009-16	Harvest Moisture	Test Weight	Chlorophyll Meter Reading[2]	Nitrate-N		Seed Protein	Seed Oil	Seed Starch	Emerge Date	Silk Date	Population
						Stalk	Fall Soil						
lb/acre	bu/ac	bu/ac	%	lb/bu	3-Aug	ppm	lbs/ac	----------%----------					plants/ac
22	141.1	130.8	20.0	54.5	16.9	20	9	6.7	2.5	75.4	20-May	22-Jul	27528
100	219.6	184.8	18.7	57.3	49.7	30	10	8.8	3.3	72.9	20-May	18-Jul	27286
100d	188.1	193.0	19.5	56.2	36.6	20	10	7.6	2.8	74.3	20-May	19-Jul	27286
150	229.2	223.6	18.7	57.7	51.4	141	11	8.9	3.2	73.0	20-May	19-Jul	27286
200	233.0	232.6	18.7	57.3	53.4	200	14	9.3	3.2	72.6	20-May	19-Jul	27225
Mean	202.2	--	19.1	56.6	41.6	82	11	8	3.0	73.6	20-May	19-Jul	27322
C.V. (%)	5.4	--	2.3	1.2	9.7	160	45	5.5	6.2	0.7	0.0	0.0	2.1
LSD 0.10	13.6	--	0.6	0.9	5.1	166	NS	0.6	0.2	0.7	NS	NS	NS
LSD 0.05	16.7	--	0.7	1.1	6.2	NS	NS	0.7	0.3	0.8	NS	NS	NS

Planting date = May 6; Harvest date = October 19; Previous Crop = Soybean

[1]Yield adjusted to 15.5% moisture.

[2]Opti-Science CCM 200.

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Strip-Till, Soybean on Corn Study

L. Besemann and H. Eslinger

MATERIALS AND METHODS

Soil:	Embden sandy loam, Hecla sandy loam and Maddock sandy loam; pH = 7.3; 2.1% organic matter; soil N was 7 lbs/acre; soil P was very high; soil K was high; soil S was medium.
Previous crop:	2015 - field corn.
Seedbed preparation:	Strip-till May 5 with an Orthman strip-till machine.
Hybrid:	Northrup King S10P9.
Planting:	May 22 @ 174,000 seeds per acre in 30-inch rows.
Fertilizer:	All plots received 12 lbs N/acre and 40 lbs P_2O_5/acre as 10-34-0 via strip-till May 9.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Roundup (40 oz/acre) + Authority Elite (25oz/acre) + AMS (1 lb/10 gal) + NIS (1.6 oz/10 gal) May 10. Endura (5.5 oz/acre) on July 15 for disease control.
Harvest:	Harvested September 29 with an Almaco plot combine. Harvest area was four two-row passes the entire length, 74 feet, of the study.

RESULTS

The soybean yield was 55.2 bu/acre at 13.0% moisture with a test weight of 56.6 lbs/bu. Most soybeans were lodged with the plants laying in between the rows. The drive wheel of the combine caused extensive shatter loss during harvest resulting in reduction in recorded yield.

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Optimizing Fungicide Application Methods for Management of Sclerotinia Head Rot of Sunflowers

M. Wunsch, B. Kraft, M. Schaefer, S. Kallis, K. Cooper, L. Besemann and H. Eslinger

Methods

General Agronomics: The study was on a Maddock and Embden sandy loam soil type. The previous crop was spring wheat (replicate 1) and soybeans (replicates 2, 3 and 4). The tillage operation consisted of disking once in the fall and spring cultivations (May 2, May 27 and June 1) to remove small weeds and to smooth the seedbed. Supplemental fertilization: 19.4 lbs N, 49.8 lbs P, 45 lbs K, and 10.4 lbs S per acre were applied on April 21. On June 24, nitrogen (applied as 28-0-0) was side-dressed at 60 lbs/acre. Authority Elite (sulfentrazone, 0.7 lb ai/gal, and s-metolachlor, 6.3 lb ai/gal; FMC Corp., Philadelphia, PA) was applied pre-emergence at 22 fl oz/acre on June 3.

Experimental design: A completely randomized split-plot design with inoculation treatment (inoculated at R5.1-R5.3, inoculated at R5.4-R5.6, and inoculated at R5.7-R5.9) as main factor and fungicide application treatment as sub-factor with four replicates.

Planting details: NuSeed 'Jaguar DMR' sunflowers were planted on June 2 using a Monosem planter. The final plant population was 17,500 plants/acre. To ensure consistent plant spacing, sunflowers were over seeded, and the final plant population of 17,500 plants/acre was accomplished by manually thinning the sunflowers. Sunflowers were thinned at the V4-V5 growth stage on June 27.

Fungicide applications: Fungicides were applied (1) through standard boom-mounted nozzles spaced 20 inches apart on a tractor-mounted boom or (2) through drop nozzles spaced 30 inches apart on a tractor-mounted boom. In treatments utilizing drop nozzles, the tractor was driven such that the drop nozzles were centered between rows. The water volume for all treatments was 15 gal/acre.

Flat-fan nozzles mounted directly on the boom: TeeJet XR8001VS flat-fan nozzles (Spraying Systems Co.; Glendale Heights, IL) were spaced 20 inches apart on the boom. Applications were made at 40 psi, and the boom was positioned such that it was 18 inches above the center of sunflower heads, the height at which spray patterns from adjacent nozzles meet without significant overlap. Applications were made in an eastern direction (90˚ from north) to half of the plots and in a western direction (270˚ from north) to half of the plots. Droplet sizes were 'fine' and application speed was 2.0 mph.

Flat-fan nozzles mounted on '360 Undercover' drop nozzles: TeeJet XR11001VS flat-fan nozzles (Spraying Systems Co.; Glendale Heights, IL) were attached to the side ports of the 360 Undercover drop nozzle (360 Yield Center; Morton, IL). Applications were made at 40 and 60 psi (tested as different treatments), with the boom positioned such that the flat-fan nozzles were centered at the mid-point of the sunflower heads and the flat-fan spray pattern was vertical. This nozzle setup was tested at 40 and 60 psi in each of two driving directions: west, 270˚ from north; and east, 90˚ from north. Droplet size was fine at 40 psi and very fine at 60 psi. Driving speed was 2.6 mph at 40 psi and 3.2 mph at 60 psi.

Hollow-cone nozzles mounted on '360 Undercover' drop nozzles: ConeJet VisiFlo TX-VK3 hollow-cone nozzles (Spraying Systems Co.; Glendale Heights, IL) were attached to the side ports of the 360 Undercover drop nozzle (360 Yield Center; Morton, IL). Applications were made at 60 psi with the boom positioned such that nozzles were centered at the mid-point of the sunflower heads. This nozzle setup was tested at 60 psi at each of two driving directions: west, 270˚ from north; and east, 90˚ from north. Droplet size was very fine and driving speed was 1.6 mph.

Fungicide application details: August 5 at 11:30 a.m. to 3:30 p.m.; temperature = 77 to 84˚F, relative humidity = 41-52%, wind speed = 3 to 6 mph; 97% of sunflowers were in bloom (ray flowers open) and 3% had not yet entered bloom; average growth stage = R5.6. Average height of the sunflowers (to the middle of the head) was 80.2 inches. Neither rust nor Sclerotinia head rot were observed. Sunflower growth stage was assessed immediately before applying fungicides by evaluating five plants at 12 arbitrarily selected locations across the trial.

Assessment of fungicide deposition: Fungicide spray deposition to the front of sunflower heads was assessed using 2 inch by 3 inch TeeJet Water-Sensitive Cards (Spraying Systems Co.; Glendale Heights, IL). Lengthwise, all treatment plots were separated from adjacent treatment plots by a 30-foot-long buffer plot, and spray deposition was assessed on sunflowers within the buffer plot immediately adjacent to the treatment plot. Spray deposition was evaluated for six arbitrarily selected sunflower heads per plot. A 3 inch by 5 inch index card, placed inside a zip lock bag, was secured to the front of the sunflower head with a rubber band to provide a dry, flat surface for mounting the water-sensitive spray card. Paper extensions were taped to the backs of the spray cards to facilitate attachment of spray cards to the bagged index cards without interference with the water-sensitive surface of the spray cards, and paper clips were used to secure the spray cards to the bagged index cards. The water sensitive cards were placed on heads immediately before fungicides were applied. They were removed after applications as soon as the water-sensitive surface had dried and were stored in a paper bag placed within a sealed container with a desiccant. The spray cards were scanned at 600 pixels per inch resolution. To avoid bias caused by any background discoloration in the spray cards caused by ambient humidity at the time fungicides were applied, the lightest shades were removed from the cards; images were opened in Photoshop CS6, converted to grayscale, and all pixels within the 0 to 100 range of intensity (on a 0 to 255 intensity scale, where 0 = white and 255 = black) were converted to 0. Additional edits were manually conducted as needed to eliminate any biases associated with smudging and handling errors. Analysis of the edited grayscale images was conducted in DepositScan (Zhu et al. 2011; Computers and Electronics in Agriculture 76:38-43). Only percent coverage results are reported; due to the positioning of sunflower heads relative to the sprayer, the spray cards were often not perpendicular to the spray direction, making it difficult to rigorously assess droplet sizes or droplet volumes on the basis of the deposition patterns on the spray cards.

Disease establishment: Spore solutions were prepared by adding laboratory-grown ascospores of Sclerotinia sclerotiorum to non-chlorinated water and adding one to two drops of Tween 20. Hand-held spray bottles were calibrated to determine how much liquid was released through each squirt of the bottle, and the spore solution was adjusted so that each squirt of the spray bottle delivered approximately 5,000 spores. In each inoculation, 15,000 spores were delivered to the front of each head (3 squirts of the spray bottle). Each head was inoculated once. At each inoculation, 15,000 spores were applied to the front of each head.

Inoculation timing 1 - R5.1 to R5.3: Inoculations were conducted on August 1 and August 3 (4 and 2 days before fungicides were applied, respectively) such that every head was inoculated once at the R5.1 to R5.3 growth stage (10 to 30% of the disk flowers blooming or already bloomed). When plants were inoculated an upper leaf was marked with a spray-paint dot to indicate that inoculation was completed.

Inoculation timing 2 - R5.6 to R5.9: Every head was inoculated on August 6 (1 day after fungicides were applied). The predominant growth stage was R5.6 to R5.9, and the average growth stage was R5.8.

Inoculation timing 3 - R5.8 to R6.0: Every head was inoculated on August 8 (3 days after fungicides were applied). The predominant growth stage was R5.8 to R6.0, and the average growth stage was R5.9.

Irrigation: Overhead irrigation was applied through micro-sprinkler misting systems from August 1 to August 25 for 3 minutes every 30 minutes during daytime hours or as needed to keep the front of sunflower heads moist.

