Oakes Irrigation Research Site

Carrington Research Extension Center
North Dakota State University

Garrison Diversion Conservancy District

2010 ANNUAL REPORT

Walter Albus, Research Agronomist
Leonard Besemann, Research Specialist
Heidi Eslinger, Research Technician

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Annual reports for 1996-2010 are available at www.ag.ndsu.nodak.edu/oakes/oakes.htm

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RESEARCH PROGRAM

Data on irrigated crop production have been collected for the past 41 years on approximately 20 acres at the Oakes Irrigation Research Site located on the Robert Titus farm. The site is located 4.5 miles south of Oakes adjacent to North Dakota State Highway 1. The objectives of these studies are:

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; Walter Albus as research agronomist, Leonard Besemann as research specialist and Heidi Eslinger as research technician. The Garrison Diversion Conservancy District provides most of the financial resources. 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 2010

The winter of 2009 - 2010 was colder than average with above average snowfall. Favorable conditions allowed early crops to be planted beginning mid-April. Row crop planting became difficult in May with untimely rainfall. The last frost in the spring was on May 9, about 7 days later than average. Summer temperatures were near average for most of the growing season. The maximum temperature equaled or exceeded 90°F eleven times; twice in May, four times in July, and five times in August. The highest temperature was 96°F on August 22. Precipitation was near average in April, May, and July; below average in June, August, and October. September rainfall was more than six inches above the long term average (9.33 inches). Annual precipitation was above average. The mean daily temperatures were above average in April, August, and October; near average in May, June, and July and below average in September. The first frost was October 15 with the first hard frost (≤ 28°F) October 21. This was about two weeks later than normal. All crops reached maturity before frost. Growing degree units in 2010 were slightly below average.

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

Month	Precipitation 2010	Precipitation 15-year average	Precipitation 25-year average	Average daily temperatures 2010	Average daily temperatures 15-year average	Average daily temperatures 25-year average
	-----------------inches-----------------			---------------------°F---------------------		
April	1.79	1.37	1.71	51	44	44
May	3.82	3.36	2.99	57	56	57
June	3.19	4.35	3.77	67	66	67
July	3.41	2.97	3.32	71	71	71
August	1.67	2.31	2.23	72	69	69
September	9.33	3.47	2.97	57	60	59
October	0.87	2.31	1.87	52	46	46

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

Month	2010	10-year average	15-year average	25-year average
May	305	294	295	321
June	515	497	492	504
July	650	649	642	629
August	648	578	586	577
September	267	374	371	361
Total	2383	2393	2387	2391

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

Table 3. Dates of last and first frosts.

	2010	10-year average	15-year average	25-year average
Last frost in Spring				
32 °F or less	9-May	5-May	2-May	4-May
28 °F or less	8-Apr	27-Apr	26-Apr	27-Apr
First frost in Fall				
32 °F or less	15-Oct	6-Oct	4-Oct	1-Oct
28 °F or less	21-Oct	9-Oct	8-Oct	6-Oct
Frost free period (days)	159	154	155	150

Table 4. Irrigation water applied, 2010.

Study	Irrigation water applied
	Inches
Barley variety trial	6.8
Dry edible bean trials	
pinto bean trial	6.8
miscellaneous edible bean variety trial	6.5
navy bean variety trial	6.5
Field corn hybrid performance trial	9.5
Field corn variety and row width study	9.5
Hard red spring wheat variety trial	6.8
Onion hybrid performance trial	11.3
Onion weed control study	11.3
Optimum corn stover removal for bio-fuel	
corn on corn	9.8
corn on soybean	9.8
soybean on corn	9.8
Potato trials	13.0
Soybean nursery	
conventional early	11.4
conventional late	11.4
natto	11.4
tufo	11.4
Soybean variety performance trials	
conventional	11.4
roundup ready	11.4
Strip-till	
corn on corn	8.8
corn on soybean	9.3
soybean on corn	9.8
Sugar beet roundup ready variety trial	13.1
Sunflower headrot study*	4.3

*Received additional irrigation via the misting system

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Barley Variety Trial

W. Albus, L. Besemann and H. Eslinger

Irrigation allows better nitrogen(N) utilization in malting barley which enhances grain quality. Intensive crop fungicide applications, split N applications, etc. facilitate the production of high yielding, high quality barley.

The objective of this study is to find barley varieties that are viable in irrigated cropping systems in Southeastern, ND and to develop and demonstrate agronomic practices that promote barley production.

MATERIALS AND METHODS

Soil:	Hecla sandy loam and Maddock loam; 2.1 % organic matter; soil-N 18 lb/acre; soil-P and soil-K was very high; soil-S was low.
Previous crop:	2009 – soybean; 2008 – onion; 2007 – wheat.
Seedbed preparation:	No-tilled with a Horsch Anderson Junior 260 plot drill.
Planting:	Planted on April 7 with a Horsch Anderson Junior 260 plot drill. Planting rate was 3 bu/acre (1,500,000 seeds/acre).
Plots:	Plots were 14.5 ft long by 5 ft wide.
Fertilizer:	April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8. Stream bar applied 60 lbs N/acre May 3 and May 19 as 28-0-0.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Applied Wolverine (1.7 pt/acre) May 14, Headline (6 oz/acre) May 19, Tilt (4 oz/acre) June 2, Folicur (4 oz/acre) June 6, and Proline (5 oz/acre) June 14.
Harvest:	July 27 with a Hege plot combine. Harvest area was five feet wide and 14.5 feet in length.

RESULTS

Four, six-row malting barley varieties: Drummond, Lacey, Stellar-ND, and Tradition have been tested for five years under irrigation at this site. Their medium-short stature and strong to very strong straw strength resist lodging. These four varieties have averaged 113.2 bu/ac and 12.0% protein. There was a negative correlation of r = -0.85 with days to head with yield in 2010. The varieties with the earliest heading date, ND22421, Lacy and Rasmusson were the highest yielding varieties. There was also a negative correlation r = -0.86 for lodging score. Varieties with lodging scores of 4.5 and higher yielded less than the trial average.

Table 1. Yield and agronomic characteristics of barley varieties at the Oakes Irrigation Research Site in 2010.

Variety	Days to Head	Plant Lodge	Plant Height	Plump >6/64	Thin <5/64	Grain Protein 2010	Grain Protein 3-yr Avg.	Test Weight	Grain Yield 2010	Grain Yield 2-yr Avg.	Grain Yield 3-yr Avg.
		0-9	inch	%	%	--------%------		lb/bu	---------bu/ac--------		
Drummond	61.0	0.3	38.5	91.3	1.0	13.8	13.1	45.0	112.8	112.8	114.6
Lacy	60.8	0.3	39.0	88.1	1.1	13.8	12.8	46.1	117.2	117.2	122.1
Tradition	62.5	1.5	38.3	87.8	1.2	13.9	12.8	45.6	111.3	111.3	118.1
Stellar-ND	61.5	0.0	39.3	92.2	0.9	13.4	12.5	43.8	117.2	117.2	121.3
Celebration	61.8	6.3	36.3	81.6	2.4	14.6		43.9	102.9	102.9	
Rasmusson	60.8	0.0	36.3	84.9	1.7	13.3		44.5	120.3	120.3	
ND22421	61.0	0.0	35.5	94.4	0.6	12.9		44.8	132.5		
Pinnacle	66.0	4.5	33.8	80.6	3.4	12.9	11.6	42.0	97.2	97.2	110.8
CDC Copeland	67.0	6.8	35.8	81.6	4.1	14.6		43.4	78.3		
Haxby	62.3	6.8	31.5	80.0	3.8	14.2		45.8	99.0		
MEAN	62.5	2.7	36.4	86.2	2.0	13.7		44.5	108.9		
CV %	1.0	57.1	4.8	5.0	44.0	2.5		2.1	6.5		
LSD.05	0.9	2.2	2.6	6.2	1.3	0.5		1.3	10.4		

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Dry Edible Bean Variety Trials

W. Albus, L. Besemann and H. Eslinger

Dry edible beans play a significant role in irrigated rotations in southeastern ND. As universities and private companies develop new varieties it is important to test them upon their release. Many producers have gone to direct harvesting of pinto beans. Pinto beans have historically been knifed, windrowed, and harvested with a bean combine. Therefore it is important to test determinate, upright, short vine pinto varieties that facilitate direct harvesting and compare their yield to the upright vine and vine types.

MATERIALS AND METHODS

Soil: Pinto bean - Maddock sandy loam; 2.0 % organic matter, soil-N 14 lb/acre, soil-P was very high, soil-K was high and soil-S was high. Navy and miscellaneous bean - Embden loam and Gardena loam; 2.6 % organic matter, soil-N 16 lb/acre, soil-P and soil-K were very high, soil-S was high.

Previous crop: Pinto bean: 2009 – field corn; 2008 - soybean; 2007 – field corn. Navy and misc bean: 2009 – wheat; 2008 – soybean; 2007 – onion and wheat.

Seedbed preparation: Disk May 10, Multiweed (field cultivate) twice May 17 to incorporate herbicide and twice May 27.

Planting: Planted May 28.

Plots: Plots were 17 ft long by 5 ft (2 rows) wide. There were 4 reps.

Fertilizer: April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8.

Irrigation: Overhead sprinkler irrigation as needed.

Pest control: All beans: Applied Trust (1½ pt/acre) May 17.
Navy and misc bean: Applied Raptor (4 oz/acre) + NIS (0.25%v/v) June 24, Basagran (1½ pt/acre) June 25, Section 2EC (12 oz/acre) + COC (1% v/v) July 9 and hand weed.
Pinto bean: hand weed.
All beans: Endura (11 oz/acre) July 6, Proline (5 oz/acre) July 14, and July 21 for disease control.

Harvest: Hand harvested August 30 to September 13 when mature. Harvest area for all bean varieties was: seventeen feet of two rows. Beans were threshed or bagged, dried, and threshed with a stationary plot thresher dependent on moisture.

RESULTS

Table 1. Pinto bean variety trial at the Oakes Irrigation Research Site in 2010.

Variety	Days to PM	Seed Weight	Test Weight	Seed Yield 2010	2-yr Avg.	3-yr Avg.
		gram/100	lb/bu	----------------lb/ac		--------------
Lapaz	88	34.7	61.1	2747	2837	2850
ND 307	88	38.2	58.5	2618	2632	--
Stampede	87	36.5	59.4	2822	2807	2898
Lariat	88	36.2	60.6	3062	2660	2802
Buster	86	38.2	61.0	3275	3353	3389
GTS 900	89	37.9	60.9	3044	2969	3040
Maverick	87	37.2	59.1	2682	2728	2731
Othello	84	38.9	62.0	2436	2456	2715
Sonora	85	31.3	60.9	2796	2871	2928
Mariah	86	35.8	61.1	2872	2702	--
Medicine Hat	84	38.1	60.7	2962	3001	--
Windbreaker	86	39.2	59.6	3490	3478	--
Santa Fe	87	44.1	59.4	3092	--	--
MEAN	87	37.4	60.3	2915		
C.V.%	2	3.3	0.7	9.5		
LSD .05	3	1.8	0.6	394		

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Table 2. Navy bean variety trial at the Oakes Irrigation Research Site in 2010.

Variety	Days to PM	Seed Weight	Test Weight	Seed Yield 2010	2-yr Avg.	3-yr Avg.
		gram/100	lb/bu	----------------lb/ac----------------		
Navigator	89	19.5	63.8	3109	2700	2478
Norstar	88	18.0	64.9	3007	2423	2403
Seahawk	90	22.7	63.8	3504	3036	2669
Vista	90	19.3	63.9	3563	3107	2925
Avalanche	88	19.3	64.4	3170	2717	2802
Ensign	88	20.2	64.0	3205	2789	2897
HMS Medalist	89	18.2	63.7	3404	3061	
Mayflower	90	19.8	63.3	3168	2742	
MEAN	88.7	19.6	64.0	3266		
C.V.%	1.2	2.1	0.6	2.9		
LSD .05	1.6	0.6	0.6	137		

Table 3. Misc bean variety trial at the Oakes Irrigation Research Site in 2010.

Variety	Days to PM	Seed Weight	Test Weight	Seed Yield 2010	2-yr Avg.	3-yr Avg.
		gram/100	lb/bu	----------------lb/ac--------------		
Eclipse	87	20.7	62.0	3247	2917	2786
Jaguar	88	20.4	62.9	3102	3002	2994
Matternorn	87	31.9	58.2	2829	2773	2707
Merlot	94	37.8	60.3	2816	2680	2771
Sedona	91	39.6	59.8	3218	3028	3083
T-39	92	20.7	63.0	3106	2854	2814
Zorro	89	22.2	63.2	3411	3168	
Loreto	91	19.8	62.8	2931		
MEAN	90	26.6	61.5	3082		
C.V.%	2	2.3	0.9	6.2		
LSD .05	2	0.9	0.8	280		

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Corn Hybrid Performance Trial

W. Albus, 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.

MATERIALS AND METHODS

Soil:	Maddock sandy loam; 2.2 % organic matter; soil-N 25 lbs/acre; soil-P and soil-K were very high; soil-S was high.
Previous crops:	2009 – potato and soybean; 2008 – field corn; 2007 – soybean.
Seedbed preparation:	Fall disk. Coulter chisel April 14 and multiweed (field cultivate) April 19.
Planting:	Planted April 23 in 30-inch rows. Thinned to 33,800 plants/acre.
Fertilizer:	April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8. Stream bar applied 60 lbs N/acre as 28-0-0 + Instinct (35 oz/acre) May 3. Sidedress 135 lbs of N/acre as 28-0-0 June 9.
Irrigation:	Overhead sprinkler irrigation as needed
Pest Control:	Applied Harness (2 pt/acre) April 27, Laudis (3 oz/acre) + Atrazine (0.5 lb/acre ai) + AMS (1 lb/10 gal) + MSO (1% v/v) June 3 and limited hand weeding controlled weeds.
Harvest:	October 12 with a plot combine. Harvest area was two rows 17 feet long

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Table 1. Corn hybrid performance trial at the Oakes Irrigation Research Site in 2010. (Page 1 of 3)

Brand	R.M.	Hybrid	Silk Date	Ear Height	Plant Height	Grain Protein	Grain Starch	Grain Oil	Harvest Moisture	Test Weight	Grain Yield[1] 2010	2-yr Avg.	3-yr Avg.
				inch	inch	%	%	%	%	lb/bu	------------bu/ac----------		
Pioneer	94	38M58	7/15	45.1	92.3	8.2	74.1	14.7	15.3	59.9	203.1	214.1	--
Pioneer	99	37K11	7/18	43.5	96.1	8.9	73.2	16.4	16.4	56.8	236.8	232.0	--
Pioneer	102	36V53	7/18	44.5	95.0	8.8	73.0	17.1	17.2	57.2	260.0	249.7	--
Dairyland Seed	94	ST-9594	7/17	38.8	94.5	8.5	73.5	14.8	15.1	59.8	203.5	219.8	210.1
Dairyland Seed	92	ST-6992	7/15	37.6	89.9	8.4	73.8	15.0	14.9	58.2	220.7	225.4	--
Dairyland Seed	95	ST-9395	7/19	45.4	92.4	8.1	74.1	15.0	14.4	57.9	221.9	228.1	--
Dairyland Seed	94	ST-6494	7/18	40.4	95.9	8.0	74.3	15.1	14.4	57.9	202.7	--	--
Hyland Seeds	87	HL CVR34	7/15	33.6	87.7	8.4	74.2	14.4	14.3	58.1	195.6	--	--
Hyland Seeds	87	8234	7/15	35.2	88.4	8.5	74.0	14.3	14.4	58.2	174.1	--	--
Hyland Seeds	87	HL B32R	7/13	39.7	90.2	8.8	74.6	14.3	14.1	58.6	197.3	--	--
Hyland Seeds	90	HL CVR48	7/16	42.5	95.9	8.2	73.9	14.7	15.4	60.6	199.2	210.7	--
Hyland Seeds	92	HL CVR54	7/18	45.9	93.3	7.9	74.5	14.8	14.4	58.5	231.4	237.1	227.7
Proseed	94	894 VT3	7/19	44.7	93.0	8.1	74.2	15.3	14.5	58.4	224.4	224.1	219.0
Fill			7/20	41.0	96.5	8.4	73.5	16.5	16.6	58.2	251.3	--	--
Proseed	96	896 VT3	7/17	41.9	94.3	8.7	74.2	15.9	16.5	59.7	211.7	212.8	--
Proseed	94	794 3000GT	7/17	43.7	94.3	8.8	74.5	14.9	14.7	57.9	202.6	209.6	214.3
North Star Genetics	87	NS87-102	7/15	36.2	83.8	9.3	73.1	14.2	14.1	59.1	178.9	--	--
North Star Genetics	84	NS84-101	7/15	35.1	83.8	8.7	74.1	14.1	14.6	59.0	191.3	--	--
Renk	91	RK434RR	7/17	37.7	92.5	8.3	73.7	14.5	14.6	58.3	220.7	227.2	--
Renk	95	RK501VT3	7/17	45.0	90.5	8.6	73.5	15.1	15.1	59.2	223.1	226.8	--
Renk	95	RK570VT3	7/19	45.3	93.4	7.8	74.3	14.9	14.6	58.0	223.3	236.9	225.9
Renk	95	RK559VT3P	7/17	44.8	90.5	8.4	74.1	15.5	15.9	59.0	212.1	--	--
Mean				41.9	92.6	8.6	73.8	15.4	15.4	58.5	219.9		
CV%				6.1	2.7	2.1	0.5	3.3	2.1	0.7	6.2		
LSD.05				3.6	3.5	0.3	0.5	0.7	0.4	0.6	18.9		

[1]Yield adjusted to 15.5% moisture.

Table 1. Corn hybrid performance trial at the Oakes Irrigation Research Site in 2010. (Page 2 of 3)

Brand	R.M.	Hybrid	Silk Date	Ear Height	Plant Height	Grain Protein	Grain Starch	Grain Oil	Harvest Moisture	Test Weight	Grain Yield[1] 2010	2-yr Avg.	3-yr Avg.
				inch	inch	%	%	%	%	lb/bu	------------bu/ac----------		
PFS	97	53B97	7/15	38.9	92.3	8.7	74.2	15.5	15.9	59.7	195.2	205.2	211.0
PFS	95	48Q95	7/17	42.0	90.4	8.7	74.6	14.2	14.4	57.6	209.6	--	--
Integra	95	9453VT3	7/17	39.7	94.7	8.2	74.0	15.3	15.0	58.3	206.7	211.9	--
Integra	97	9472VT3	7/17	42.8	87.7	8.5	73.8	15.0	15.4	59.0	190.3	203.1	--
Fill			7/19	47.9	100.5	8.4	73.7	16.2	16.6	58.2	251.5	--	--
Seeds 2000	99	9901 VT3	7/17	40.2	93.6	8.8	73.6	15.5	16.1	59.9	219.2	223.0	222.8
Seeds 2000	96	9602 G3	7/17	44.2	95.1	8.8	74.5	15.1	14.7	57.7	220.4	--	--
Seeds 2000	95	9502 VT3	7/17	37.2	91.9	8.2	74.0	15.5	15.3	58.4	212.4	217.2	--
Seeds 2000	98	2982GT	7/19	48.5	98.2	8.8	73.2	16.1	15.5	57.8	244.4	--	--
NuTech	95	5N-695 GT/CB/LL/RW	7/18	47.1	94.7	9.0	73.6	15.5	15.0	58.9	230.7	--	--
NuTech	97	5N-197 GT/CB/LL/RW	7/19	49.2	98.7	8.7	73.1	15.5	15.2	58.0	235.2	--	--
NuTech	101	3T-401 VT3	7/20	47.8	101.8	8.5	73.6	16.1	16.5	58.4	247.9	--	--
G2 Genetics	95	5X-895 RR/HXT	7/18	39.6	94.5	8.2	73.8	16.9	16.0	56.3	235.1	--	--
G2 Genetics	96	5H-696 RR/HX	7/18	43.2	92.0	9.2	73.4	17.0	16.3	57.5	255.3	--	--
G2 Genetics	97	5H-597 RR/HX	7/18	45.7	97.9	8.8	73.5	16.5	16.1	57.9	243.0	--	--
G2 Genetics	97	5H-797 RR/HX	7/17	37.5	91.9	8.6	73.5	16.5	16.4	57.1	226.6	--	--
G2 Genetics	98	5X-598 RR/HXT	7/17	50.2	98.2	8.9	73.2	16.7	16.5	56.8	231.5	--	--
G2 Genetics	98	5X-598A RR/HXT	7/18	50.8	96.6	8.8	73.1	16.8	16.7	56.6	231.4	--	--
G2 Genetics	99	5H-999 RR/HX	7/16	40.0	89.5	8.8	74.1	16.7	16.8	58.8	227.4	--	--
Mean				41.9	92.6	8.6	73.8	15.4	15.4	58.5	219.9		
CV%				6.1	2.7	2.1	0.5	3.3	2.1	0.7	6.2		
LSD.05				3.6	3.5	0.3	0.5	0.7	0.4	0.6	18.9		

[1]Yield adjusted to 15.5% moisture.

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Table 1. Corn hybrid performance trial at the Oakes Irrigation Research Site in 2010. (Page 3 of 3)

Brand	R.M.	Hybrid	Silk Date	Ear Height	Plant Height	Grain Protein	Grain Starch	Grain Oil	Harvest Moisture	Test Weight	Grain Yield[1] 2010	2-yr Avg.	3-yr Avg.
				inch	inch	%	%	%	%	lb/bu	------------bu/ac----------		
G2 Genetics	100	5X-500 RR/HXT	7/18	47.4	95.6	8.1	74.8	15.3	15.6	59.1	238.5	--	--
G2 Genetics	100	5H-700 RR/HX	7/18	36.7	86.6	8.5	73.8	16.7	17.3	59.2	240.3	--	--
G2 Genetics	101	5H-501 RR/HX	7/18	48.0	102.1	8.7	73.5	17.4	17.5	58.3	251.6	245.5	--
Channel	89	189-59VT3 Brand	7/15	36.4	90.2	9.1	72.8	14.8	14.9	58.7	210.2	--	--
Channel	90	190-21VT3P Brand	7/15	32.8	83.5	8.4	73.6	15.1	15.5	59.0	197.2	--	--
Dekalb	92	DKC42-72	7/14	38.5	87.6	8.5	74.7	14.6	14.7	58.6	206.8	--	--
Dekalb	98	DKC48-37	7/15	41.1	90.4	8.4	74.1	15.0	15.4	60.3	220.7	219.2	--
Dekalb	100	DKC50-66	7/15	42.9	94.2	8.3	74.2	15.0	15.5	59.0	225.0	--	--
Dekalb	95	DKC45-52	7/15	37.2	90.5	8.6	73.7	15.1	15.4	59.7	209.3	--	--
Wensman Seed	90	W 8107VT2PRO	7/15	40.5	91.6	8.2	74.2	14.3	14.2	58.7	202.9	--	--
Wensman Seed	92	W 6114GTCBLL	7/15	34.4	84.5	9.7	73.4	14.3	14.3	58.5	206.3	--	--
Wensman Seed	95	W 8180STX	7/18	44.0	98.2	8.7	73.7	15.9	15.9	58.9	222.0	228.4	--
Wensman Seed	96	W 7230VT3	7/18	38.9	90.8	9.6	72.2	15.4	15.0	58.6	213.1	--	--
Wensman Seed	97	W 7267VT3	7/20	43.3	87.4	8.7	73.5	15.8	14.9	58.3	235.8	230.3	236.7
Wensman Seed	97	W 7268VT3	7/18	41.5	92.4	8.1	74.0	15.4	15.4	58.7	228.7	--	--
Wensman Seed	98	W 7273VT3	7/19	42.9	86.9	8.7	73.6	15.8	15.0	57.8	222.0	224.1	222.9
Wensman Seed	99	W 7289VT3	7/16	41.2	94.7	8.6	73.9	15.8	16.4	59.7	223.7	227.7	221.3
Mean				41.9	92.6	8.6	73.8	15.4	15.4	58.5	219.9		
CV%				6.1	2.7	2.1	0.5	3.3	2.1	0.7	6.2		
LSD.05				3.6	3.5	0.3	0.5	0.7	0.4	0.6	18.9		

[1]Yield adjusted to 15.5% moisture.

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Hard Red Spring Wheat Variety Trial

W. Albus, L. Besemann and H. Eslinger

Although wheat yields seem to have leveled off, researchers and producers using intensive management are having different results. In intensive management, all areas of production from plant population, seeding depth, fungicide applications, nitrogen rate, time of application, weed control, etc., are closely monitored. Healthy wheat plants that lodge less result in higher yields and grain protein content.