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In-season notes
Disease severity: On September 21-22 at the R9 growth stage every plant was assessed for the percent of the head exhibiting Sclerotinia head rot. All plants in each plot were evaluated.

Harvest and seed yield and quality assessment: To facilitate harvest before significant bird predation occurred, sunflower heads were manually clipped and bagged on September 27 at the early R9 growth stage, placed in a drier, and then passed through a combine. Yields were calculated on the basis of the measured plot lengths. Seed moisture and contamination with sclerotia were assessed, and yield data were adjusted to a standard 10% moisture and to report seed yield excluding sclerotia. Several severe wind and rain storms occurred during August, resulting in significant lodging in some plots. Heads were only harvested from plants that had not lodged.

Sclerotia in harvested grain: Percent sclerotia (by weight) was assessed by manually removing all sclerotia from a 200-gram subsample of harvested grain from each plot.
Sclerotia in cleaned grain: Percent sclerotia (by weight) that could not be mechanically separated on the basis of size was assessed by manually separating all sclerotia from a subsample of grain that had been cleaned by passing it through a shaker equipped with an upper sieve with 30/64 round holes and a lower sieve with 7 x 3/4 slotted holes.
Yield assessment: Yields were adjusted by the percent sclerotia in the cleaned grain such that reported yields excluded all sclerotia contamination. Test weights were evaluated on a subsample of grain from which all sclerotia were manually removed.

Statistical analysis: Data were evaluated with analysis of variance. Assumptions of ANOVA: (1) The assumption of constant variance was assessed with Levene's test for homogeneity of variances and visually confirmed by plotting residuals against predicted values. (2) The assumption of normality was assessed with the Shapiro-Wilk test and visually confirmed with a normal probability plot. (3) The assumption of additivity of main-factor effects across replicates (no replicate-by-treatment interaction) was evaluated with Tukey's test for nonadditivity. All data met model assumptions except the head rot incidence and severity index data within the non-inoculated treatments. To address these distributional problems, a systematic natural-log transformation [LN(x+1) for data sets that include values less than 1.0] was applied to these data. All other data met model assumptions. Within each inoculation treatment, analyses of fungicide application treatments were conducted with replicate and treatment as main factor effects. Combined analyses: Combined analyses of (1) fungicide application treatments across inoculation treatments and (2) inoculation treatments across fungicide application treatments were conducted with replicate and irrigation treatment as main-factor effects and seeding rate and foliar fungicide treatment as a sub-factor and controlling for replicate by main-factor and main-factor by treatment interactions. F-tests for the combined analysis of the main factor (inoculation treatment) and the sub-factor (fungicide application method) were conducted utilizing replicate-by-main-factor interaction for the error term. Treatment contrasts: Single-degree-of-freedom contrasts were performed for all pairwise comparisons of treatments; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure was employed. Software used for analyses: Analyses were implemented in PROC UNIVARIATE and PROC GLM of SAS (version 9.4; SAS Institute, Cary, NC).

This material is based upon work supported by the U.S. Department of Agriculture, Agricultural Research Service, and the Specialty Crop Grant program. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

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Inoculations were conducted **August 1** and **3** such that each head was inoculated once at R5.1 to R5.3, **August 6** when sunflowers were at predominantly R5.6 to R5.9, or **August 8** when sunflowers were at predominantly R5.8 to R6.0. *Fungicides were applied August 5.*

	Nozzle Placement	Spray Pattern	Nozzles utilized (Spraying Systems TeeJet)	Application Pressure	Droplet Size	Driving Speed	Driving Direction
1	Non-treated control						
2	Boom-mounted nozzles	flat fan	XR8001VS at 20-inch spacing	40 psi	Fine	2.0	
3	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	East (90˚ from the north)
4	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	West (270˚ from the north)
5	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	East (90˚ from the north)
6	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	West (270˚ from the north)
7	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	East (90˚ from the north)
8	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	West (270˚ from the north)

1	Inoculated at **R5.1 to R5.3** with heads inoculated August 1 or 3.
2	Inoculated at predominant **R5.6 to R5.9** (average R5.8) with heads inoculated August 6.
3	Inoculated at predominant **R5.8 to R6.0** (average R5.9) with heads inoculated August 8.

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	Fungicide	Sclerotinia head rot			Rust	Yield	Test Wt.	Kernel Wt.	Sclerotia in	Sclerotia in	Dehulled	Seed over	Seed over	Seed through
	Coverage	Incidence (%)	Severity (%)	Sev. Index (%)		10% moisture			harvested grain	cleaned grain	kernels	23/64 sieve	22/64 sieve	20/64 sieve
	%	- Sept 21-22 | R9 growth stage -			Sept. 15; R8	lbs/ac	lbs/bu	seeds/lb	% by weight	% by weight	%	% by weight		
1		**76** c*	**100** a*	**76** c*	**6.3** b*‡	**899** c*	**21.5** a*	**3492** a*	**12** a*	**7** a*‡	**2** a*‡	**28** a*	**47** a*	**14** a*
2	**0.2** b*‡	**62** b	**100** a	**62** b	**0.1** a	**1273** abc	**22.2** a	**3413** a	**11** a	**7** a	**2** a	**29** a	**46** a	**17** a
3	**5.3** ab	**70** abc	**100** a	**70** abc	**0.1** a	**1549** ab	**22.5** a	**3293** a	**11** a	**7** a	**4** a	**28** a	**48** a	**16** a
4	**2.2** ab	**70** abc	**99** a	**70** abc	**0.0** a	**985** bc	**22.1** a	**3535** a	**11** a	**7** a	**2** a	**32** a	**49** a	**15** a
5	**3.1** ab	**69** abc	**99** a	**68** abc	**0.2** a	**1438** ab	**21.8** a	**3457** a	**11** a	**6** a	**1** a	**38** a	**55** a	**13** a
6	**3.8** ab	**74** bc	**100** a	**74** cb	**0.1** a	**869** c	**21.5** a	**3445** a	**12** a	**8** a	**3** a	**36** a	**55** a	**14** a
7	**17.3** a	**60** a	**100** a	**60** a	**0.4** a	**1618** a	**22.5** a	**3353** a	**10** a	**6** a	**2** a	**35** a	**54** a	**13** a
8	**7.6** ab	**69** abc	**99** a	**68** abc	**0.1** a	**1203** abc	**21.8** a	**3373** a	**11** a	**7** a	**4** a	**38** a	**56** a	**13** a
F:	2.69	3.13	0.56	3.09	34.49	5.66	2.15	0.93	0.65	1.06	0.98	1.41	1.47	1.00
P>F:	0.0485	0.0068	0.7879	0.0073	< 0.0001	< 0.0001	0.0507	0.4875	0.7096	0.3999	0.4572	0.2192	0.1956	1.0000
CV:	69.1	15.3	1.9	15.4	112.5	32.8	4.4	7.3	24.4	15.1	61.5	36.4	22.1	32.4

	Sclerotinia head rot			Rust	Yield	Test Wt.	Kernel Wt.	Sclerotia in	Sclerotia in	Dehulled	Seed over	Seed over	Seed through
	Incidence (%)	Severity (%)	Sev. Index (%)		10% moisture			harvested grain	cleaned grain	kernels	23/64 sieve	22/64 sieve	20/64 sieve
	- Sept 21-22 | R9 growth stage -			Sept. 15; R8	lbs/ac	lbs/bu	seeds/lb	% by weight	% by weight	%	% by weight		
1	**39** a*	**99** a*	**39** a*	**0.9** a*	**1630** a*	**24** a*	**3318** a*	**5** a*	**3** a*‡	**1** a*‡	**23** b*	**42** b*	**19** b*
2	**93** b	**100** a	**93** b	**1.1** a	**739** b	**20** c	**3539** a	**18** c	**11** c	**4** a	**42** a	**59** a	**10** a
3	**74** b	**100** a	**74** b	**0.7** a	**1290** a	**22** b	**3406** a	**10** b	**6** b	**2** a	**35** a	**53** a	**13** a
F:	35.76	1.26	35.29	0.45	12.47	32.28	2.27	33.38	32.89	4.71	14.92	22.88	1.00
P>F:	0.0005	0.3497	0.0005	0.6565	0.0073	0.0006	0.1846	0.0006	0.0006	0.0589	0.0047	0.0016	1.0000
CV:	15.3	1.9	15.4	112.5	32.8	4.4	7.3	24.4	15.1	61.5	36.4	22.1	32.4

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INOCULATED at R5.1-R5.3

Inoculations were conducted **August 1** and **3** such that each head was inoculated once at the target growth stage. *Fungicides were applied August 5.*

	Nozzle Placement	Spray Pattern	Nozzles utilized (Spraying Systems TeeJet)	Application Pressure	Droplet Size	Driving Speed	Driving Direction
1	Non-treated control						
2	Boom-mounted nozzles	flat fan	XR8001VS at 20-inch spacing	40 psi	Fine	2.0	
3	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	East (90˚ from the north)
4	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	West (270˚ from the north)
5	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	East (90˚ from the north)
6	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	West (270˚ from the north)
7	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	East (90˚ from the north)
8	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	West (270˚ from the north)

	Sclerotinia head rot			Rust	Yield	Test Wt.	Kernel Wt.	Sclerotia in	Sclerotia in	Dehulled	Seed over	Seed over	Seed through
	Incidence (%)	Severity (%)	Sev. Index (%)		10% moisture			harvested grain	cleaned grain	kernels	23/64 sieve	22/64 sieve	20/64 sieve
	- Sept 21-22 | R9 growth stage -			Sept. 15; R8	lbs/ac	lbs/bu	seeds/lb	% by weight	% by weight	%	% by weight		
1	**49** b*‡	**100** a*	**49** a*‡	**5.5** b*‡	**1213** a*	**23.4** a*	**3426** a*	**6** a*	**3** a*	**1.2** a*‡	**19** a*	**37** a*	**20** a*
2	**34** ab	**99** a	**33** a	**0.1** a	**1738** a	**24.4** a	**3325** a	**5** a	**3** a	**0.5** a	**19** a	**35** a	**24** a
3	**40** ab	**100** a	**40** a	**0.3** a	**1829** a	**24.4** a	**3363** a	**6** a	**4** a	**1.7** a	**22** a	**39** a	**22** a
4	**41** ab	**100** a	**41** a	**0.0** a	**1327** a	**23.7** a	**3268** a	**5** a	**3** a	**2.1** a	**24** a	**41** a	**19** a
5	**42** ab	**97** a	**41** a	**0.1** a	**1705** a	**23.3** a	**3291** a	**6** a	**4** a	**0.6** a	**26** a	**47** a	**15** a
6	**44** ab	**100** a	**44** a	**0.2** a	**1342** a	**23.2** a	**3326** a	**5** a	**3** a	**1.1** a	**28** a	**47** a	**17** a
7	**23** a	**100** a	**23** a	**0.8** a	**2315** a	**24.6** a	**3211** a	**3** a	**2** a	**1.0** a	**26** a	**46** a	**18** a
8	**37** ab	**97** a	**36** a	**0.1** a	**1570** a	**23.5** a	**3332** a	**5** a	**3** a	**1.4** a	**21** a	**41** a	**17** a
F:	2.50	0.75	2.41	7.84	1.70	1.77	1.18	1.36	1.54	0.42	1.16	2.00	1.87
P>F:	0.0493	0.6333	0.0557	< 0.0001	0.1643	0.1471	0.3577	0.2720	0.2094	0.8757	0.3663	0.1030	0.1261
CV:	9.0	2.9	9.1	113.7	32.2	3.6	3.5	29.9	33.8	88.7	29.7	16.0	22.2

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INOCULATED at R5.6-R5.9

Every head was inoculated on **August 6**; predominant growth stage was R5.6-R5.9, and average growth stage was R5.8. *Fungicides were applied August 5.*

	Nozzle Placement	Spray Pattern	Nozzles utilized (Spraying Systems TeeJet)	Application Pressure	Droplet Size	Driving Speed	Driving Direction
1	Non-treated control						
2	Boom-mounted nozzles	flat fan	XR8001VS at 20-inch spacing	40 psi	Fine	2.0	
3	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	East (90˚ from the north)
4	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	West (270˚ from the north)
5	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	East (90˚ from the north)
6	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	West (270˚ from the north)
7	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	East (90˚ from the north)
8	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	West (270˚ from the north)

	Sclerotinia head rot			Rust	Yield	Test Wt.	Kernel Wt.	Sclerotia in	Sclerotia in	Dehulled	Seed over	Seed over	Seed through
	Incidence (%)	Severity (%)	Sev. Index (%)		10% moisture			harvested grain	cleaned grain	kernels	23/64 sieve	22/64 sieve	20/64 sieve
	- Sept 21-22 | R9 growth stage -			Sept. 15; R8	lbs/ac	lbs/bu	seeds/lb	% by weight	% by weight	%	% by weight		
1	**97** a*	**100** a*	**97** a*	**8.8** b*‡	**594** a*	**19.6** a*	**3687** a*	**20** a*	**12** a*	**3** a*‡	**34** a*	**54** a*	**9** a*
2	**94** a	**100** a	**94** a	**0.0** a	**613** a	**19.6** a	**3582** a	**19** a	**12** a	**4** a	**42** a	**60** a	**10** a
3	**92** a	**100** a	**92** a	**0.1** a	**1058** a	**20.4** a	**3316** a	**18** a	**9** a	**7** a	**31** a	**54** a	**12** a
4	**95** a	**100** a	**95** a	**0.1** a	**576** a	**20.5** a	**3667** a	**19** a	**13** a	**2** a	**33** a	**50** a	**14** a
5	**92** a	**100** a	**92** a	**0.1** a	**998** a	**20.0** a	**3401** a	**17** a	**9** a	**2** a	**53** a	**68** a	**8** a
6	**95** a	**99** a	**95** a	**0.1** a	**283** a	**19.9** a	**3665** a	**16** a	**15** a	**4** a	**48** a	**64** a	**9** a
7	**93** a	**100** a	**93** a	**0.2** a	**973** a	**20.2** a	**3454** a	**17** a	**10** a	**3** a	**44** a	**62** a	**9** a
8	**89** a	**100** a	**89** a	**0.0** a	**779** a	**20.7** a	**3586** a	**17** a	**10** a	**11** a	**51** a	**66** a	**12** a
F:	1.26	1.00	1.18	126.95	1.89	0.65	1.11	0.51	0.65	1.65	1.46	1.01	1.18
P>F:	0.3172	0.4586	0.3540	< 0.0001	0.1282	0.7076	0.3990	0.8191	0.7101	0.1777	0.2392	0.4577	0.3606
CV:	4.5	0.4	4.6	42.3	42.1	5.4	7.2	20.4	42.2	44.5	33.5	20.9	36.0

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INOCULATED at R5.8-R6.0

Every head was inoculated on **August 8**; predominant growth stage was R5.8-R6.0, and average growth stage was R5.9. *Fungicides were applied August 5.*

	Nozzle Placement	Spray Pattern	Nozzles utilized (Spraying Systems TeeJet)	Application Pressure	Droplet Size	Driving Speed	Driving Direction
1	Non-treated control						
2	Boom-mounted nozzles	flat fan	XR8001VS at 20-inch spacing	40 psi	Fine	2.0	
3	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	East (90˚ from the north)
4	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	40 psi	Fine	2.6	West (270˚ from the north)
5	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	East (90˚ from the north)
6	Undercover 360 drop nozzle	flat fan	XR11001VS on side ports	60 psi	Very Fine	3.2	West (270˚ from the north)
7	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	East (90˚ from the north)
8	Undercover 360 drop nozzle	hollow cone	TX-VK3 on side ports	60 psi	Very Fine	1.6	West (270˚ from the north)

	Sclerotinia head rot			Rust	Yield	Test Wt.	Kernel Wt.	Sclerotia in	Sclerotia in	Dehulled	Seed over	Seed over	Seed through
	Incidence (%)	Severity (%)	Sev. Index (%)		10% moisture			harvested grain	cleaned grain	kernels	23/64 sieve	22/64 sieve	20/64 sieve
	- Sept 21-22 | R9 growth stage -			Sept. 15; R8	lbs/ac	lbs/bu	seeds/lb	% by weight	% by weight	%	% by weight		
1	**83** a*	**100** a*	**83** a*	**4.8** b*‡	**891** b*	**21.6** a*	**3364** a*	**10** a*	**6** a*	**1.2** a*‡	**33** a*	**51** a*	**14** a*
2	**59** a	**100** a	**59** a	**0.1** a	**1468** ab	**22.8** a	**3334** a	**9** a	**5** a	**1.6** a	**27** a	**45** a	**18** a
3	**78** a	**100** a	**78** a	**0.1** a	**1638** a	**22.7** a	**3216** a	**10** a	**6** a	**2.3** a	**31** a	**51** a	**12** a
4	**74** a	**98** a	**73** a	**0.0** a	**1052** ab	**22.1** a	**3604** a	**10** a	**5** a	**1.6** a	**40** a	**56** a	**12** a
5	**72** a	**100** a	**72** a	**0.4** ab	**1612** a	**22.0** a	**3679** a	**10** a	**5** a	**1.7** a	**34** a	**51** a	**16** a
6	**82** a	**100** a	**82** a	**0.1** a	**834** b	**21.4** a	**3400** a	**13** a	**6** a	**3.4** a	**36** a	**57** a	**12** a
7	**64** a	**100** a	**64** a	**0.2** a	**1565** ab	**22.7** a	**3394** a	**9** a	**6** a	**2.0** a	**36** a	**55** a	**11** a
8	**79** a	**100** a	**79** a	**0.1** a	**1260** ab	**21.3** a	**3255** a	**12** a	**7** a	**1.5** a	**42** a	**62** a	**8** a
F:	1.83	1.00	1.86	4.00	3.57	1.69	0.98	1.59	0.76	0.46	0.44	0.58	1.03
P>*F:*	0.1342	0.4586	0.1282	0.0063	0.0110	0.1652	0.4697	0.1927	0.6226	0.8507	0.8656	0.7663	0.4417
CV:	17.1	1.5	17.1	172.3	26.2	4.2	9.5	24.8	32.5	67.0	40.3	25.7	42.9

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Optimizing Fungicide Application Methods for Management of Sclerotinia in Dry Edible Beans

M. Wunsch, B. Kraft, M. Schaefer J. Hafner, S. Kallis, K. Cooper, L. Besemann and H. Eslinger

Methods

General Agronomics: The study was on a Maddock sandy loam soil type. The previous crop was spring wheat. The tillage operation consisted of disking once in the fall and spring cultivations (May 2 and June 6). Supplemental fertilization: 19.4 lbs N, 49.8 lbs P, 45 lbs K, and 10.4 lbs S per acre were applied on April 19.

Maintenance herbicide applications: This field trial was first planted on May 17. Spartan Elite (sulfentrazone, 0.7 lb ai/gal, and s-metolachlor, 6.3 lb ai/gal; FMC Corp., Philadelphia, PA) was applied at 22 fl oz/ac on May 19; the herbicide caused significant damage to the dry beans, and emergence was very poor. The trial was replanted on June 8, and the pre-emergence herbicide was not applied again. Post-emergence, 12 fl oz/ac SelectMax (clethodim, 0.97 gal/acre; Valent USA, Walnut Creek, CA) + 1 pt/acre NIS were applied for grass control, and broadleaf weeds were manually removed by hand weeding.

Experimental design: A randomized complete block design with six replicates. The seeded plot size was 5 feet (center to center) by 25 feet long. The harvested plot size was 5 feet (center to center) and approximately 20 feet long. Untreated buffer plots were established between treatment plots.

Planting details: 'Lariat', a pinto bean was seeded at 90,000 pure live seeds/acre. The study was planted on June 8.

Fungicide applications: Proline 480SC 5.7 fl oz/acre was the product and rate used for all applications.

Application timing:
Application A: July 22 at 10:30 a.m. - 1:30 p.m.; 95% of plants with an open blossom, 65-90% canopy closure (average 79%), canopy 15.0-22.5 inches tall (average 19 inches); temperature = 87-89˚F, relative humidity = 63-73%, wind speed = 2-6 mph.
Application B: August 2 at 10:45 a.m. - 3:15 p.m.; 45% of plants with at least one pod at maximum length, 99.5% canopy closure, canopy 16.9 inches tall (average 19 inches); temperature = 82-87˚F, relative humidity = 36-55%, wind speed = 2-4 mph.
The canopy was closed on August 2 (relative to July 22), caused by lodging. Because the use of the drop nozzles in the closed canopy would have resulted in significant crop damage, all drop nozzle treatments (treatments 8 to 12) were sprayed with boom-mounted XR11004 nozzles and 0.25% v/v Silkin spreader-sticker adjuvant on Aug. 2.

Application methods: Applications were made with nozzles mounted 20 inches apart on a tractor-mounted boom or with nozzles mounted to the side ports or side and lower rear ports of Undercover 360 drop nozzles (Yield 360; Morton, IL). The drop nozzles were spaced 21 inches apart (the same as the dry bean row spacing), and the tractor was driven such that the drop nozzles passed half way between each row. The spray mixture was pressured with CO_2. The boom was situated such that the boom-mounted nozzles were 20 inches above the top of the average canopy height (39 inches above the ground for the first application and 36.9 in. above the ground for the second application) and the drop nozzle-mounted nozzles were at the midpoint of the average canopy height (9.5 inches above the ground for the first application). The canopy was closed when the second application was made on August 2; because the use of the drop nozzles in the closed canopy would have resulted in significant crop damage, all drop nozzle treatments (treatments 8 to 12) were sprayed with boom-mounted XR11004 nozzles and 0.25% v/v Silkin spreader-sticker adjuvant on August 2.