The objective of this trial is to test hard red spring wheat varieties for yield and other agronomic parameters grown with intensive management in an irrigated environment.

MATERIALS AND METHODS

Soil:	Hecla sandy loam and Maddock loam; 2.1 % organic matter; soil-N 18 lb/acre; soil-P and soil-K was very high; soil-S was low.
Previous crop:	2009 - soybean; 2008 - onion; 2007 - wheat.
Seedbed preparation:	No-till with a Horsch Anderson Junior 260 plot drill.
Planting:	Planted April 8 with a Horsch Anderson Junior 260 plot drill. Planting rate was 1.85 bu/acre (1,500,000 seeds/acre).
Plots:	Plots were 14.5 ft long by 5 ft wide. There were four reps.
Fertilizer:	April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8. Stream bar applied 60 lbs N/acre May 3 and May 19 as 28-0-0.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Applied Wolverine (1.7 pt/acre) May 14, Headline (6 oz/acre) May 19, Tilt (4 oz/acre) June 2, Folicur (4 oz/acre) June 12, and Proline (5 oz/acre) June 14.
Harvest:	July 27 with a Hege plot combine. Harvest area was five feet wide and 14.5 feet in length.

RESULTS

Yield, test weight, grain protein, plant height, and maturity were significantly different among varieties. Yields were 64.1 bu/ac in 2010 compared to the five year average of 68.2 bu/ac. There was a tendency for short strong-strawed varieties to yield more. Diseases in more susceptible varieties were kept in check with fungicides.

Table 1. Yield and agronomic characteristics in a hard red spring wheat variety trial at the Oakes Irrigation Research Site in 2010.

Variety	Days to Head	Plant Lodge	Plant Height	Grain Protein 2010	Grain Protein 3-yr Avg.	1000 KWT	Test Weight	Grain Yield 2010	Grain Yield 2-yr Avg.	Grain Yield 3-yr Avg.
		0-9	inch	---------%--------		gram	lb/bu	-----------bu/ac-----------		
Glenn	63.3	0.0	39.8	14.4	14.4	31.6	59.3	50.4	58.9	64.6
Faller	67.5	0.8	35.5	13.6	13.6	32.4	56.7	61.1	69.9	75.4
Howard	65.8	0.8	36.8	14.2	14.2	31.1	57.3	56.3	62.2	69.0
Kuntz	65.8	0.0	34.8	13.9	13.9	29.9	58.3	69.6	70.4	73.5
RB07	61.8	0.0	35.0	14.0		30.8	57.9	67.2		
Barlow	64.0	0.5	36.3	14.7		32.4	58.5	61.7	63.0	
Brick	61.3	0.5	38.5	14.4		31.0	57.8	56.4	59.1	
Big Red	65.5	1.0	35.3	14.0	14.0	31.6	59.4	63.3	62.6	69.2
Brennan	65.0	0.0	33.3	14.4		32.3	60.2	76.9	72.7	
Select	60.8	0.8	37.8	13.9		30.7	59.3	62.0		
Albany	68.3	0.0	33.8	14.2		31.0	55.9	67.0		
Samson	65.5	0.0	33.5	14.1		32.0	56.4	73.5		
ND811	66.3	0.0	37.3	14.0		31.6	56.6	66.4		
Pivot	66.3	0.0	29.3	14.8		30.6	54.3	65.8	68.4	
MEAN	64.8	0.3	35.5	14.2		31.4	57.7	64.1		
CV %	0.9	173.1	3.9	2.8		3.6	1.4	6.4		
LSD.05	0.9	0.8	2.0	0.6		1.6	1.1	5.9		

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Onion Hybrid Performance Trial

W. Albus, L. Besemann and H. Eslinger

Onions have done well under irrigation in ND. Yellow sweet Spanish is the predominate type grown. Some red onions are also produced. This study tested 25 sweet Spanish hybrids.

MATERIALS AND METHODS

Soil:	Embden sandy loam; 2.4 % organic matter; soil-N 27 lbs/acre; soil-P was very high; soil-K and soil-S were high.
Previous crops:	2009 – soybean; 2008 – field corn; 2007 – edible bean.
Seedbed preparation:	Fall disk. Coulter chisel once and multiweed (field cultivate) twice April 14.
Planting:	Direct seeded onions (285,000 seeds/acre) April 15 with a Monosem precision planter. Onions were planted: 2 lines per row with 2.5 inches between lines and rows on 16-inch centers.
Plots:	Plots were 3 ft (two rows) wide by 17 ft long. The study had 4 reps.
Fertilizer:	April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8. Stream-bar 30 lbs N/acre as 28-0-0 on June 4, June 11, June 25 and July 14.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Applied Buctril (4 oz/acre and 16 oz/acre) May 27 and June 2 respectively; Section 2EC (8 oz/acre and 12 oz/acre) + COC (1 % v/v) June 14 and July 7 respectively. Buctril (1½ pt/acre and 1 pt/acre) + Goal 2EC (0.6 oz/acre) June 14 and June 29 respectively, and hand weeding.

RESULTS

Sedona, Delgado, and Crocket averaged 815, 741, and 705 cwt/ac respectively from 2007-2010. Sedona, Delgado, and Crocket averaged 556, 552 and 467 cwt/ac in the greater than 3 inch size from 2007-2010

Table 1. Onion hybrid performance trial at the Oakes Irrigation Research Site in 2010.

Hybrid	Seed Source	Days to Down[1]	> 4"	3 to 4"	2¼ to 3"	1 to 2¼"	Total	Culls	Single Center[2]	Total Bulbs
			----------	----------	----------	cwt	----------	----------	%	/ac
Stanley	SO	8/23	5	172	268	71	516	6	30	154702
Livingston	SO	8/23	0	178	209	60	447	19	40	129479
Marco	SO	8/8	0	69	120	49	238	7	38	93206
Polo	SO	8/24	0	209	247	40	496	6	70	136445
4012	NZ	8/19	19	385	167	19	590	7	68	116507
37-64	NZ	8/24	0	192	220	62	473	6	30	134283
Maverick	NZ	9/4	38	457	143	16	654	13	53	115546
Pulsar	NU	8/11	8	333	186	28	555	9	65	126116
Nebula	NU	8/19	0	310	226	35	571	5	73	138607
Infinity	NU	8/20	26	366	212	26	630	3	83	136205
Granero	NU	8/25	9	423	178	26	635	14	60	133082
Marquette	SM	8/23	5	207	234	57	503	20	80	142210
De Soto	SM	8/13	0	51	90	60	201	3	53	90083
La Salle	SM	8/13	0	78	160	57	296	1	68	104256
Vespucci	SM	8/23	8	197	182	46	433	2	53	114585
Hamlet	SM	8/23	6	60	152	70	288	4	60	109781
Patterson	BE	8/23	0	149	195	43	388	4	63	112663
Gunnison	BE	8/13	3	297	190	36	525	2	68	130440
Tamara	BE	8/18	0	255	224	38	517	6	53	130680
Crockett	BE	8/28	15	319	159	23	504	16	60	141970
Talon	BE	8/16	2	246	207	33	488	6	58	126116
Delgado	BE	8/29	16	379	111	19	524	64	18	106898
Calibra	BE	8/22	11	311	194	34	550	53	15	132602
Sedona	BE	8/26	0	449	172	20	650	12	50	127076
Cyprus	SM	8/28	0	37	97	57	191	5	48	78552
Mean			7	245	182	41	475	12	54	122483
CV%			138.8	25.2	23.0	23.5	17.7	74.7	26.7	9.4
LSD.05			13	87	59	14	119	13	2	16314

[1]Days from planting to when half the onion tops have fallen over. This is an indication of maturity.
[2]Percent of onions with single centers from ten large onions selected at random.

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Processing Potato Trial-Oakes, North Dakota 2010

Asunta (Susie) Thompson and Walt Albus
Potato Breeder and Research Agronomist

The potato, Solanum tuberosum L., is the most important vegetable crop grown in North Dakota and the Northern Plains. In 2010, approximately 81,000 acres of potato were harvested. Total production was about 22.3million cwt., and the yield per acre averaged across irrigated and non-irrigated fields was 275 cwt/acre. Total farmgate value for 2009 was estimated at $181 million.

The North Dakota State University (NDSU) potato breeding program was initiated in 1930 by the North Dakota Agricultural Experiment Station (NDAES). Since 1930, 24 cultivars have been named and released by the NDAES, in cooperation with the USDA-ARS, and others. The most recent is Dakota Trailblazer, a beautiful dual-purpose russet and the first NDSU cultivar release suitable for processing into French fries. About 60% of the potatoes grown in ND and MN are used in the manufacture of frozen French fries. NDSU potato cultivar releases have traditionally been widely adapted and accepted, and have significantly impacted production in North Dakota, Minnesota, the Northern Plains, and throughout North America. The primary objective of the NDSU potato improvement team is to identify and release superior, multi-purpose cultivars that are high yielding, possess multiple resistances to diseases, insect pests, and environmental stresses, have excellent processing and/or culinary quality, and that are adapted to production in North Dakota, Minnesota, and the Northern Plains. Our research team emphasizes late blight, cold-sweetening, Colorado potato beetle, pink rot and *Pythium* leak, sugar end, and Verticillium wilt resistance breeding. We use germplasm enhancement to incorporate important pest resistances and improved quality traits via exploitation of wild species, wild species hybrids, named cultivars, and advanced germplasm from around the globe as a means of developing durable, long-term, host-plant resistance.

In 2010, yield and evaluation trials were grown at six locations in North Dakota, four irrigated (Larimore, Oakes, Inkster and Williston) and two non-irrigated locations (Hoople and Crystal). Twenty advancing dual-purpose russet selections and commercially acceptable cultivars were grown in the Oakes processing trial. One entry, ND8229-3, a high yielding, dual-purpose russet, with moderate resistance to sugar ends and Verticillium wilt was included in the North Central Regional Potato Variety Trial (NCRPVT). The NCRPVT is grown at seven sites in the north central US and Canada.

Agronomic and quality evaluations, yield and grade, and French fry quality for the Oakes trial entries are summarized Tables 1, 2 and 3, respectively. Percentage stand ranged from 88 to 100%. ND8068-5Russ had the smallest vine, while Dakota Trailblazer had the largest vine size. Due to the lateness of harvest notes, many selections and cultivars were dead, thus vine maturity is skewed toward early maturity when many are much later maturing than the scores would indicate. ND8068-5Russ is the earliest of all the selections, about 5 to 7 days earlier than Russet Norkotah, while Alturas is the latest maturing, exceeding 130 days to vine maturity. Stems per plant is indicative of seed quality (physiological age), tuber eye number, and length of dormancy (genetic). Total yield ranged from 259 cwt./acre to 684 cwt./acre for ND049546-1Russ and ND049381C-2Russ, respectively. Dakota Trailblazer produced 96% US No. 1 tubers, compared to only 69% for Russet Burbank. Several advancing selections and Dakota Trailblazer had outstanding French fry color when fried at harvest or after storage at 45F for 8 weeks. Many also demonstrated sugar end resistance.

Our research efforts continue to identify processing (both chip and frozen) germplasm that will reliably and consistently process from long-term cold storage. As we grade, a field (zero time) sample is collected for immediate French fry processing. French fry/frozen processing selections are also evaluated from 45F (7.2C) storage after eight weeks and again the following June for fry color, stem end fry color, sugar ends, and other defects. All trial entries are evaluated for blackspot and shatter bruise potential.

As part of our collaborative field, greenhouse and laboratory testing in 2010, Dr. Gary Secor's program evaluated seedling families for late blight resistance using a detached leaf assay in the greenhouse. Resistant selections were retained for field evaluation in 2011. Field trials included late blight foliar and tuber evaluation trials with Dr. Secor, in addition to evaluation for resistance to tuber blemish diseases. Bacterial ring rot expression and resistance to Verticillium wilt, pink rot and Pythium leak are collaborative efforts with Dr. Neil Gudmestad's program. Dr. Deirdre Prischmann-Voldseth's program conducted Colorado potato beetle resistance screening. Sucrose rating, invertase/ugpase analysis, and serial chipping of chip and French fry/frozen processing selections is conducted by Marty Glynn (USDA-ARS), and Dr. Joseph Sowokinos (UMN) at the USDA-ARS Potato Worksite in East Grand Forks, MN. We also submitted entries in many cooperative trials with various producers, industry, and research groups around North America.

The most promising advancing dual-purpose russet selections, ND8229-3, ND8068-5Russ and several hybrids between Dakota Trailblazer and ND8229-3, possess excellent appearance, yield and grade, and processing qualities. ND8068-5Russ has early maturity, about seven days earlier than Russet Norkotah. Unlike Russet Norkotah, it processes from the field and 45F storage. Characteristics of Dakota Trailblazer and superior advancing processing selections are summarized at the end of this report.

A highlight for 2010 was being the first project to move into the new NDSU greenhouse complex. In our first crop, several families of seedlings were grown, in addition to several advancing selections for minituber production. This crop was tremendous in terms of size of tubers and number of tubers per pot. A subsequent crop in two separate pods (chambers) was recently harvested and both pods will be replanted soon. This state-of-art facility is allowing the potato breeding program to produce seedlings and minitubers with reduced fear of insect pests that vector diseases such as tomato spotted wilt and impatiens necrotic spot viruses, which are present in other greenhouse ranges on campus. The precise environmental controls allow us to define strict production parameters, which were evident in the high yield and quality of our first two crops produced in less than 7 months in this high tech facility.

We are grateful for the opportunity to conduct cooperative and interdisciplinary research with members of the NDSU potato improvement team, the USDA-ARS programs in Fargo and East Grand Forks, the North Central group and other research programs across the globe. Our sincere thanks, to our many grower, industry, and research cooperators in North Dakota, Minnesota, and beyond; your support of our research program is amazing, making our work exciting and a joy. We wish to express our gratitude to the Northern Plains Potato Growers Association and MN Area II Potato Research and Promotion Council, KBO, R.D. Offutt Co. and Jorde Certified Seed LLC, for research funding, certified seed potatoes, and fungicides in support of the processing trial at the Oakes Research Extension Site. We are also grateful for the assistance of Richard Nilles, Leonard Besemann, Heidi Eslinger, Bryce Farnsworth, and student interns, graduate students and hourly help, in maintaining and harvesting the research plot at Oakes.

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Location:	Oakes Irrigation Research Site, Oakes, ND
Dates:	
Planting:	April 16, 2010
Vine kill:	Flailed on October 5, 2010
Harvest:	October 5, 2010
Days to vine kill:	172 days
Days to harvest:	172 days
Plot information:	
Row width:	36 inches
Seed spacing:	12 inches
Hills per plot:	20
Replicates:	4

Method of planting: 2-row Harriston plot planter, Admire Pro (7 oz/acre) applied in-furrow. Seed piece treatment (PST 6%) was applied at cutting on April 15.

Method of harvest:	Machine - single row digger and hand pick up
Irrigation:	Linear – applied per ET
Fertilizer:	May 25 - 50 lb N June 21 - 40 lb N June 28 - 20 lb N July 6 - 20 lb N July 12 - 20 lb N July 20 - 20 lb N July 26 - 20 lb N August 2 - 10 lb N
Fungicide:	June 16 - Quadris Opti 1.6 pt/A June 24 – Curzate 32 oz/A + Bravo ZN 1.5 pts/A June 29 - Revus Top 7 oz/A July 5 - Quadris Opti 1.6 pt/A July 10 - Revus Top 7 oz/A July 15 - Bravo Zn 2.25 pt/A July 20 - Dithane 2 lb/A July 25 - Bravo Zn 2.25 pt/A July 30 - Dithane 2 lb/A August 4 - Bravo Zn 2.25 pt/A August 9 - Dithane 2 lb/A August 14 - Bravo Zn 2.25 pt/A August 19 - Dithane 2 lb/A August 25 - Bravo Weatherstik 1.75 pt/A September 2 - Dithane 2 lb/A September 13 - Bravo Zn 2.25 pt/A
Insecticides applied:	Admire Pro @ 7 oz/A applied in-furrow at planting July 25 - Mustang Max 4 oz/A August 20 - Mustang Max 4 oz/A September 2 - Mustang Max 4 oz/A
Comments:	Late blight was confirmed in area on June 24. Several very large rain events occurred during summer and early fall 2010.

Table 1. Agronomic and quality evaluations for advanced processing selections and cultivars, full season, Oakes, 2010.

Clone	% Stand	Vine Size[1]	Vine Maturity[2]	Stems per Plant	Tubers per plant	Specific Gravity[3]	% Hollow Heart[4]	Black-spot Bruise[5]
1. AOND95292-3Russ	96	2.5	1.0	2.2	5.9	1.0897	3	1.2
2. ND7882b-7Russ	91	2.3	1.0	2.3	6.4	1.0789	0	3.7
3. ND8068-5Russ	91	2.0	1.0	2.9	6.5	1.0903	0	3.4
4. ND8229-3	90	3.0	1.6	1.7	7.3	1.0890	0	2.2
5. ND8413-7Russ	96	3.5	1.0	3.2	8.4	1.0838	0	3.0
6. ND049289-1Russ	90	3.0	1.3	1.7	6.1	1.0820	1	2.6
7. ND049546-10Russ	88	2.5	1.0	1.3	4.6	1.0818	0	3.3
8. ND049589B-5Russ	94	3.0	1.6	1.3	5.9	1.1008	0	2.1
9. ND049381C-2Russ	93	4.0	1.0	1.9	10.4	1.0941	0	3.3
10. Alpine Russet	95	3.5	1.3	1.7	6.8	1.0893	0	2.4
11. Alturas	89	4.5	3.5	2.4	8.8	1.0919	0	1.1
12. Bannock Russet	95	4.3	3.3	2.8	7.1	1.0924	4	2.0
13. Dakota Trailblazer	94	4.5	3.0	1.8	7.7	1.1150	8	2.0
14. Innovator	91	3.0	1.0	2.2	5.6	1.0788	0	3.0
15. Norqueen Russet	86	2.8	1.0	2.7	7.5	1.0682	1	3.7
16. Ranger Russet	100	3.0	1.0	1.9	5.8	1.0926	0	3.4
17. Russet Burbank	91	3.3	1.1	2.9	11.8	1.0842	0	3.7
18. Russet Norkotah	88	2.5	1.0	2.8	8.9	1.0793	0	3.2
19. Shepody	88	3.3	1.1	2.1	5.7	1.0776	0	2.5
20. Umatilla Russet	96	3.0	1.0	2.1	7.2	1.0913	0	2.0
Mean	92	3.2	1.4	2.2	7.2	1.0875	1	2.7
LSD ($\propto$=0.05)	10	0.7	0.4	0.6	1.4	0.0062	4	0.8

[1] Vine size – scale 1-5, 1 = small, 5 = large.
[2] Vine maturity – scale 1-5, 1 = early, 5 = late.
[3] Determined using weight-in-air, weight-in-water method.
[4] Hollow heart includes brown center.
[5] Blackspot bruise determined by the abrasive peel method, scale 1-5, 1=none, 5=severe.

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Table 2. Yield and grade for advanced processing selections and cultivars, full season, Oakes, 2010.

Clone	Total Yield Cwt./A	US No. 1 Cwt./A	US No. 1 %	0-4 oz. %	4-6 oz. %	6-12 oz. %	>12 oz. %	US No. 2 %	Culls %
1. AOND95292-3Russ	386	348	90	5	17	58	15	0	5
2. ND7882b-7Russ	479	446	93	5	2	42	41	0	2
3. ND8068-5Russ	283	233	82	17	31	46	5	0	1
4. ND8229-3	413	371	90	10	16	57	17	0	0
5. ND8413-7Russ	434	375	86	14	25	49	12	0	0
6. ND049289-1Russ	510	440	86	3	5	36	44	0	11
7. ND049546-10Russ	259	238	92	8	17	56	19	0	1
8. ND049589B-5Russ	445	422	95	4	10	50	36	0	1
9. ND049381C-2Russ	684	618	90	7	13	40	38	0	2
10. Alpine Russet	590	534	90	3	6	37	47	1	6
11. Alturas	476	330	58	16	13	31	14	3	23
12. Bannock Russet	482	440	91	7	14	49	29	0	2
13. Dakota Trailblazer	569	543	96	3	9	56	31	0	1
14. Innovator	439	355	82	3	9	41	32	2	13
15. Norqueen Russet	384	326	85	12	20	47	18	0	3
16. Ranger Russet	375	289	76	11	16	44	16	1	13
17. Russet Burbank	565	388	69	16	19	35	15	1	14
18. Russet Norkotah	514	462	90	9	14	53	23	1	1
19. Shepody	478	388	81	3	7	28	46	0	16
20. Umatilla Russet	411	333	81	12	17	48	15	0	7
Mean	459	394	85	8	14	45	26	0	6
LSD ($\propto$=0.05)	115	108	13	6	6	11	10	2	9

Table 3. Shatter bruise potential and French fry evaluations following harvest and after 8 weeks storage at 45F, full season trial, Oakes, 2010.

Clone	Shatter Bruise[1]	Fry Color[2]	Stem-end Color	% Sugar End[3]	Fry Color[2]	Stem-end Color	% Sugar End[3]
		Field Fry			Following 8 wks. at 45F		
1. AOND95292-3Russ	2.6	0.25	0.72	17	0.20	0.20	0
2. ND7882b-7Russ	1.9	0.35	1.80	67	0.63	1.02	58
3. ND8068-5Russ	2.1	0.10	0.10	0	0.36	0.44	17
4. ND8229-3	1.9	0.10	0.10	0	0.40	0.42	25
5. ND8413-7Russ	1.9	0.40	0.97	42	1.00	1.00	0
6. ND049289-1Russ	2.8	0.35	1.18	58	0.45	1.44	67
7. ND049546-10Russ	1.9	0.20	0.40	17	0.35	0.61	33
8. ND049589B-5Russ	2.1	0.10	0.10	0	0.25	0.25	0
9. ND049381C-2Russ	2.6	1.16	1.28	8	0.45	0.84	50
10. Alpine Russet	2.3	0.40	0.53	17	0.40	0.66	42
11. Alturas	2.1	0.30	0.33	8	0.30	0.30	0
12. Bannock Russet	2.6	0.30	0.88	59	0.50	0.67	33
13. Dakota Trailblazer	1.7	0.10	0.10	0	0.15	0.15	0
14. Innovator	1.9	0.88	1.79	50	0.88	1.54	58
15. Norqueen Russet	2.1	0.88	2.63	84	1.38	1.88	25
16. Ranger Russet	2.0	0.20	0.50	25	0.44	0.54	8
17. Russet Burbank	2.4	0.68	1.69	75	0.45	1.17	83
18. Russet Norkotah	1.4	0.88	1.50	84	1.25	1.25	0
19. Shepody	2.3	0.48	2.67	92	1.83	2.46	25
20. Umatilla Russet	1.8	0.30	0.36	8	0.30	0.42	17
Mean	2.1	0.42	0.98	35	0.60	0.87	27
LSD ($\propto$=0.05)	0.7	0.39	0.79	34	0.40	0.55	42

[12]Shatter bruise is evaluated using a bruising chamber with digger chain link baffles. Tubers are stored at 45F prior bruising. Shatter bruises are rated on a scale of 1-5, with 1 = none and 5 = many and severe.

[2] Fry color scores: 0.1 corresponds to 000, 0.3 corresponds to 00, 0.5 corresponds to 0, 1.0 equals 1.0 and subsequent numbers follow French fry rating scale 000 to 4.0.

[3] Any stem end darker than the main fry is considered a sugar end, the worst case scenario. The processing industry defines a sugar end as a 3.0 or darker.

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Soybean Variety Trial

W. Albus, L. Besemann and H. Eslinger

Two soybean variety trials were conducted at the Oakes Irrigation Research Site, a non-GMO (conventional trial) and a roundup ready trial. Results for the conventional trial are listed in Table 1 and results for the roundup ready trial are listed in Table 2.

MATERIALS AND METHODS

Soil:	Maddock sandy loam; 1.7 % organic matter; soil-N 12 lbs/acre; soil-P was very high; soil-K and soil-S were high.
Previous crop:	2009 - field corn and onion; 2008 - barley, edible bean, and potato; 2007 - field corn and soybean.
Seedbed preparation:	Fall disk. Coulter chisel once April 14, disk twice May 10 and multiweed (field cultivate) twice May 17.
Planting:	Planted conventional soybean May 18 and roundup ready soybean May 19 in 30-inch rows.
Plots:	Plots were 17 ft long by 5 ft (2 rows) wide. There were 4 reps.
Fertilizer:	April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Conventional soybean: Applied Trust (1.5 pt/acre) May 17, Raptor (4 oz/acre) + MSO (1.5 pt/acre) + AMS (2.5 lb/acre) June 16. Roundup ready soybean: Applied Roundup Power Max (22 oz/acre) + AMS (1 lb/10 gal) June 14 and June 28. Conventional and roundup soybean: Applied Endura (11 oz/acre) July 6, Prothioconazole (5 oz/acre) July 14 and July 21 for disease control. Mustang Max (4 oz/acre) for insect control.
Harvest:	October 11 with a plot combine.