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Assessment of spray deposition: Spray deposition within the canopy was assessed with the second fungicide application on August 2. Because drop nozzles were not utilized on August 2, spray deposition was only assessed in treatments 2 to 7. Water-sensitive paper (5 cm x 7.5 cm) for monitoring spray distribution (Syngenta Corp.; Basel, Switzerland) was utilized to assess spray deposition within the dry bean canopy. Paper tabs were taped to the back of the water-sensitive paper such that they extended slightly beyond the water-sensitive paper, and the water-sensitive paper was fastened onto brackets attached to aluminum rods (to assess leaf deposition) or onto paper tabs attached to wooden stakes (to assess stem deposition) with paper clips on the paper tab. The brackets on the aluminum rods were situated such that the lower bracket (to assess deposition to leaves in the lower canopy) and the upper bracket (to assess deposition in the upper canopy) faced in opposite direction such that placement of a spray card mounted on the upper bracket did not interfere with spray deposition to a spray card mounted on the lower bracket. After mounting the water-sensitive paper, the aluminum rods and wooden stakes were driven into the ground within the plot, with care taken to ensure that leaf placement around and above the rods/stakes was representative of a fully closed canopy.

Assessment of spray deposition to lower leaves: Water-sensitive paper was upward-facing and placed 5.6 inches above the ground (one-third of the height up the canopy; canopy height was 16.9 inches).

Assessment of spray deposition to upper leaves: Water-sensitive paper was upward-facing and placed 11.3 inches above the ground (two-thirds of the height up the canopy; canopy height was 16.9 inches).

Assessment of spray deposition to stems: Water-sensitive paper was side-facing and placed 8.45 inches above the ground (one-half of the height up the canopy; canopy height was 16.9 inches).

Analysis of spray deposition: Spray deposition to the water-sensitive paper was evaluated with the Java-based computer program DepositScan (Zhu et al. 2011; Computers and Electronics in Agriculture 76:38-43.). This program evaluates the following parameters:

DV 1: the distribution of droplet diameters such that droplets with a diameter smaller than DV.1 compose 10% of the total liquid volume.

DV 5: the distribution of droplet diameters such that droplets with a diameter smaller than DV.5 compose 50% of the total liquid volume.

DV 9: the distribution of droplet diameters such that droplets with a diameter smaller than DV.9 compose 90% of the total liquid volume.

Coverage (%): the percent of the spray card surface that received fungicide product. An average 36.3 cm^2 was evaluated in each card.

Deposits (number/cm^2): the number of spray droplets per square centimeter.

Deposition (µL/cm^2): the calculated spray deposition volume; assessed with the formula Dd = 1.06 As0.455.

Sclerotinia incidence: Percent of plants exhibiting symptoms of Sclerotinia stem rot (white mold); assessed August 29 to September 2 at the R7 growth stage (striping). In plots with relatively even disease pressure across the plot, 30 plants (15 sequential plants in each of the southern and middle rows) in each third of the plot were individually assessed for the percent of the plant exhibiting white mold; 90 plants were assessed per plot. In plots with noticeably uneven disease pressure across the plot, all plants in the middle and eastern rows of the plot were individually assessed for the percent of the plant exhibiting white mold.

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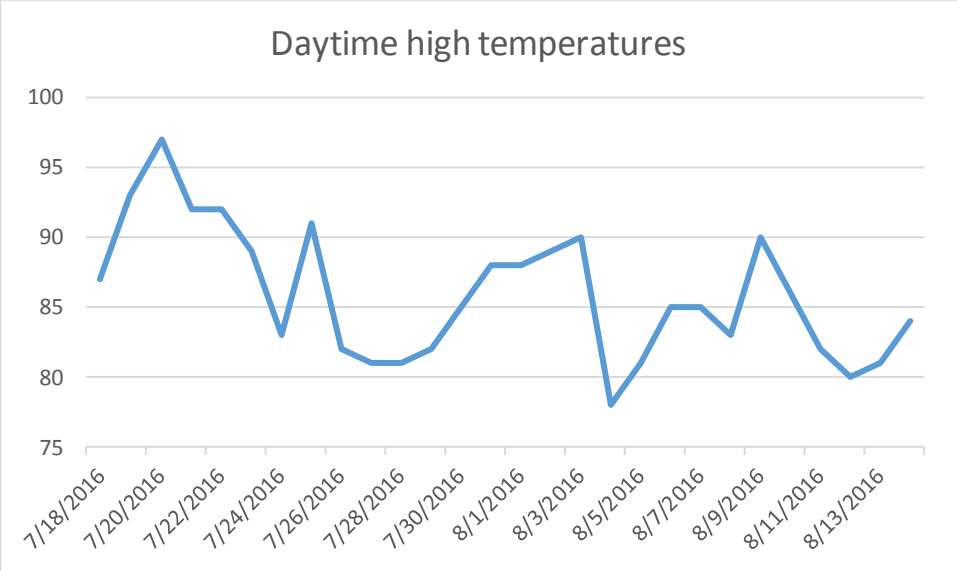
Sclerotinia severity index: Average Sclerotinia stem rot severity across all plants, including those that did not develop disease, was assessed on August 29 to September 2 at the R7 growth stage. In plots with relatively even disease pressure across the plot, 30 plants (15 sequential plants in each of the southern and middle rows) in each third of the plot were individually assessed for the percent of the plant exhibiting white mold; 90 plants were assessed per plot. In plots with noticeably uneven disease pressure across the plot, all plants in the middle and eastern rows of the plot were individually assessed for the percent of the plant exhibiting white mold.

Harvest and seed yield and quality assessment: The beans were harvested September 12. To facilitate accurate yield assessment, plot lengths were measured at harvest. Yields were calculated on the basis of a 5-ft plot width and the measured plot length. Seed moisture was assessed after the grain was cleaned. Seed yield and quality results were adjusted from the grain actual moisture to a standard 13.5% moisture level.

Statistical analysis: Data were evaluated with analysis of variance. (1) The assumption of constant variance was assessed with Levene's test for homogeneity of variances and visually confirmed by plotting residuals against predicted values. (2) The assumption of normality was assessed with the Shapiro-Wilk test and visually confirmed with a normal probability plot. (3) The assumption of additivity of main-factor effects across replicates (no replicate-by-treatment interaction) was evaluated with Tukey's test for nonadditivity. The spray deposition data did not always meet model assumptions; the distributional problems were corrected by subjecting the data to a systematic natural-log transformation, and ANOVA was conducted on the transformed data. Data that were subjected to a natural-log transformation are identified in the summary table with a cross sign (‡) at the top of the column of treatment averages. The yield data met model assumptions and were analyzed. Single-degree-of-freedom contrasts were performed for all pairwise comparisons of isolates; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure was employed. Analyses were conducted with replicate and treatment as main factor effects, and they were implemented in PROC UNIVARIATE and PROC GLM of SAS (version 9.4; SAS Institute, Cary, NC).

Comments: Early bloom and early to mid-pod fill, the growth stages at which dry beans are most susceptible to Sclerotinia stem rot, coincided with high temperatures and poor canopy closure. Disease onset occurred late in crop development, reducing the impact of disease on yield.



Partial funding for this project was provided by the North Dakota Crop Protection Product Harmonization and Registration Board.

DISEASE CONTROL AND YIELD RESPONSE

- Drop nozzles were utilized only in the the first application on July 19, when 95% of plants had an open blossom. The canopy was closed on August 2; because the use of the drop nozzles in the closed canopy would have resulted in significant crop damage, all drop nozzle treatments (treatments 8 to 12) were sprayed with boom-mounted XR11004 nozzles and 0.25% v/v Silkin spreader-sticker adjuvant on August 2.
- White mold developed late in crop development, resulting in very little impact on yield. The canopy did not close until the R3 growth stage, and during the period in which dry beans are most susceptible to white mold - early bloom and early to mid pod-fill - daytime highs were often in the upper 80-degree to mid 90-degree Fahrenheit range, which is not conducive to disease development.
- High variability in disease pressure across the footprint of the trial (note the high coefficients of variation) and late disease onset made it difficult to differentiate the impact of nozzle type, nozzle placement, application pressure, spray volume, and adjuvants on disease control and pinto bean yield and quality.

Fungicide applied: Proline 480SC 5.7 fl oz/acre

									Sclerotinia stem rot			Yield	Test Wt.
	Application	Nozzle		Droplet	Applic.	Spray	Adjuvant	Driving	Incidence (%)	Severity (%)	Sev. Index (%)	13.5% moisture	
	Timing	Placement	Nozzle	Size	Pressure	Volume		Speed	- Aug. 29 - Sept. 2 | R7 growth stage -			lbs/ac	lbs/bu
1	Non-treated control								**48** b*	**36** a*	**17** b*	**2663** a*	**63.1** a*
2	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	**None**	5.9 mph	**33** ab	**31** a	**10** ab	**2452** a	**63.1** a
3	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph	**21** a	**32** a	**6** a	**2363** a	**62.9** a
4	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	6.4 fl oz/ac Masterlock	5.9 mph	**30** ab	**36** a	**10** ab	**2781** a	**62.7** a
5	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	20 gal/ac	0.25% v/v Silkin	1.5 mph	**23** a	**30** a	**7** a	**2532** a	**62.8** a
6	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	**10 gal/ac**	0.25% v/v Silkin	3.0 mph	**27** ab	**30** a	**8** ab	**2734** a	**62.7** a
7	**A, B** (Jul. 19, Aug. 2)	Boom	TT11002	M	**60 psi**	20 gal/ac	0.25% v/v Silkin	3.6 mph	**26** ab	**39** a	**9** ab	**2678** a	**62.7** a
8	**A** (Jul. 19)	Drop Nozzle	TT11001 (side ports), TX-VK6 (lower rear)	M, F	40 psi	20 gal/ac	**None**	4.2 mph	**27** ab	**33** a	**9** ab	**2427** a	**62.8** a
	B (Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph					
9	**A** (Jul. 19)	Drop Nozzle	TT11001 (side ports), TX-VK6 (lower rear)	M, F	40 psi	20 gal/ac	0.25% v/v Silkin	4.2 mph	**25** a	**34** a	**9** ab	**2890** a	**62.7** a
	B (Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph					
10	**A** (Jul. 19)	Drop Nozzle	TX-VK3 (side and lower rear ports)	VF	40 psi	20 gal/ac	0.25% v/v Silkin	2.1 mph	**33** ab	**33** a	**11** ab	**2471** a	**63.0** a
	B (Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph					
11	**A** (Jul. 19)	Drop Nozzle	TX-VK3 (side and lower rear ports)	VF	40 psi	**10 gal/ac**	0.25% v/v Silkin	4.2 mph	**23** a	**32** a	**7** a	**2725** a	**62.7** a
	B (Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph					
12	**A** (Jul. 19)	Drop Nozzle	TX-VK6 (side and lower rear ports)	VF	**60 psi**	**15 gal/ac**	0.25% v/v Silkin	7.5 mph	**23** a	**35** a	**8** ab	**2568** a	**62.5** a
	B (Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph					
								F:	2.53	0.53	2.02	1.04	0.58
								P>F:	0.0090	0.8892	0.0379	0.4224	0.8392
								CV:	38.8	26.6	49.3	14.9	0.8

* Within-column means followed by the same letter are not significantly different ($P < 0.05$; Tukey multiple comparison procedure).