RESULTS

Grain yield, plant lodging, plant height, seed oil and protein %, and test weight were significantly affected by variety in both trials. Yields in the Roundup Ready trial averaged 63.6 bu/ac compared to the four year average of 62.8 bu/ac. A hard washing rain with resultant soil crusting significantly reduced plant stands in several varieties in the conventional trial resulting in reduced yields. Varieties with reduced stands have a notation on them in Table 1.

Table 1. Soybean variety trial (conventional) at the Oakes Irrigation Research Site in 2010.

	Variety	Mat. Group[1]	Maturity Date	Plant Ht	Plant Lodge[2]	Seeds/ pound	Seed Oil	Seed Protein	Test Weight	2010[3]
				inch	0-9		%	%	lb/bu	bu/ac
Dairyland	DST10-002/STS	1.0	9/27	40.0	0.8	3109	18.4	34.1	57.0	62.6
Richland Organics	MK0508	0.5	9/23	31.5	5.5	4944	17.4	33.0	59.4	40.9[4]
Richland Organics	MK1016	1.0	9/27	36.0	4.5	4638	16.0	37.0	59.2	36.1[4]
Richland Organics	MK9101	1.1	9/25	40.8	0.0	2105	20.1	34.6	58.7	52.6
Richland Organics	MK9120	1.2	9/25	39.8	2.5	1681	18.8	32.9	57.5	42.3
Richland Organics	MK1401T	1.4	9/24	40.8	0.3	2089	18.3	36.2	58.6	49.0
Seeds 2000	2102LN	1.0	9/25	44.0	0.0	2344	18.8	32.7	59.1	60.1
NDSU	Ashtabula	0.4	9/14	38.5	0.0	2524	20.1	32.5	56.9	53.0
NDSU	Sheyenne	0.8	9/24	40.3	1.3	2507	18.9	32.8	57.8	46.7[4]
NDSU	ProSoy	0.8	9/25	37.5	4.5	2230	17.4	37.7	57.9	49.1
NDSU	ND04-11421	0.8	9/10	36.5	0.3	2673	18.1	35.8	57.8	52.0
Mean				38.7	1.8	2804	18.4	34.5	58.2	49.5
CV%				3.5	50.3	3	1.8	1.4	0.6	9.8
LSD.05				2.0	1.3	135	0.5	0.7	0.5	7.0

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

[2]Lodging is from 0 to 9; 0 is erect, 9 is flat.

[3]Yield is adjusted to 13% moisture.

[4]These varieties had reduced stands due to a hard washing rain that increased planted depth and formed a hard soil crust.

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Table 2. Soybean variety trial (roundup ready) at the Oakes Irrigation Research Site in 2010. (1 of 3)

										Seed Yield[3]		
	Variety	Mat. Group[1]	Maturity Date	Plant Ht	Plant Lodge[2]	Seeds/ pound	Seed Oil	Seed Protein	Test Weight	2010	2-yr Avg.	3-yr Avg.
				inch	0-9		%	%	lb/bu	-------------bu/ac----------		
Kruger	K2-0401	0.4	9/16	36.3	1.0	2439	18.4	35.5	57.2	61.7	--	--
Kruger	K2-0501	0.6	9/16	36.0	1.3	2541	18.4	34.9	57.3	63.1	--	--
Kruger	K2-0801	0.8	9/23	37.8	0.8	2513	18.4	33.7	57.7	63.2	--	--
Kruger	K2-1001	1.0	9/24	36.8	3.0	2527	17.9	34.8	57.2	61.8	--	--
Kruger	K2-1101	1.1	9/27	39.0	2.5	2530	18.0	35.1	57.5	64.1	--	--
Pioneer	90Y80	0.8	9/19	38.5	1.0	2303	19.9	33.1	56.9	62.0	63.4	--
Pioneer	91Y22	1.2	9/25	37.3	1.8	2676	18.4	35.0	56.7	64.4	--	--
Pioneer	91Y60	1.6	9/27	41.0	1.8	2287	18.6	34.2	57.3	57.5	--	--
Pioneer	91Y70	1.7	9/29	40.0	3.8	2625	19.4	32.9	57.9	58.4	--	--
Mustang	M-08331	0.8	9/24	36.0	1.3	2475	18.2	34.0	57.7	65.7	--	--
Mustang	M-11030	1.1	9/27	39.0	2.8	2448	18.3	34.6	57.1	62.9	--	--
Hyland	EXP08RY05	0.8	9/22	38.0	0.5	2637	17.7	34.7	59.1	63.4	--	--
Hyland	HXR2Y21	0.8	9/23	37.8	0.3	2577	17.7	34.8	59.1	65.7	--	--
NK Brand	S06-W2	0.6	9/16	38.0	1.3	2671	18.0	34.6	57.1	64.0	64.5	63.8
NK Brand	S08-A2	0.8	9/15	37.3	0.0	2684	19.3	32.8	58.0	63.9	61.6	--
NK Brand	S09-N6	0.9	9/20	36.3	0.8	2445	18.7	34.7	57.1	63.5	64.6	--
Mean				37.8	1.9	2546	18.2	34.4	57.4	63.6		
CV%				2.9	53.5	3.5	0.7	0.8	0.5	6.1		
LSD.05				1.5	1.4	0.9	0.3	0.2	0.4	5.4		

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

[2]Lodging is from 0 to 9; 0 is erect, 9 is flat.

[3]Yield is adjusted to 13% moisture.

Table 2. Soybean variety trial (roundup ready) at the Oakes Irrigation Research Site in 2010. (2 of 3)

											Seed Yield[3]	
		Mat.	Maturity	Plant	Plant	Seeds/	Seed	Seed	Test		2-yr	3-yr
	Variety	Group[1]	Date	Ht	Lodge[2]	pound	Oil	Protein	Weight	2010	Avg.	Avg.
				inch	0-9		%	%	lb/bu	-------------bu/ac----------		
Dairyland	DSR-0747/R2Y	0.7	9/23	36.5	1.8	2516	18.1	34.6	57.0	66.9	65.8	--
Dairyland	DSR-1100/RR	1.1	9/27	36.8	2.5	2555	18.7	34.3	57.6	68.0	65.0	--
Dairyland	DSR-1215/R2Y	1.2	9/30	38.8	3.0	2733	17.6	33.8	57.9	63.8	--	--
Dairyland	DSR-1370/R2Y	1.3	9/29	38.3	2.8	2630	17.9	34.0	57.2	71.0	--	--
Peterson Farms Seed	1013RR	1.3	9/26	37.8	2.5	2251	18.2	35.6	57.5	61.0	--	--
Peterson Farms Seed	EX2010.10RR2Y	1.0	9/23	39.8	0.5	2800	19.8	32.7	56.7	58.7	--	--
Peterson Farms Seed	EX2010.12RR2Y	1.2	9/29	38.0	3.0	2592	17.9	33.9	57.0	67.8	--	--
Proseed	P2 10-80 RR2Y	0.8	9/23	37.0	2.3	2523	18.3	33.8	57.8	61.4	--	--
Proseed	P2 90-90	0.9	9/23	38.3	1.0	2394	17.9	35.8	57.8	64.2	64.6	--
Proseed	P2 90-01 N	0.9	9/25	38.8	1.5	2516	18.1	34.6	57.5	62.1	--	--
North Star Genetics	NS0853RR	0.8	9/24	38.8	0.5	2821	18.2	35.2	56.4	67.9	64.0	63.2
North Star Genetics	NS0914 NRR	0.9	9/22	37.5	1.3	2926	18.2	33.7	57.5	57.1	--	--
Integra	78070R	0.8	9/24	37.5	0.0	2812	18.2	35.2	56.2	67.0	--	--
Integra	20800	0.8	9/22	37.3	1.5	2551	18.3	33.9	57.9	64.9	--	--
Integra	21100	1.1	9/27	38.3	2.5	2226	18.0	35.0	57.3	65.7	--	--
REA	66G21	0.6	9/21	38.3	2.0	2485	18.5	34.7	57.0	61.2	--	--
REA	67G61	0.7	9/23	36.3	1.5	2551	18.3	33.9	57.9	64.0	--	--
REA	6791RR	0.9	9/25	35.3	3.0	2445	18.7	34.5	58.1	63.7	61.0	61.0
REA	71G20	1.1	9/24	35.8	3.0	2537	18.0	34.7	57.1	64.0	--	--
REA	72G21	1.2	9/29	39.3	4.5	2282	17.9	34.5	57.4	69.1	--	--
Mean				37.8	1.9	2546	18.2	34.4	57.4	63.6		
CV%				2.9	53.5	3.5	0.7	0.8	0.5	6.1		
LSD.05				1.5	1.4	0.9	0.3	0.2	0.4	5.4		

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

[2]Lodging is from 0 to 9; 0 is erect, 9 is flat.

[3]Yield is adjusted to 13% moisture.

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Table 2. Soybean variety trial (roundup ready) at the Oakes Irrigation Research Site in 2010. (3 of 3)

	Variety	Mat. Group[1]	Maturity Date	Plant Ht	Plant Lodge[2]	Seeds/ pound	Seed Oil	Seed Protein	Test Weight	Seed Yield[3] 2010	2-yr Avg.	3-yr Avg.
				inch	0-9		%	%	lb/bu	bu/ac		
Thunder Seed	2908 RR	0.8	9/28	36.8	3.5	2974	17.6	33.7	58.3	56.9	--	--
Thunder Seed	3108 R2Y	0.8	9/22	37.5	2.0	2520	18.2	33.9	57.9	62.2	--	--
Thunder Seed	2810 RR	1.0	9/28	37.0	1.0	2917	18.0	34.8	56.9	58.8	59.1	--
Thunder Seed	3114 R2Y	1.4	9/29	38.8	3.8	2637	17.6	34.9	57.1	57.5	--	--
NuTech	6082	0.8	9/28	38.3	4.8	2911	17.8	33.6	58.4	61.0	--	--
NuTech	6088	0.8	9/23	38.0	0.3	2660	18.3	35.0	56.5	68.5	65.2	--
NuTech	6090	0.9	9/20	36.8	2.3	2162	18.6	36.0	56.4	59.4	--	--
G2 NuTech	6098	0.9	9/23	38.5	0.0	2422	18.7	32.4	57.6	69.6	68.2	--
G2 NuTech	7110	1.1	9/24	38.3	0.5	2074	18.5	33.9	56.9	63.2	--	--
NuTech	6118	--	9/26	37.5	1.5	2541	18.8	34.3	57.6	66.0	--	--
Asgrow	AG0730	0.7	9/20	36.8	0.5	2744	17.8	34.8	57.5	63.7	--	--
Asgrow	AG1031	1.0	9/24	37.8	2.5	2353	17.4	35.9	57.1	61.9	--	--
Asgrow	AG1230	1.2	9/26	38.8	1.3	2435	18.0	35.2	57.3	62.8	--	--
Seeds 2000	2120	1.2	9/24	36.5	1.0	2959	17.8	34.1	58.9	65.5	--	--
Wensman	W 3089NR2	0.8	9/24	38.0	1.8	2472	18.3	34.5	57.3	65.5	--	--
Wensman	W 3096R2	0.9	9/22	38.3	2.5	2481	18.4	34.9	57.1	62.3	--	--
Wensman	W 3101R2	1.0	9/23	37.5	2.0	2329	17.8	36.1	57.6	66.8	65.1	--
Wensman	W 3114R2	1.1	9/30	39.0	4.0	2224	17.9	34.9	57.5	67.2	--	--
Wensman	W 3131R2	1.3	9/29	38.8	2.5	2671	18.0	33.9	57.1	66.6	--	--
Wensman	W 3142NR2	1.4	9/28	39.3	1.8	2570	18.0	34.0	57.2	60.8	--	--
Mean				37.8	1.9	2546	18.2	34.4	57.4	63.6		
CV%				2.9	53.5	3.5	0.7	0.8	0.5	6.1		
LSD.05				1.5	1.4	0.9	0.3	0.2	0.4	5.4		

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

[2]Lodging is from 0 to 9; 0 is erect, 9 is flat.

[3]Yield is adjusted to 13% moisture.

Soybean Breeding Nursery

Ted Helms, NDSU Department of Plant Sciences

Four different breeding experiments were conducted at the Oakes Irrigation Research Site in 2010. These experiments are combined with testing at other sites to provide information regarding how experimental soybean lines perform in diverse environments. The best experimental lines are then advanced to the next stage of testing or perhaps released as named cultivars. The released cultivars are then distributed to farmers to grow on their farms. Oakes is an especially useful testing site because of the high yield and the tendency for the plants to grow tall and lodge, due to the application of irrigation. Those genotypes that are susceptible to lodging can then be identified and discarded. Farmers do not want cultivars that are susceptible to lodging and Oakes is the best location to identify lodging problems. The four experiments consisted of an experiment to evaluate natto types for the value-added specialty market, an experiment to evaluate tofu types for the value-added specialty market, an early experimental line test and a late experimental line test.

MATERIALS AND METHODS

Soil:	Maddock sandy loam; Early and late soybean; 1.8% organic matter, soil-N 14 lbs/acre, soil-P was very high, soil-K and soil-S were high. Natto soybean; 2.2% organic matter, soil-N 25 lbs/acre, soil-P and soil-K were very high, soil-S was high. Tufo soybean; 1.7% organic matter, soil-N 13 lbs/acre, soil P and soil-K were high, soil-S was very high.
Previous crop:	Conventional soybean early and late; 2009 – onion and sugarbeet, 2008 - barley and wheat, 2007 – soybean. Tufo soybean; 2009 – sugarbeet, 2008 – barley, 2007 – soybean. Natto soybean; 2009 – potato, 2008 - field corn, 2007 – soybean.
Seedbed preparation:	Fall disk. Coulter chisel April 14, and multiweed (field cultivate) twice May 17.
Planting:	Planted all soybeans May 18, in 30-inch rows.
Plots:	Plots were 17 ft long by 5 ft (2 rows) wide. All studies had 3 reps.
Fertilizer:	April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	All studies: Applied Trust (1.5 pt/acre) May 17, Raptor (5 oz/acre) + MSO (1½ pt/acre + AMS (2.5 lb/acre) June 16. Endura (11 oz/acre) July 6; Prothioconazole (5 oz/acre) July 14 and July 21. Mustang Max (4 oz/acre) August 4.
Harvest:	October 11 with a plot combine.

Table 1. Conventional early soybean at the Oakes Irrigation Research Site in 2010.

Entry	Yield	Maturity date*	Lodging score**	Plant height
	bu/A			inches
Pembina	42.2	3-Sep	2.0	31
Traill	52.9	9-Sep	2.0	32
Cavalier	40.9	9-Sep	1.0	31
ND07-3684(Rps)	59.3	9-Sep	1.0	33
ND07-1842(Rps)	38.6	9-Sep	1.3	29
ND04-11421(SCN)	55.4	10-Sep	1.0	36
ND07-2019(Rps)	57.9	10-Sep	1.0	35
Walsh	51.2	11-Sep	1.3	35
ND05-17835(Rps)	52.4	11-Sep	1.0	37
ND06-5210(Rps)	61.2	11-Sep	1.3	35
ND07-4027(Rps)	54.2	11-Sep	1.0	36
AG 0301	52.6	12-Sep	1.0	41
AG 0604	55.9	13-Sep	1.7	37
ND07-1550(SCN)	57.4	13-Sep	1.0	37
AG 0202	62.2	14-Sep	1.0	39
ND07-1834(Rps)	54.4	14-Sep	1.3	41
ND07-2239(Rps)	62.6	14-Sep	1.3	35
ND07-2359(Rps)	67.1	14-Sep	1.0	37
Ashtabula	58.3	14-Sep	1.0	39
ND07-2260(Rps)	58.6	15-Sep	1.0	34
ND07-2303(Rps)	59.3	15-Sep	1.5	38
ND07-2226(Rps)	58.5	15-Sep	1.0	34
ND07-4595(Rps)	53.5	16-Sep	2.7	36
ND07-3761(Rps)	59.9	18-Sep	1.0	36
ND07-4050(Rps)	62.3	18-Sep	1.3	41
ND07-4044(Rps)	53.2	19-Sep	1.0	42
ND07-3510(Rps)	59.3	19-Sep	1.7	40
ND07-3962(Rps)	49.3	20-Sep	1.0	38
ND07-1995(Rps)	52.9	20-Sep	1.3	40
ND07-3772(Rps)	42.8	21-Sep	1.0	40
AG 0803	67.0	22-Sep	1.7	42
Sheyenne	48.3	23-Sep	1.0	41
ND07-3381(Rps)	53.6	24-Sep	1.0	41
ND07-1855(Rps)	50.8	24-Sep	1.0	39
ND07-2343(Rps)	48.5	30-Sep	3.8	42
Average	54.7	46	1.3	37
LSD(0.05)	7.9	3.2	0.7	3
CV	8.7	4.4	25.3	5

*Maturity: date of 95% mature pods.
**Lodging: 1-best, 5-flat on ground

Table 2. Conventional late soybean at the Oakes Irrigation Research Site in 2010. (Page 1 of 2)

Entry	Yield	Maturity date*	Lodging score**	Plant height
	bu/A			inches
Cavalier	39.9	8-Sep	1.0	32
Traill	55.3	9-Sep	2.5	34
AG 0202	67.6	13-Sep	1.0	37
ND07-2347(Rps)	61.4	15-Sep	1.7	40
AG 0604	57.4	16-Sep	1.8	39
ND07-3664(Rps)	66.1	16-Sep	1.0	38
ND07-3683(Rps)	55.1	16-Sep	1.0	42
Ashtabula	65.8	17-Sep	1.4	40
ND07-1656(SCN)	66.6	18-Sep	1.3	42
ND07-2205(Rps)	70.1	18-Sep	1.0	35
ND03-7566(SCN)	55.7	18-Sep	1.0	38
ND07-1812(SCN)	64.8	19-Sep	1.3	42
ND07-3978(Rps)	60.4	19-Sep	1.3	41
ND07-2334(Rps)	65.2	19-Sep	1.3	39
ND07-3925(Rps)	52.6	19-Sep	1.7	37
ND07-3947(Rps)	70.8	20-Sep	1.5	40
ND07-4069(Rps)	61.0	20-Sep	1.0	43
ND07-4635(SCN)	56.1	20-Sep	1.3	36
ND03-5441(SCN)	56.7	20-Sep	1.0	37
ND07-3726(Rps)	62.7	20-Sep	1.0	37
ND07-1574(SCN)	63.6	20-Sep	1.3	35
ND07-3994(SCN)	55.9	20-Sep	2.2	43
ND07-4140(SCN)	54.3	20-Sep	1.5	34
ND07-4002(SCN)	53.5	21-Sep	2.2	43
ND07-3512(Rps)	68.8	21-Sep	1.8	37
ND07-3987(SCN)	59.0	21-Sep	2.0	41
MN0902CN	42.2	22-Sep	1.0	39
ND07-2222(Rps)	59.4	22-Sep	1.3	41
ND07-2321(Rps)	57.7	22-Sep	1.0	40
ND07-2307(Rps)	66.0	22-Sep	1.0	36
ND07-4047(Rps)	78.0	22-Sep	1.5	43
AG 0801	66.7	22-Sep	1.0	41
ND07-3728(Rps)	60.9	22-Sep	1.3	38
AG 0803	67.3	23-Sep	1.5	42
Average	61.1	21-Sep	1.5	40
LSD(0.05)	8.8	2	1	3
CV	8.7	9.6	39.1	4.6

*Maturity: date of 95% mature pods.
**Lodging: 1-best, 5-flat on ground

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Table 2. Conventional late soybean at the Oakes Irrigation Research Site in 2010. (Page 2 of 2)

Entry	Yield	Maturity date*	Lodging score**	Plant height
	bu/A			inches
ND07-3975(SCN)	60.9	23-Sep	1.8	43
ND07-1816(Rps)	64.6	23-Sep	1.7	42
ND07-3376(Rps)	70.5	23-Sep	2.0	43
ND07-3865(Rps)	60.8	23-Sep	1.5	38
ND07-1967(Rps)	67.7	24-Sep	1.7	45
ND07-2320(Rps)	59.0	24-Sep	1.0	37
ND06-25513(SCN)	65.9	24-Sep	1.7	43
ND07-1831(Rps)	65.7	24-Sep	1.3	42
ND07-2302(Rps)	58.9	24-Sep	1.3	38
Sheyenne	64.6	25-Sep	1.4	43
ND07-3674(Rps)	63.0	25-Sep	1.7	41
ND07-1729(SCN)	57.9	27-Sep	2.8	42
ND07-3935(Rps)	45.3	28-Sep	2.7	39
Average	61.1	21-Sep	1.5	40
LSD(0.05)	8.8	2	1	3
CV	8.7	9.6	39.1	4.6

*Maturity: date of 95% mature pods.
**Lodging: 1-best, 5-flat on ground

Table 3. Natto specialty soybean at the Oakes Irrigation Research Site in 2010.

Entry	Yield	Maturity date*	Lodging score**	Plant height
	bu/A			inches
Cavalier	57.5	5-Sep	1.7	29
Traill	52.7	6-Sep	1.5	27
ND04-10906	28.8	8-Sep	1.7	24
ND04-10637B(small)	47.4	12-Sep	3.0	30
ND04-4061	51.8	12-Sep	1.3	27
ND04-10637	38.7	13-Sep	3.3	27
Nannonatto	28.6	14-Sep	3.5	26
Ashtabula	59.8	15-Sep	2.3	36
ND04-10745	42.0	16-Sep	2.8	26
Nornatto	33.9	17-Sep	3.7	25
ND04-10723	47.8	17-Sep	2.7	28
ND06-4088	52.5	17-Sep	1.0	22
ND06-4098	48.9	19-Sep	3.0	29
ND06-4070	43.6	20-Sep	1.7	26
ND06-4822	54.8	21-Sep	1.7	27
Sheyenne	70.3	22-Sep	1.8	40
Average	47.4	14-Sep	2.3	28
LSD(0.05)	9.1	2	1.6	6
CV	11.5	11.7	33.5	12.3

*Maturity: date of 95% mature pods.
**Lodging: 1-best, 5-flat on ground

Table 4. Tofu specialty soybean at the Oakes Irrigation Research Site in 2010.

Entry	Yield	Maturity date*	Lodging score**	Plant height
	bu/A			inches
Cavalier	55.5	6-Sep	1.3	33
ND04-10352	47.9	9-Sep	1.3	34
Traill	43.3	10-Sep	1.5	33
ND06-4040	47.9	12-Sep	1.3	39
ND04-10046	49.4	14-Sep	1.7	37
Walsh	52.1	14-Sep	2.3	36
Ashtabula	58.1	15-Sep	1.2	38
ND04-10249	48.4	15-Sep	1.7	40
ND06-4047	47.7	15-Sep	1.3	40
Norpro	45.6	15-Sep	1.0	38
ND04-10327	53.5	17-Sep	1.9	38
ND06-4639	48.9	20-Sep	1.7	39
ND06-4642	55.0	20-Sep	2.0	41
ND06-4026	54.7	20-Sep	2.3	34
ND06-4640	54.0	22-Sep	2.3	40
ND06-4648	48.8	23-Sep	2.3	39
ND06-4042	57.0	23-Sep	2.3	42
Sheyenne	62.3	23-Sep	1.0	43
ND06-4730	61.2	25-Sep	1.3	41
ProSoy	52.6	28-Sep	2.8	43
ND06-4045	54.1	28-Sep	2.0	41
Average	52.3	49	1.7	38
LSD(0.05)	8.2	2	2.1	4
CV	12.3	9.6	28.4	14.1

*Maturity: date of 95% mature pods.
**Lodging: 1-best, 5-flat on ground

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Cover crops and desiccation methods to control weeds in potato

Mehring, Grant H., Harlene Hatterman-Valenti, Collin Auwarter, and Walter Albus

An experiment was conducted at the Oakes Irrigation Research Site to evaluate alternative weed control methods for organic and low external input potato production. Cover crop, desiccation technique of the cover crop, and potato variety were the three factors investigated (Table 1). A randomized complete block with four replicates was the experimental design. The research commenced with the tilling of previous cereal and dry bean plots following harvest in 2009 and came to a close with potato harvest in 2010 (Table 2). Cover crops were planted with an International Harvester grain drill at the rates of 135 lbs/acre winter triticale, 120 lbs/acre winter rye, 5 lbs/acre turnip, 5 lbs/acre radish, and 5 lbs/acre canola. Cover crop desiccation was done with 32 fl oz/acre Roundup Weathermax, disk till, or rototill. 2 ounce potato seed was planted with 36 inch row spacing and 12 inch plant spacing using an Iron Age potato planter. Treatments were evaluated for overall weed control using a visual scale from 0-100% three times throughout the season at 14, 29, and 51 days after planting. To further evaluate weed control, weed counts and biomass inside a one foot quadrat were taken. Plots were cultivated at 14 and 29 days after planting. Potatoes were harvested then graded in Fargo, ND.