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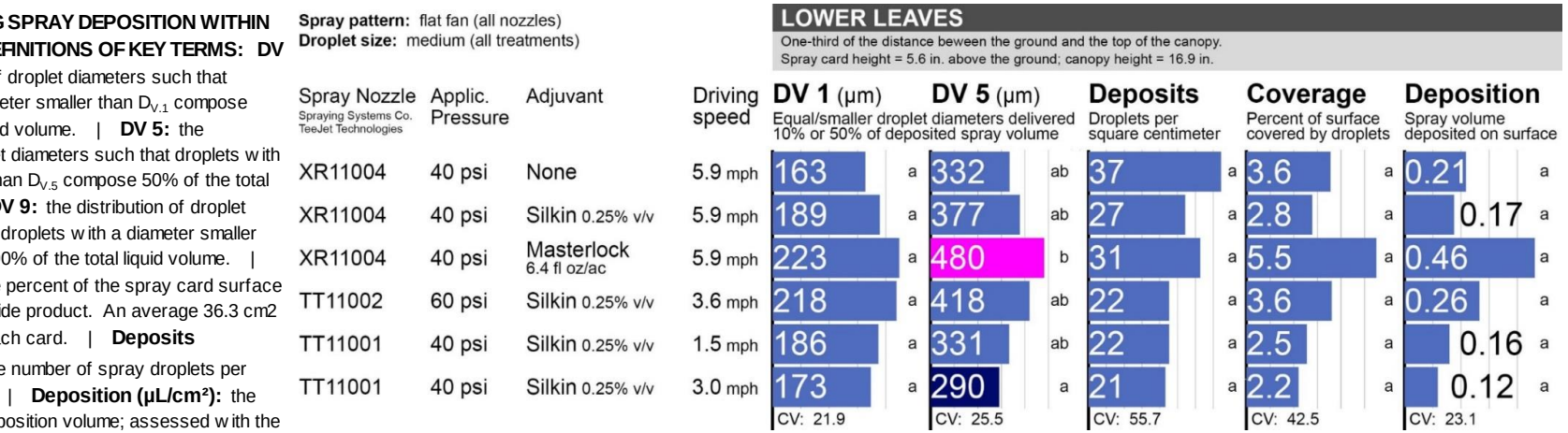
SPRAY DEPOSITION WITHIN THE CANOPY

- Spray deposition was assessed in the second fungicide application on August 2.
- The canopy was closed on Aug. 2; because the use of the drop nozzles in the closed canopy would have resulted in significant crop damage, all drop nozzle treatments (treatments 8 to 12) were sprayed with boom-mounted XR11004 nozzles and 0.25% v/v Silkin spreader-sticker adjuvant on Aug. 2. Because nozzle type, nozzle placement, application pressure, spray volume and adjuvant were identical for treatments 3 and treatments 8 through 12 on August 12, spray deposition was only assessed for treatments 2 to 7.

CHARACTERIZING SPRAY DEPOSITION WITHIN THE CANOPY - DEFINITIONS OF KEY TERMS: DV 1: the distribution of droplet diameters such that droplets with a diameter smaller than $D_{V.1}$ compose 10% of the total liquid volume. | **DV 5:** the distribution of droplet diameters such that droplets with a diameter smaller than $D_{V.5}$ compose 50% of the total liquid volume. | **DV 9:** the distribution of droplet diameters such that droplets with a diameter smaller than $D_{V.9}$ compose 90% of the total liquid volume. | **Coverage (%):** the percent of the spray card surface that received fungicide product. An average 36.3 cm2 was evaluated in each card. | **Deposits (number/cm^2):** the number of spray droplets per square centimeter. | **Deposition (µL/cm²):** the calculated spray deposition volume; assessed with the formula $D_d = 1.06\ A_s^{0.455}$

Spray pattern: flat fan (all nozzles)
Droplet size: medium (all treatments)



Spray deposition - Lower leaves

	Application Timing	Nozzle Placement	Nozzle	Droplet Size	Applic. Pressure	Spray Volume	Adjuvant	Driving Speed	DV 1 µm	DV 5 µm	DV 9 µm	Deposits No./cm²	Coverage %	Deposition µL/cm²
2	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	**None**	5.9 mph	**163** a*	**332** ab*	**608** ab*	**37** a*	**3.6** a*‡	**0.21** a*‡
3	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph	**189** a	**377** ab	**697** ab	**27** a	**2.8** a	**0.17** a
4	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	6.4 fl oz/ac Masterlock	5.9 mph	**223** a	**480** b	**805** b	**31** a	**5.5** a	**0.46** a
7	**A, B** (Jul. 19, Aug. 2)	Boom	TT11002	M	**60 psi**	20 gal/ac	0.25% v/v Silkin	1.5 mph	**218** a	**418** ab	**777** ab	**22** a	**3.6** a	**0.26** a
5	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	20 gal/ac	0.25% v/v Silkin	3.0 mph	**186** a	**331** ab	**582** ab	**22** a	**2.5** a	**0.16** a
6	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	**10 gal/ac**	0.25% v/v Silkin	3.6 mph	**173** a	**290** a	**504** a	**21** a	**2.2** a	**0.12** a
								F:	1.98	3.20	3.13	1.02	1.00	1.04
								P>F:	0.1162	0.0228	0.0250	0.4261	0.4361	0.4187
								CV:	21.9	25.5	24.6	55.7	42.5	23.1

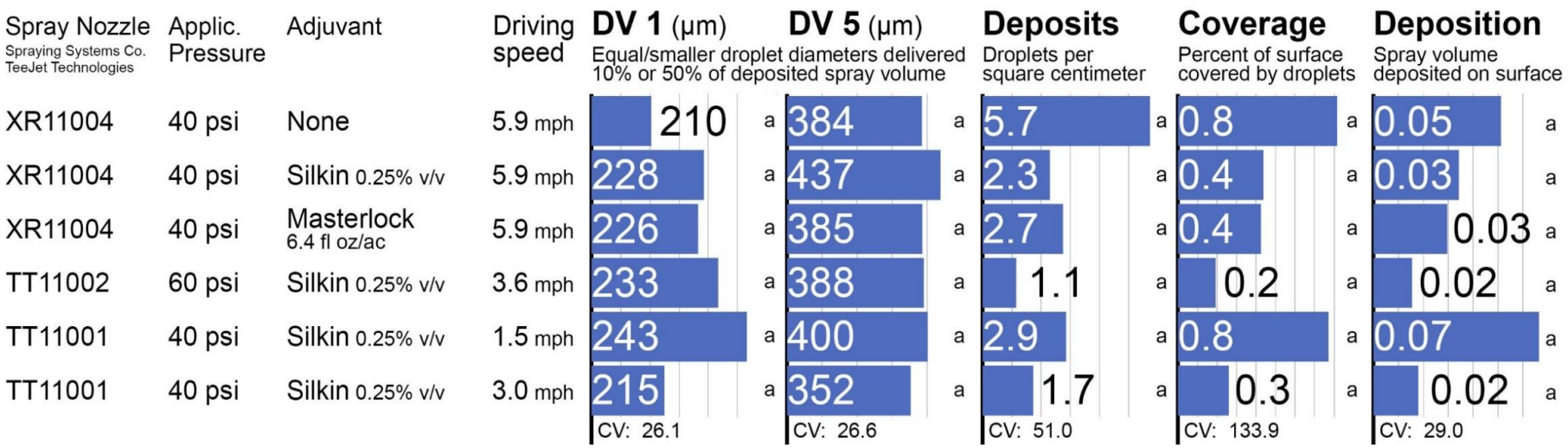
* Within-column means followed by the same letter are not significantly different ($P < 0.05$; Tukey multiple comparison procedure).

‡ To meet model assumptions of normality and/or homoskedasticity, analysis of variance was conducted on data that were subjected to a systematic natural-log transformation [LN(x) for data sets in which all numbers > 1.0; otherwise, LN(x+1)]. For ease of interpretation, treatment averages in the summary table are calculated from the untransformed data.

Spray pattern: flat fan (all nozzles)
Droplet size: medium (all treatments)

MIDDLE STEM

One-half of the distance beween the ground and the top of the canopy.
Spray card mid-point = 8.45 in. above the ground; canopy height = 16.9 in.



Spray deposition - Mid-Stem

	Application Timing	Nozzle Placement	Nozzle	Droplet Size	Applic. Pressure	Spray Volume	Adjuvant	Driving Speed	DV 1 µm	DV 5 µm	DV 9 µm	Deposits No./cm²	Coverage %	Deposition µL/cm²
2	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	**None**	5.9 mph	**210** a*	**384** a*	**526** a*	**5.7** a*‡	**0.8** a*	**0.05** a*‡
3	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph	**228** a	**437** a	**611** a	**2.3** a	**0.4** a	**0.03** a
4	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	6.4 fl oz/ac Masterlock	5.9 mph	**226** a	**385** a	**538** a	**2.7** a	**0.4** a	**0.03** a
7	**A, B** (Jul. 19, Aug. 2)	Boom	TT11002	M	**60 psi**	20 gal/ac	0.25% v/v Silkin	1.5 mph	**233** a	**388** a	**531** a	**1.1** a	**0.2** a	**0.02** a
5	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	20 gal/ac	0.25% v/v Silkin	3.0 mph	**243** a	**400** a	**552** a	**2.9** a	**0.8** a	**0.07** a
6	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	**10 gal/ac**	0.25% v/v Silkin	3.6 mph	**215** a	**352** a	**460** a	**1.7** a	**0.3** a	**0.02** a
								F:	0.25	0.42	0.76	1.33	0.96	1.74
								P>F:	0.9342	0.8305	0.5900	0.2833	0.4580	0.1620
								CV:	26.1	26.6	23.5	51.0	133.9	29.0

* Within-column means followed by the same letter are not significantly different ($P < 0.05$; Tukey multiple comparison procedure).

‡ To meet model assumptions of normality and/or homoskedasticity, analysis of variance was conducted on data that were subjected to a systematic natural-log transformation [LN(x) for data sets in which all numbers > 1.0; otherwise, LN(x+1)]. For ease of interpretation, treatment averages in the summary table are calculated from the untransformed data.