Table 1. Treatments in the factorial arrangement

Cover crop	Desiccant	Potato variety
Winter triticale	Disk till	Russet Norkotah
Winter rye	Rototill	Yukon Gold
Turnip/radish	Herbicide	
Winter rye/canola		
No cover crop		

Table 2. Schedule of field operations.

	Date	
Field	2009	2010
Planting winter annual cover crops	September 28	-
Planting summer annual cover crops	-	April 20
Burndown herbicide applied to cover	-	May 24
Rototill and disk till termination of cover crop	-	June 1
Potato planting	-	June 2
Potato harvest	-	October 13

Results: The dry weight biomass accumulations for the four cover crop treatments were adequate for weed suppression with cover crops (Table 3). Biomass for the no cover crop treatment came from the weed biomass present at collection. All cover crop treatments outperformed the no cover crop no-till weedy check with little noteworthy differences between the four treatments for measures of weed control (Table 4). Weed density and weed weight were negligible throughout the cover crop treatments. While there were counts of up to 11 weeds in cover crop plots, the weight was minimal as most of the weeds found were seedlings. Marketable yields were large enough to be considered acceptable but not exceptional.

Table 3. Average biomass for each Cover crop treatment.

Cover crop	DW (kg/ha)
Winter triticale	5551
Winter rye	4954
Turnip/radish	2115
Winter rye/canola	5892
No cover crop	2186

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Table 4. Effect of cover crop, desiccation, and potato variety on weed control, weed density, weed weight, and potato yield.

Cover crop	Desiccation	Variety	Visual evaluation (% weed control)	Weed density (plants/1 ft^2)	Weed weight (g)	Total yield (Cwt/A)	Total marketable (Cwt/A)
Winter triticale	Disk till	Russet Norkotah	89	8.42	0.13	27	22
Winter triticale	Rototill	Russet Norkotah	94	4.17	0.25	28	23
Winter triticale	Herbicide	Russet Norkotah	92	3.67	0.00	24	18
Winter rye	Disk till	Russet Norkotah	93	5.67	0.04	22	17
Winter rye	Rototill	Russet Norkotah	94	2.17	0.04	24	20
Winter rye	Herbicide	Russet Norkotah	92	3.42	0.21	20	17
Turnip/radish	Disk till	Russet Norkotah	83	5.75	0.17	21	17
Turnip/radish	Rototill	Russet Norkotah	89	8.67	0.00	27	22
Turnip/radish	Herbicide	Russet Norkotah	91	7.67	0.00	20	17
Winter rye/canola	Disk till	Russet Norkotah	90	5.67	0.96	26	21
Winter rye/canola	Rototill	Russet Norkotah	93	3.83	0.21	28	23
Winter rye/canola	Herbicide	Russet Norkotah	92	6.83	1.75	24	20
No cover crop	Disk till	Russet Norkotah	81	7.00	1.38	23	19
No cover crop	Weedy Check	Russet Norkotah	0	6.00	52.88	18	13
No cover crop	Herbicide	Russet Norkotah	88	6.92	0.00	24	20
Winter triticale	Disk till	Yukon Gold	89	11.08	4.46	21	17
Winter triticale	Rototill	Yukon Gold	94	5.50	0.29	23	19
Winter triticale	Herbicide	Yukon Gold	92	3.83	0.00	27	21
Winter rye	Disk till	Yukon Gold	93	4.42	0.08	23	20
Winter rye	Rototill	Yukon Gold	94	2.83	0.00	23	18
Winter rye	Herbicide	Yukon Gold	92	2.50	0.08	22	18
Turnip/radish	Disk till	Yukon Gold	83	5.75	0.21	26	22
Turnip/radish	Rototill	Yukon Gold	89	9.42	1.50	26	22
Turnip/radish	Herbicide	Yukon Gold	91	7.58	0.04	26	20
Winter rye/canola	Disk till	Yukon Gold	90	7.33	0.29	23	21
Winter rye/canola	Rototill	Yukon Gold	93	3.42	0.21	29	25
Winter rye/canola	Herbicide	Yukon Gold	92	4.08	1.63	26	21
No cover crop	Disk till	Yukon Gold	81	4.25	14.75	25	21
No cover crop	Weedy Check	Yukon Gold	0	5.50	44.58	12	91
No cover crop	Herbicide	Yukon Gold	88	7.17	0.83	25	21

Micro-rate system for weed control in onion

Loken, James R., Harlene Hatterman-Valenti, and Walt Albus

An experiment was conducted at the Oakes Irrigation Research Site to compare micro-rate herbicide treatments (Table 1) with and without PRE herbicide applications for early-season broadleaf weed control in onion (*Allium cepa* L.). The soil was an Embden sandy loam with 2.4% organic matter and 6.7 pH. Onion variety 'Sedona' pelleted seed was planted at 285,000 seeds/A using a Monosem four, paired-row planter on April 15. Plots were 6 ft wide by 17 ft long and arranged in a randomized complete block design with four replicates. Early PRE herbicide applications were made on April 21 and PRE herbicide applications with glyphosate were made May 3. At time of weed cotyledon stage (May 8) herbicides were applied as micro-rates every 7 days, with four total applications. Herbicide micro-rates were applied with a CO_2 pressurized backpack sprayer. Standard applications of bromoxynil and oxyfluorfen were made mid-season to maintain weed control. Standard applications were applied using a tractor mounted sprayer. Best management practices were used for fertility, disease, insect, and grass weed control. Treatments were evaluated for overall control of redroot pigweed (*Amaranthus retroflexus* L.) and common lambsquarters (*Chenopodium album* L.) after all micro-rate treatments were completed using visual evaluations. On September 13, 7 ft of the middle two rows of each plot were harvested for grade and yield analysis. After harvest, onions were allowed to cure and then were graded. Split and diseased bulbs were graded as culls regardless of diameter.

Herbicide application dates, timings, and environmental conditions for Oakes REC, 2010.

Application Date:	5-8	5-18	5-26	6-2	6-16
Onion Stage:	loop	flag lf	lf	2 lf	3 lf
Air Temp., (F):	53	74	68	65	77
Wind speed, (MPH):	6	10	8	4	2
Operating Pressure:	40 psi	40 psi	40 psi	40 psi	40 psi
Nozzle Type:	Flat Fan	Flat Fan	Flat Fan	Flat Fan	Flat Fan
Nozzle Size:	8002	8002	8002	8002	8002
Spray Volume, GPA:	20	20	20	20	20

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Table 1. Effect of micro-rate system on weed control and yield at Oakes, ND.

Treatment		Overall weed control		Yield		
PRE (rate lb/acre)	POST herbicide micro-rate (rate lb/acre)	6 [g]WAT1	12 WAT1	Medium	Large	Total
		--------------- % --------------		--------------------- lb/A x 10^3---------------------		
[a]gly (1)	[c]oxy + [d]brom + [e]cleth + [f]MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	89	44	11	6	20
[b]pend (1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	81	66	14	29	44
gly + pend (1 + 1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	91	79	9	23	34
none	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	90	54	19	21	42
[2a]gly (1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	85	41	10	9	24
[b]pend (1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	85	44	15	12	32
gly + pend (1 + 1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	88	51	9	28	39
none	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	76	26	15	2	23
[a]gly (1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	83	40	13	4	22
[b]pend (1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	78	44	26	20	50
gly + pend (1 + 1)	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	81	38	11	13	25
none	oxy + brom + cleth + MSO (0.06 + 0.06 + 0.03 + 0.5% v/v)	68	13	7	0.3	16
none	brom + MSO (0.06 + 0.5% v/v)	65	23	18	2	20
none	oxy + MSO (0.06 + 0.5% v/v)	54	0	2	0	6
dcpa (7.5)	brom + oxy (0.25 + 1)	88	89	24	40	66
hand-weeded check		100	100	19	26	47
weedy check		0	0	0	0	0
LSD		10	25	9	12	15

Abbreviations: [a]gly = glyphosate; [b]pend = pendimethalin; [c]oxy = oxyfluorfen; [d]brom = bromoxynil; [e]cleth = clethodim; [f]MSO = methylated seed oil; WAT1 = weeks after treatment one;

Energy Beet Variety Trial

Syngenta, Green Vision and NDSU

An irrigated energy beet variety trial was initiated at the Oakes as a cooperative project among the Green Vision Group, Syngenta, NDSU in 2009 and 2010. Syngenta and Betaseed, Inc were partners in trials across ND in 2010. Energy beets hold a great potential as feed stock for ethanol plants. High yielding energy beet germplasm may yield higher than germplasm for sugarbeets that must meet rigid sugar quality and impurity indexes. It is the objective of this trial to determine the yield potential of energy beets under irrigation in SE ND.

Results

Although yields were good in 2009, a late planting date of May 27, capped yields (Figure 1). The effect of planting date is shown in Figure 2 as beets averaged 37 ton/ac in 2010 when planted on April 14. This is nearly identical to the three year average of 38 ton/ac from 2006 to 2008. Beets have averaged about 36 tons/ac over the past five years (Figure 3). If the yield was reduced some to account for plot yield versus field yield, the yield would still make beets a very profitable crop to grow as an ethanol feedstock

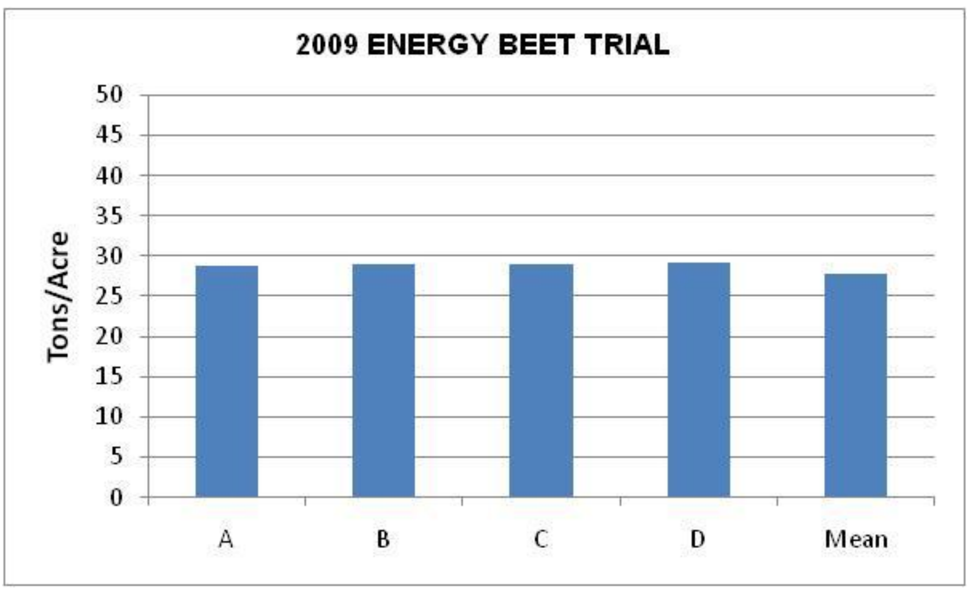

Figure 1. The yield of the four highest yielding energy beet varieties and the mean of 16 beet varieties at the Oakes Irrigation Research Site in 2009.