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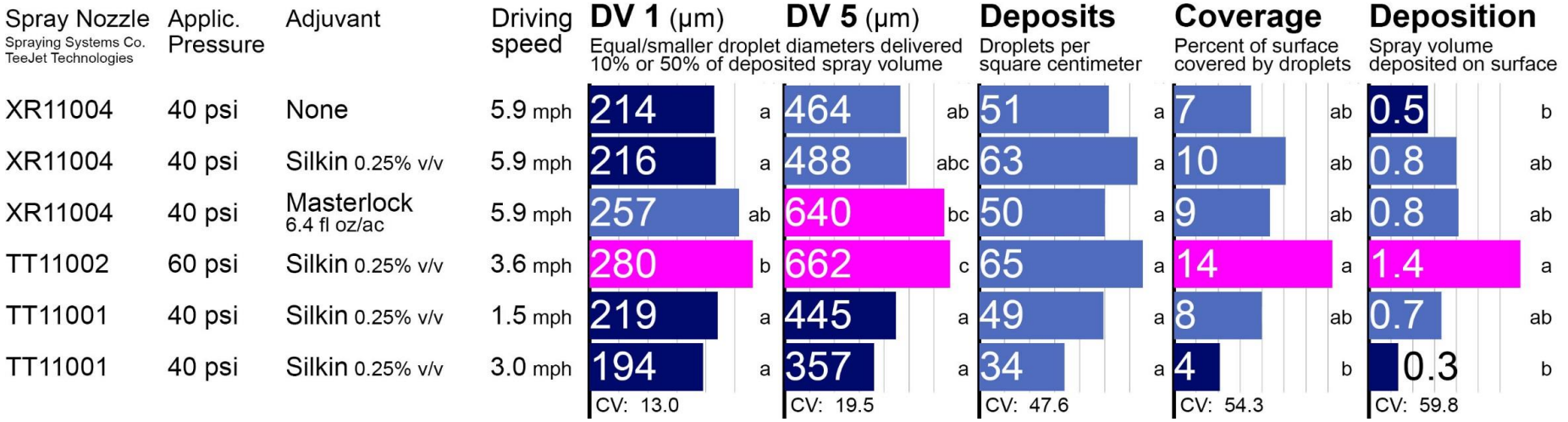
Spray pattern: flat fan (all nozzles)
Droplet size: medium (all treatments)

UPPER LEAVES

One-third of the distance beween the ground and the top of the canopy.
Spray card height = 11.3 in. above the ground; canopy height = 16.9 in.



Spray deposition - Upper leaves

	Application Timing	Nozzle Placement	Nozzle	Droplet Size	Applic. Pressure	Spray Volume	Adjuvant	Driving Speed	DV 1 µm	DV 5 µm	DV 9 µm	Deposits No./cm²	Coverage %	Deposition µL/cm²
2	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	**None**	5.9 mph	**214** a*	**464** ab*	**804** a*	**51** a*	**7** ab*	**0.5** b*
3	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	0.25% v/v Silkin	5.9 mph	**216** a	**488** abc	**952** ab	**63** a	**10** ab	**0.8** ab
4	**A, B** (Jul. 19, Aug. 2)	Boom	XR11004	M	40 psi	20 gal/ac	6.4 fl oz/ac Masterlock	5.9 mph	**257** ab	**640** bc	### ab	**50** a	**9** ab	**0.8** ab
7	**A, B** (Jul. 19, Aug. 2)	Boom	TT11002	M	**60 psi**	20 gal/ac	0.25% v/v Silkin	1.5 mph	**280** b	**662** c	### c	**65** a	**14** a	**1.4** a
5	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	20 gal/ac	0.25% v/v Silkin	3.0 mph	**219** a	**445** a	**808** bc	**49** a	**8** ab	**0.7** ab
6	**A, B** (Jul. 19, Aug. 2)	Boom	TT11001	M	40 psi	**10 gal/ac**	0.25% v/v Silkin	3.6 mph	**194** a	**357** a	**638** bc	**34** a	**4** b	**0.3** b
								F:	6.84	8.53	8.36	1.25	3.19	4.27
								P>F:	0.0004	< 0.0001	< 0.0001	0.3179	0.0231	0.0061
								CV:	13.0	19.5	18.7	47.6	54.3	59.8

* Within-column means followed by the same letter are not significantly different ($P < 0.05$; Tukey multiple comparison procedure).

DV 1: the distribution of droplet diameters such that droplets with a diameter smaller than $D_{V.1}$ compose 10% of the total liquid volume

DV 5: the distribution of droplet diameters such that droplets with a diameter smaller than $D_{V.5}$ compose 50% of the total liquid volume

DV 9: the distribution of droplet diameters such that droplets with a diameter smaller than $D_{V.9}$ compose 90% of the total liquid volume

Coverage (%): the percent of the spray card surface that received fungicide product. An average 36.3 cm^2 was evaluated in each card.

Deposits (number/cm^2): the number of spray droplets per square centimeter.

Deposition (µL/cm^2): the calculated spray deposition volume; assessed with the formula $D_d = 1.06\ A_s^{0.455}$

Field Evaluation of Oilseed Sunflowers for Resistance to Sclerotinia Head Rot

M. Wunsch, B. Kraft, M. Schaefer, S. Kallis, K. Cooper, L. Besemann and H. Eslinger

Methods

General Agronomics: The study was on a Maddock sandy loam soil type. The previous crop was onion and the tillage operation consisted of disking once in the fall and spring cultivations (May 2, May 27 and June 1) to remove small weeds and to smooth the seedbed. Authority Elite (sulfentrazone, 0.7 lb ai/gal, and s-metolachlor, 6.3 lb ai/gal; FMC Corp., Philadelphia, PA) was applied pre-emergence at 22 fl oz/acre on June 3.

Experimental design: A completely randomized block design with four replicates. The seeded plot size was 5 feet (center to center) by 25 feet long. The harvested plot size was five feet (center to center) by approximately twenty-one feet long. There were two rows per plot and the row spacing was 30 inches. Guard plots (10 feet wide) were established along all perimeters of the trial.

Planting details: Sunflowers were planted on June 2 using a Kinze 2000 planter with cone units. The seeding rate was 3.83 seeds/linear foot of row = 60,000 seeds/acre. The final plant population was 1 plant every 10 inches of row = 21,000 plants/acre. The final population was established by manual thinning the sunflowers during early vegetative growth.

Disease establishment: Inoculations were conducted over multiple days such that every head was inoculated twice - once at approximately R5.4 to R5.6 (40 to 60% of the disk flowers blooming or already bloomed) and once at approximately R5.7 to R5.9 (70 to 90% of the disk flowers blooming or already bloomed). To ensure that every plant was inoculated twice, plants were given a dot of spray paint on an upper leaf at each inoculation; once a plant received two dots of spray paint, the plant received no additional inoculations. Inoculations were conducted on August 3, 5, 6, 9, 10, and 12.

Inoculations: At each inoculation, 15,000 spores were applied to the front of each head (each head received a total of 30,000 spores over two inoculations).

Irrigation: Overhead irrigation was applied through micro-sprinkler misting systems. From August 3 (when the first inoculations commenced) through August 17, irrigation was applied, with water delivered 2 or 3 minutes every 30 or 60 minutes as needed to keep the front of sunflower heads moist to the touch.

Parts of this trial experienced severe lodging caused by several strong wind storms that occurred in August and September.
Data collection: (disease assessments, harvest) was conducted only in plots that suffered less than 30% lodging.

Disease assessments: Conducted shortly before harvest on September 19-21 at the late R8 to early R9 growth stage, with every plant assessed for the percent of the head exhibiting Sclerotinia head rot. Plants exhibiting damage from sunflower midge were excluded from the analysis; otherwise, all plants in each row were evaluated. Strong storms in August and early September caused significant lodging in parts of the trial. Plots were only assessed for disease if fewer than 30% of plants within the plot were lodged, and disease assessments were not taken on any lodged plants.

Assessments of shattered head tissue: Conducted immediately before harvest on September 26 at the R9 growth stage, with every plant exhibiting Sclerotinia head rot assessed for the percent of the head that was shattered (diseased head tissue often shatters and falls to the ground prior to harvest). Strong storms in August and early September caused significant lodging in parts of the trial. Plots were only assessed for disease and shattering if fewer than 30% of plants within the plot were lodged, and disease and shattering assessments were not taken on any lodged plants.

Harvest and seed yield and quality assessment: Sunflower heads were manually clipped at the R9 growth stage on September 26, placed in a drier, and passed through the combine on October 5. Strong storms in August and early September caused significant lodging in parts of the trial, and plots were only harvested if fewer than 30% of plants within the plot were lodged.

Sclerotia in harvested grain: Percent sclerotia by weight in the harvested grain prior to cleaning the grain. From each plot, sclerotia were manually removed from a 120-gram subsample of harvested grain.

Sclerotia in cleaned grain: Percent sclerotia by weight that could not be mechanically removed on the basis of size. Harvested grain was cleaned on a mechanical shaker equipped with an upper sieve with 18/64 or 20/64 round holes, depending on the variety, and a lower sieve with 6 x 3/4 slotted holes. From each plot, sclerotia were manually removed from the cleaned grain from an average 441-gram (maximum, 651-gram; minimum, 126-gram) subsample.

Seed quality – Dehulled seed and seeds per pound: Percent of seeds that were dehulled. Dehulled seeds within a subsample of 500 seeds were manually counted from each plot. Seed weight of hulled seeds. Five hundred seeds were counted, dehulled seeds were counted and manually removed, and the number and weight of the remaining hulled seeds was used to calculate seeds per pound from each plot.

Test weight and yield: After the grain was mechanically cleaned, all remaining sclerotia were manually removed from the samples utilized to evaluate the test weight. After the grain was mechanically cleaned, the percent contamination of the cleaned grain with sclerotia was assessed on the cleaned grain, and plot-level yields were proportionally adjusted such that reported yields excluded contamination with sclerotia.

Statistical analysis: Data were evaluated with analysis of variance. Assumptions of ANOVA: (1) The assumption of constant variance was assessed with Levene's test for homogeneity of variances and visually confirmed by plotting residuals against predicted values. (2) The assumption of normality was assessed with the Shapiro-Wilk test and visually confirmed with a normal probability plot. (3) The assumption of additivity of main-factor effects across replicates (no replicate-by-treatment interaction) was evaluated with Tukey's test for nonadditivity. To meet model assumptions, a systematic natural-log transformation was applied to the dehulled seed data. All other data met model assumptions.

Assessment of treatment differences: Analyses were conducted with replicate and treatment as main factor effects. Single-degree-of-freedom contrasts were performed for all pairwise comparisons of isolates; to control the Type I error rate at the level of the experiment, the Tukey multiple comparison procedure was employed. Analyses were implemented in PROC UNIVARIATE and PROC GLM of SAS (version 9.4; SAS Institute, Cary, NC).

This material is based upon work supported by the U.S. Department of Agriculture, Agricultural Research Service, and the Specialty Crop Grant program. Any opinions, findings, conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

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HYBRIDS FOR WHICH DATA WERE COLLECTED (MINIMUM-3 REPLICATES): Plots exhibiting severe lodging (>30% lodged) were not assessed.

SUMMARY TABLE - oilseed sunflowers, Oakes (2016).

				Head Rot			Shattering - diseased heads		
				Incidence	Severity	Sev. Index	Incidence	Severity	Sev. Index
Entry	Type	Company	Entry	Sept. 19-21 (R8-R9 growth stage)			Sept. 25 (R9 growth stage)		
Number	Commercial / experimental		Name	%	%	%	%	%	%
1	Resistant Check	Croplan	343 DMR HO	**29** ab*	100 a*	**29** ab*	**65** bcd*	**78** bc*	**50** b-e*
4	Experimental	Syngenta	NX64189	**63** cd	100 a	**63** cd	**37** ab	**64** abc	**23** abc
6	Experimental	Syngenta	NX54267	**14** a	100 a	**14** a	**55** bcd	**80** bc	**43** bcd
7	Commercial	Syngenta	SY7919	**23** ab	96 a	**22** ab	**43** abc	**78** abc	**35** a-d
8	Experimental	NuSeed	EXP6561	**63** cd	100 a	**63** cd	**64** bcd	**86** c	**55** cde
9	Experimental	NuSeed	EXP8962	**44** bc	100 a	**44** bc	**65** bcd	**90** c	**57** cde
14	Experimental	NuSeed	EXP1157	**32** ab	100 a	**32** ab	**77** cd	**91** c	**71** de
16	Experimental	NuSeed	EXP2570	**76** de	100 a	**75** de	**12** a	**40** a	**5** a
19	Experimental	NuSeed	EXP2548	**89** e	99 a	**89** e	**66** bcd	**80** bc	**52** cde
20	Experimental	NuSeed	EXP6938	**82** de	100 a	**82** de	**38** abc	**71** abc	**27** abc
23	Commercial	NuSeed	COBALT II	**72** cde	100 a	**72** cde	**92** d	**91** c	**83** e
24	Commercial	NuSeed	FALCON	**20** ab	95 a	**20** ab	**26** ab	**63** ab	**15** ab
			F:	23.56	1.88	24.06	8.81	5.24	10.63
			P>F:	< 0.0001	0.0851	< 0.0001	< 0.0001	0.0002	< 0.0001
			CV:	19.6	2.2	19.4	27.5	20.1	31.8

SUMMARY TABLE - oilseed sunflowers, Oakes (2016) continued.

Sclerotinia head rot index	Sclerotinia head rot index	Sclerotia in harvested	Sclerotia in cleaned	Dehulled		Seeds per pound	Test weight	Yield
Sept. 25 (R9)	Sept. 25 (R9)	grain	grain	seed	Oil	---------- 10% moisture ----------		
0 to 100	0 to 100	% by weight	% by weight	%	%	seeds	bu/ac	lbs/ac
22 abc*	**17** a*	**2** a*	**1** a*	**0** a*‡	-	**7831** abc*	**34.4** a*	**1652** a*
39 cd	**57** cd	**10** bc	**6** bc	**10** de	-	**8593** a-d	**30.3** d	**1245** ab
10 a	**8** a	**2** a	**1** a	**2** abc	-	**9285** cd	**32.1** bcd	**1721** a
15 abc	**16** a	**2** a	**1** ab	**4** a-d	-	**10000** de	**31.5** cd	**1948** a
49 de	**44** bc	**10** bc	**6** bc	**6** bcd	-	**9640** cde	**33.6** abc	**1080** ab
37 bcd	**23** ab	**4** a	**2** ab	**2** abc	-	**9149** bcd	**32.9** a-d	**1956** a
30 a-d	**7** a	**4** a	**1** ab	**1** ab	-	**7425** ab	**34.4** ab	**1302** ab
39 cd	**75** de	**13** c	**8** cd	**16** e	-	**10894** ef	**25.9** e	**1188** ab
68 e	**81** e	**21** d	**11** d	**5** cde	-	**7302** a	**25.5** e	**806** b
52 de	**78** de	**15** c	**8** cd	**5** bcd	-	**7406** a	**25.7** e	**1130** ab
66 e	**31** ab	**6** ab	**4** ab	**3** a-d	-	**9743** de	**34.1** ab	**628** b
11 ab	**18** ab	**3** a	**1** ab	**2** a-d	-	**11731** f	**34.9** a	**1499** ab
16.25	31.29	27.63	18.60	8.72		20.16	55.71	5.54
< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001		< 0.0001	< 0.0001	0.0002
24.7	23.7	27.3	35.5	31.6		6.6	2.9	25.1

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HYBRIDS THAT WERE EXCLUDED FROM THE ANALYSIS DUE TO SEVERE LODGING:

HYBRIDS FOR WHICH DATA WERE COLLECTED (MINIMUM-3 REPLICATES): Plots exhibiting severe lodging (>30% lodged) were not assessed.

SUMMARY TABLE - oilseed sunflowers, Oakes (2016).

				Head Rot			Shattering - diseased heads		
				Incidence	Severity	Sev. Index	Incidence	Severity	Sev. Index
Entry	Type	Company	Entry	Sept. 19-21 (R8-R9 growth stage)			Sept. 25 (R9 growth stage)		
Number	Commercial / experimental		Name	%	%	%	%	%	%
2	Susceptible Check	Croplan	305 DMR NS	---------- NO DATA (all replicates were severely lodged) ----------					
3	Experimental	Syngenta	NX64288	67	100	67	18	100	18
5	Experimental	Syngenta	NX64290	88	100	88	63	84	53
10	Experimental	NuSeed	EXP3712	17	100	17	63	75	47
11	Experimental	NuSeed	EXP6912	12	100	12	100	80	80
12	Experimental	NuSeed	EXP0757	82	100	82	96	93	89
13	Experimental	NuSeed	EXP0857	31	100	31	40	83	34
15	Experimental	NuSeed	EXP5457	---------- NO DATA (all replicates were severely lodged) ----------					
17	Experimental	NuSeed	EXP2577	68	100	68	55	75	42
18	Experimental	NuSeed	EXP3331	76	100	76	56	68	38
21	Experimental	NuSeed	EXP8912	---------- NO DATA (all replicates were severely lodged) ----------					
22	Commercial	NuSeed	CAMARO II	44	100	44	91	96	88

SUMMARY TABLE - oilseed sunflowers, Oakes (2016) continued.

Sclerotinia head rot index	Sclerotinia head rot index	Sclerotia in harvested	Sclerotia in cleaned	Dehulled		Seeds per pound	Test weight	Yield
Sept. 25 (R9)	Sept. 25 (R9)	grain	grain	seed	Oil	---------- 10% moisture ----------		
0 to 100	0 to 100	% by weight	% by weight	%	%	seeds	bu/ac	lbs/ac
---------- NO DATA (all replicates were severely lodged) ----------								
39	62	8	4	5	0	8817	33	1276
64	77	15	11	7	0	11446	28	592
13	10	4	1	1	0	10776	30	1931
11	3	0	1	0	0	10319	34	1688
78	33	45	25	20	0	9935	No Data	189
21	23	7	5	4	0	10540	31	1142
---------- NO DATA (all replicates were severely lodged) ----------								
48	56	16	12	13	0	12162	28	575
53	66	16	10	6	0	10500	27	775
---------- NO DATA (all replicates were severely lodged) ----------								
40	15	4	2	1	0	9329	35	1103

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Optimum Corn Stover Removal for Biofuels and the Environment

K. Cooper, L. Besemann and H. Eslinger

The 2007 U.S. energy bill called for 36 billion gallons of ethanol to be produced by 2020. In 2007 the U.S. produced 6.5 billion gallons of ethanol. If corn grain was able to supply 15 billion gallons of ethanol, 21 billion gallons of ethanol would have to come from cellulosic material (biomass) to meet the 2020 mandate. The production of 21 billion gallons of cellulosic ethanol will require 350 million tons of dry biomass. Presently, perennial grasses and corn stover are the most available. About 194 million tons of biomass is produced in U.S. production agriculture annually, with 75 million tons coming from corn stover. Therefore corn stover is being looked at to play a major role in cellulosic ethanol production.

Before we commit ourselves to using corn stover for fuel, we need to study the environmental and economic consequences of this action. What effect will stover removal have on soil organic matter, soil erosion, and ultimately, sustainability of the land resource?

The objective of this study is to determine what rates of stover removal within different cropping systems are conducive to maintaining and possibly improving the productive capacity of the land while providing a renewable energy source.

MATERIALS AND METHODS

Rotations:	Block I: 2016 - field corn, 2015 - field corn, 2014 - field corn, 2013 - field corn, 2012 - field corn, 2011 - field corn, 2010 - field corn, 2009 field corn, 2008 - field corn, 2007 - field corn.
	Block II: 2016 - soybean, 2015 - field corn, 2014 - soybean, 2013 - field corn, 2012 - soybean, 2011 - field corn, 2010 - soybean, 2009 - field corn, 2008 - soybean, 2007 - field corn.
	Block III: 2016 - field corn, 2015 - soybean, 2014 - field corn, 2013 - soybean, 2012 - field corn, 2011 - soybean, 2010 - field corn, 2009 - soybean, 2008 - field corn, 2007 - onion.
Soil:	Embden sandy loam, Hecla sandy loam and Maddock sandy loam.
	Block I: pH = 6.2; 2.7% organic matter; soil N 79 lbs/acre; soil P was very high; soil K was very low; soil S was medium.
	Block II: pH = 6.0; 2.4% organic matter; soil N 127 lbs/acre; soil P was very high: soil K was high; soil S was medium.
	Block III: pH = 7.1; 1.5% organic matter; soil N 23 lbs/acre; soil P and soil K were very high; soil S was low.
Seedbed preparation:	Strip-tilled May 6 with an Orthman strip-till machine.
Hybrid:	Corn: Wensman W8184VT2RIB.
Variety:	Soybean: Northrup King S10P9.
Planting:	Block I: Corn, May 6 in 30-inch rows @ 33,000 seeds/acre.
	Block II: Soybean, May 9 in 30-inch rows @ 174,200 seeds/acre.
	Block III: Corn, May 6 in 30-inch rows @ 33,000 seeds/acre.

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Fertilizer:	Block I: Stream-bar 12 lbs N/acre and 40 lbs P_2O_5/acre as 10-34-0; 13 lbs N/acre and 18 lbs S/acre as 15-0-0-20 May 9. Stream-bar 50 lbs N/acre as 28-0-0 May 10. Sidedress 145 lbs N/acre as 28-0-0 June 17.
	Block II: Stream-bar 12 lbs N/acre and 40 lbs P_2O_5/acre as 10-34-0 May 9.
	Block III: Stream-bar 12 lbs N/acre and 40 lbs P_2O_5/acre as 10-34-0; 13 lbs N/acre and 18 lbs S/acre as 15-0-0-20 May 9. Stream-bar 50 lbs N/acre as 28-0-0 May 10. Sidedress 145 lbs N/acre as 28-0-0 June 17.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Block I: Roundup (40 oz/acre) + Harness (2 pt/acre) + AMS (1 lb/10 gal) + Preference (1.6 oz/10 gal) May 10, Laudis (3 oz/acre) + Roundup (32 oz/acre) +NIS (1 pt/100 gal) + AMS (1 lb/10 gal) + Interlock (4 oz/acre) June 20.
	Block II: Roundup (40 oz/acre) + Authority Elite (25 oz/acre) + AMS (1 lb/10 gal) + Preference (1.6 oz/10 gal) May 10. Endura (5.5 oz/acre) July 15
	Block III: Roundup (40 oz/acre) + Harness (2 pt/acre) + AMS (1 lb/10 gal) + Preference (1.6 oz/10 gal) May 10 and Laudis (3 oz/acre) + Roundup (32 oz/acre) + NIS (1 pt/100 gal) + AMS (1 lb/10 gal) + Interlock (4 oz/acre) June 20.
Remote sensing:	Remote sensing was achieved with an Opti-Sciences CCM 200 Plus chlorophyll meter
Harvest:	Block I: Hand harvested 27 feet from rows 6 and 7 from each plot on October 19 and October 20.
	Block II: Harvested four two-row passes 101.5 ft in length September 29 with an Almaco plot combine.
	Block III: Hand harvested 27 feet from rows 6 and 7 from each plot on October 20.

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RESULTS BLOCK I (Corn/Corn) - 2016

Corn stover was removed at the 33, 67 and 100 percent removal rates in block I (corn/corn rotation). Stover removal had no significant effect on grain yield, moisture and test weight at the 95 percent confidence level. Stover removal had no effect on chlorophyll readings (Opti-Science CCM 200), and stalk nitrate-N (Table 1) at the 95 percent confidence level. Longer term data from 2009 to 2016 is presented in Table 2. The effect on revenue for the higher yield of the 100 percent removal rate compared to the 0 percent removal rate when the cost of N, P and K are accounted for is shown in Figure 1.

RESULTS BLOCK II (Soybean/ Corn) - 2016

All soybean plots were combine harvested and bulked. The soybeans yielded 56.7 bu/acre @ 13 % (harvest moisture = 9.2%) and a test weight of 57.2 lbs/bu.

RESULTS BLOCK III (Corn/ Soybean) - 2016

Stover removal rates of 33, 67, and 100 had no effect on grain yield, moisture or test weight (Table 3).

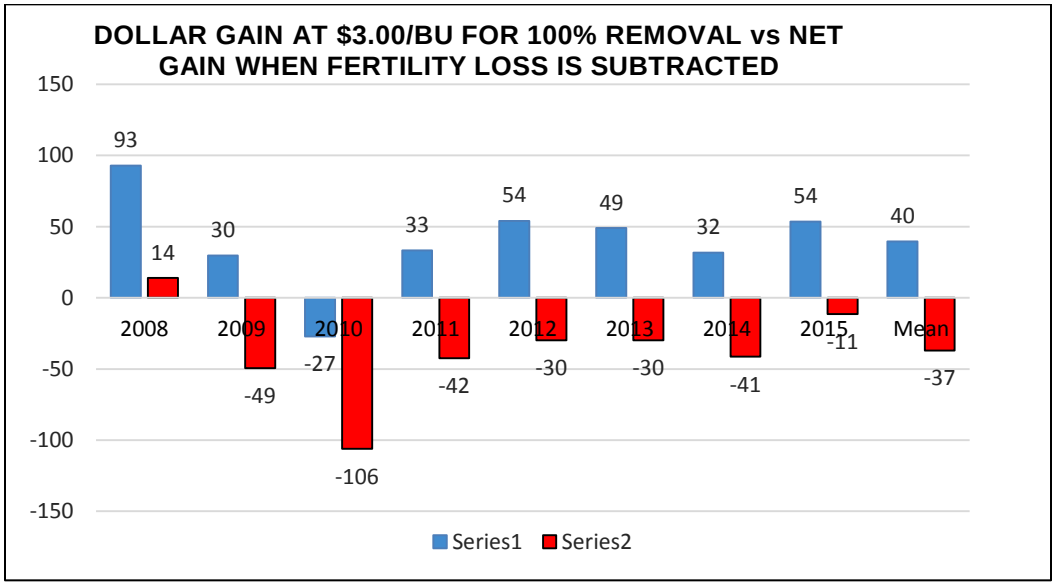

Figure 1. The net return when the fertility cost leaving the field is subtracted from the yield advantage in 100 percent removal plots compared to 0 percent removal plots for corn on corn 2008 to 2015 (Mean) at the Oakes Irrigation Research Site.

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Table 1. The affect of corn stover removal from 0 to 100% on grain yield and other agronomic parameters for corn on corn plots in 2016.

Stover Removal	Grain Yield[1]	Grain Yield 2009-16	Harvest Moisture	Test Weight	Stalk DM Removal[2]	Stalk DM Removal 2008-15	Chlorophyll Meter Reading[3]	Population	Stalk Nitrate-N	Fall soil Nitrate-N
%	bu/ac	bu/ac	%	lb/bu	------ ton/ac ------		3-Aug	plants/ac	ppm	lbs
0	233.3	215.6	18.2	57.5	0.0	0.0	47.3	34770	1816	42
33	236.4	221.0	18.6	57.4	0.8	2.1	49.0	34346	1192	33
67	243.0	223.2	18.4	57.4	0.8	3.0	49.9	33838	1058	29
100	251.1	224.9	18.5	57.2	1.7	4.6	51.7	35173	1061	24
Mean	240.9	--	18.4	57.4	0.8	--	49.5	34531	1282	32
C.V. (%)	3.8	--	2.0	0.6	16.3	--	3.6	2.2	64.4	26.0
LSD 0.10	11.8	--	0.48	NS	0.18	--	2.3	975	NS	11
LSD 0.05	14.6	--	NS	NS	0.22	--	2.8	1203	NS	13

Table 1. The affect of corn stover removal from 0 to 100% on grain yield and other agronomic parameters for corn on corn plots in 2016.

Stover Removal	Seed			Emerge Date	Silk Date	Nutrients in stover[2]			Nutrient Value	
	Oil	Protein	Starch			N	P	K	2016[2]	2008-2015
%	----------%----------					------ lb/acre ------			------ $/ac ------	
0	3.0	8.6	73.5	21-May	20-Jul	0	0.0	0	0	0
33	3.0	8.5	73.6	20-May	20-Jul	8	0.5	6	5	32
67	3.0	8.6	73.6	20-May	19-Jul	8	0.5	6	5	45
100	3.0	8.5	73.6	20-May	19-Jul	15	0.9	11	9	65
Mean	3.0	8.6	73.6	20-May	19-Jul	8	0.5	5	5	--
C.V. (%)	6.9	1.6	0.6	0	0	22.3	50.5	24.0	16.8	--
LSD 0.10	NS	NS	NS	0.5	0.6	2.2	0.3	1.7	1.0	--
LSD 0.05	NS	NS	NS	0.6	0.8	2.7	0.4	2.1	1.2	--

Planting Date = May 6; Harvest Date = October 20 ; Previous Crop = Corn.

Fertilizer Rate lbs/acre = 220 N, 40 P_2O_5, 18 S; Irrigation = 12.0 inches.

[1] Yield adjusted to 15.5% moisture.

[2] Corn stover removed spring of 2016 from 2015 corn crop.

[3] Opti-Science CCM 200.

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Table 2. Corn on corn stover removal - NDSU Oakes Irrigation Research Site 2009-2016.

Stover Removal	Grain Yield	Harvest Moisture	Test Weight	Chloroph Reading	Reading NDRE[1]	Stalk Nitrate-N	Grain Protein	Silk Date	Mature Date[2]
%	bu/ac	%	lb/bu			ppm	%		
0	215.6	20.5	54.6	53.9	0.3545	2294	8.7	23-Jul	29-Sep
33	221.0	19.9	55.0	55.2	0.3566	2564	8.6	22-Jul	28-Sep
67	223.2	19.9	54.8	56.9	0.3570	2530	8.6	21-Jul	27-Sep
100	224.9	19.5	55.0	56.2	0.3525	2683	8.7	20-Jul	27-Sep
Mean	221.2	19.9	54.9	55.6	0.3551	2518	8.6	22-Jul	28-Sep

[1]Data only available from 2010-2015.

[2]Maturity dates from 2009-2014

Table 3. The affect of corn stover removal from 0 to 100% on grain yield and other agronomic parameters for corn on soybean plots 2016.

Stover Removal	Grain Yield[1]	Grain Yield 2009-16	Harvest Moisture	Test Weight	Chlorophyll Meter Reading2	Stalk Nitrate-	Fall soil Nitrate-N	Population	Seed			Emerge Date	Silk Date
									Oil	Protein	Starch		
%	bu/ac	bu/ac	%	lb/bu	3-Aug	ppm	lbs	plants/ac	--------%--------				
0	267.4	231.0	18.8	57.7	49.4	934	23	36418	2.6	8.6	74.3	20-May	19-Jul
33	253.6	224.9	18.7	57.7	49.5	688	23	35135	2.9	8.4	73.9	20-May	19-Jul
67	250.7	225.4	18.3	57.8	47.1	595	16	35237	2.7	8.2	74.3	20-May	18-Jul
100	258.1	228.5	18.7	57.4	49.1	869	21	35126	3.0	8.4	73.8	20-May	18-Jul
Mean	257.5	--	18.6	57.6	48.8	771	20.8	35479	2.8	8	74	20-May	18-Jul
C.V. (%)	5.3	--	2.2	0.7	5.4	52.3	56.4	1.4	10.2	3.4	0.9	0.0	0.0
LSD 0.10	NS	--	NS	NS	NS	NS	NS	656	NS	0.37	NS	NS	0.5
LSD 0.05	NS	--	NS	NS	NS	NS	NS	810	NS	NS	NS	NS	0.7

Planting Date = May 6; Harvest Date = October 20 ; Previous Crop = Corn.

Fertilizer Rate lbs/acre = 220 N, 40 P_2O_5, 18 S; Irrigation = 12.0 inches.

[1] Yield adjusted to 15.5% moisture.

[2]Opti-Science CCM 200.

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