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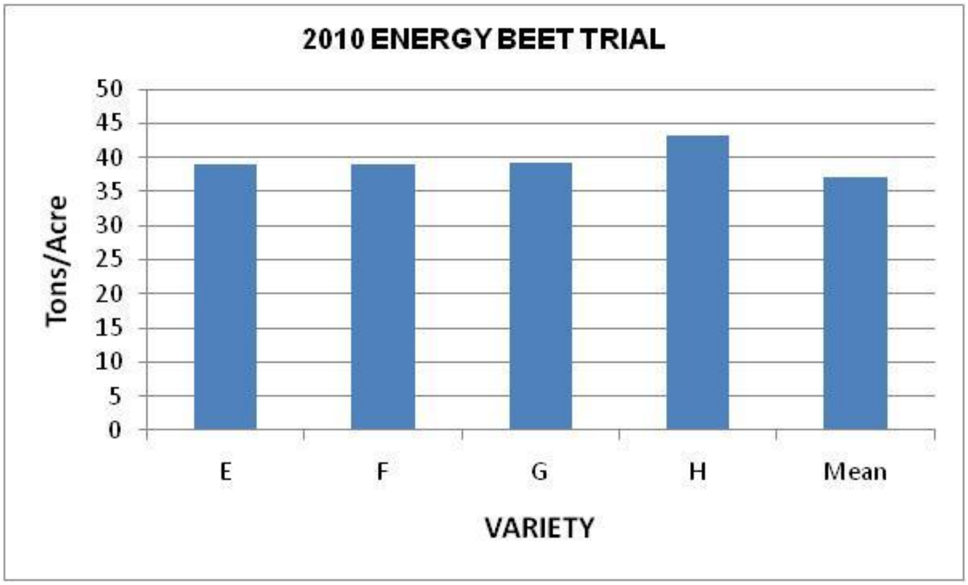

Figure 2. The yield of the four highest yielding energy beet varieties and the mean of 16 beet varieties at the Oakes Irrigation Research Site in 2010

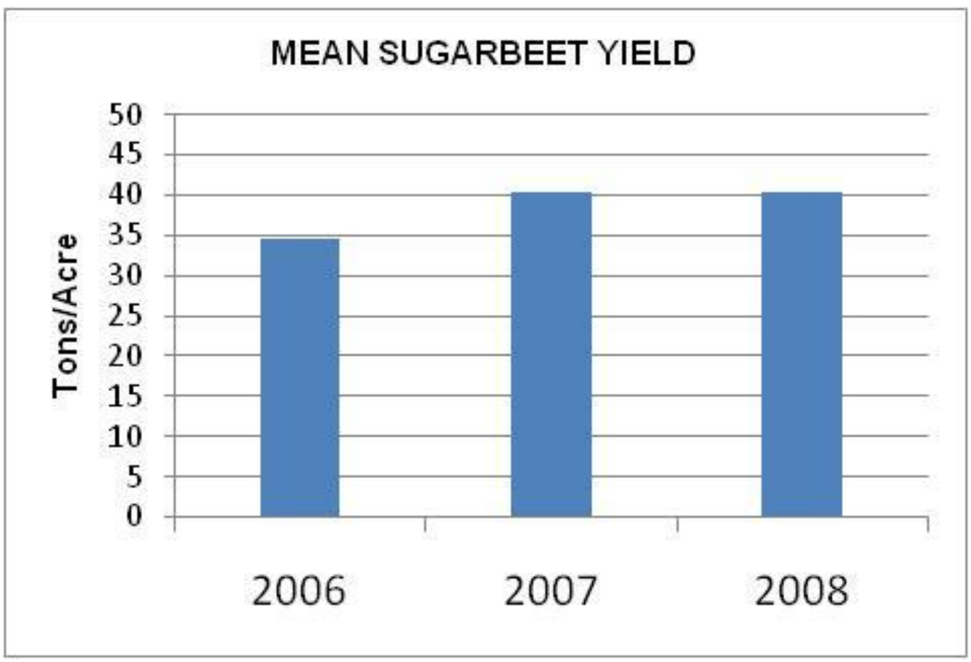

Figure 3. The mean yield for sugarbeet variety trials from 2006 to 2008 at the Oakes Irrigation Research site.

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Corn Hybrid and Row Width Study

W. Albus, L. Besemann and H. Eslinger

A three year study on corn row width and population from 2006-2008 showed no significant yield advantage to 15-inch or 30-inch paired rows over 30-inch rows. Increasing population increased yield up to the highest population studied, 35,000 plants/ac. The lack of response to narrower rows goes against research at this site in the 70's and 80's. Although the lack of response to narrow rows was very consistent from 2006-2008, row width is such a major decision in planter selection that the row width part of this study will be continued. Since 15-inch rows gives the most inter-row plant spacing it was decided there is no reason to test other narrow row configurations until we get a yield response to 15-inch rows.

MATERIALS AND METHODS

Soil:	Maddock sandy loam; 2.0% organic matter; soil-N 20 lbs/acre; soil-P was high; soil-K was very high; soil-S was high.
Previous crop:	2009 – soybean; 2008 – field corn; 2007 – soybean.
Seedbed Preparation:	Fall disk. Coulter chisel April 14 and multiweed (field cultivate) April 17.
Planting:	Planted April 19 in 30-inch and 15-inch row spacing.
Plots:	Plots were 34 ft long by 10 ft wide. Plots with 30-inch row spacing had 4 rows; plots with 15-inch spacing had 8 rows. Corn was thinned to 28,700 plants per acre. There were four reps.
Fertilizer:	April 6 broadcast 28 lbs N/acre, 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8. Stream bar 60 lbs N/acre May 3 and 90 lbs N/acre as 28-0-0 June 7.
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Applied Harness (2 pt/acre) April 27 and Laudis (3 oz/acre) + Atrazine (0.5 lb/acre ai) + AMS (1 lb/10 gal) + MSO (1% v/v) June 3.
Harvest:	Hand harvested R5 August 16 and August 24; R6 October 4 and October 8. Harvest area was a 10 foot by 5 foot section from each plot (two rows from the 30-inch row plots and four rows from the 15-inch row plots).

RESULTS

Although 15-inch rows yielded more than 30-inch rows the difference was not significant. Stand establishment was a problem in this trial and resulted in the 15-inch rows having a final stand of 35,000 compared to 30,500 for the 30-inch rows. Most of the higher yield in the 15-inch rows can probably be attributed to the higher population. Corn yield among 15-inch, paired 30-inch and 30-inch rows was not different from 2006-2008, Figure1.

Table 1. Corn hybrid and row width study at the Oakes Irrigation Research Site in 2010.

	Grain[1] Yield	Harvest Moisture	Test Weight	Population	Ears/Plant	Ear Height	Plant Height	Grain Oil	Grain Protein	Grain Starch	Silk Date	Mature Date
	bu/ac	%	lb/bu	plants/ac		-----inches------		----------------%-------------				
Row Width												
15	252.5	21.8	59.4	35030	0.99	37	89	2.7	8.2	74.3	7/16	9/20
30	238.0	22.1	59.4	30492	1.01	37	87	2.7	8.2	74.3	7/16	9/17
Mean	245.2	22.0	59.4	32761	1.0	36.9	88	2.7	8.2	74.3	7/16	9/18
CV%	6.1	2.4	1.1	15.9	2.6	6.4	1.7	9.6	1.7	0.2		
LSD.05	NS	NS	NS	NS	NS	NS	2	NS	NS	NS		
Hybrid												
W8180STX	245.5	21.7	59.1	32806	0.99	40	94	2.8	8.1	74.0	7/17	9/19
35F44	263.5	26.0	59.8	32398	0.99	39	93	2.9	8.4	74.1	7/18	9/26
DKC43-27	226.7	18.2	59.2	33078	1.01	32	78	2.3	8.1	74.9	7/13	9/11
CV%	5.4	3.5	1.7	8.2	2.0	6.8	2.3	7.6	1.8	0.5		
LSD.05	14.5	0.8	NS	NS	NS	NS	2	0.2	0.2	0.4		
Row by Hybrid												
15 W8180STX	255.4	21.4	58.6	35120	0.99	38	95	3.0	8.1	73.8	7/17	9/20
30 W8180STX	235.5	22.0	59.6	29675	0.99	41	94	2.7	8.2	74.1	7/17	9/18
15 35F44	262.0	26.3	60.2	33215	0.99	39	94	2.8	8.3	74.2	7/18	9/27
30 35F44	265.0	25.7	59.5	31037	1.00	38	91	3.0	8.4	73.9	7/18	9/25
15 DKC43-27	240.0	17.9	59.3	35393	0.99	32	79	2.3	8.1	74.8	7/13	9/13
30 DKC43-27	213.5	18.6	59.1	31309	1.03	33	77	2.3	8.0	75.0	7/13	9/10
LSD.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		

[1]Yield adjusted to 15.5% moisture.

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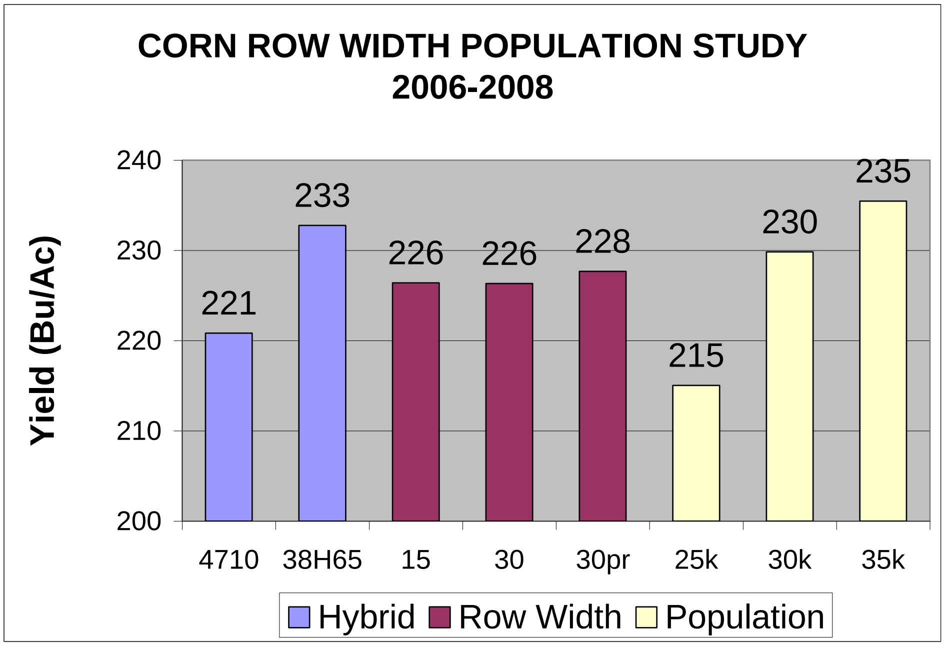

Figure 1. Corn grain yield for hybrids, row width and population from 2006-2008 at the Oakes Irrigation Research Site.

The Response of Three Potato Cultivars to Nitrogen Rate

W. Albus, A. Thompson, L. Besemann and H. Eslinger

Three potato varieties, Russet Burbank, Bannock Russet and Dakota Trailblazer were grown in separate trials each at 120, 180, 240 and 300 lb N /ac. Leaf petiole analysis for nitrate-N, chlorophyll meter readings with a Minolta SPAD 502 and canopy vegetative index's with a Crop Circle ACS 430 were taken periodically to measure nitrogen sufficiency. The canopy index used in these comparisons was the normalized difference red edge index (NDRE).

MATERIALS AND METHODS

Soil:	Egeland loam and Maddock sandy loam; 2.0 % organic matter; soil-N 14 lb/acre; soil-P was very high; soil-K and soil-S were high.
Previous crop:	2009 – field corn; 2008 – soybean; 2007 - field corn.
Seedbed Preparation:	Fall disk. Coulter chisel twice April 14.
Planting:	April 16. Planting rate was one seed piece per foot.
Plots:	Plots were 77 ft long by 18 ft wide (6 rows). There were two reps.
Fertilizer:	April 6 broadcast 43 lbs P_2O_5/acre, 53 lbs K_2O/acre and 21 lbs S/acre as 11-17-20-8. See Table 2. for N rate treatments.
Irrigation:	Overhead sprinkler irrigation as needed.

Pest control: Applied Matrix (1½ oz/acre) + Lexone (⅓ lb/acre) + NIS (0.125% v/v) June 14 for weed control. See Table 1. for fungicides used for disease control. Applied Mustang Max (4 oz/acre) July 25, August 20 and September 2 for insect control.

Harvest: Roto-beat vines and harvest October 5. Harvested two separate 20 foot sections from the 3rd row of each plot from each variety.

Table 1. Fungicide treatment dates and rates for potato cultivars at the Oakes Irrigation Research Site in 2010.

Date	Fungicide	Rate
16-Jun	Quadris Opti	1.6 pt/ac
24-Jun	Curzate + Bravo Zn	3.2 oz/ac + 1.5 pt/ac
29-Jun	Revus Top	7 oz/ac
5-Jul	Quadris Opti	1.6 pt/ac
10-Jul	Revus Top	7 oz/ac
15-Jul	Bravo Zn	2.25 pt/ac
20-Jul	Dithane	2.0 lb/ac
25-Jul	Bravo Zn	2 pt/ac
30-Jul	Dithane	2.0 lb/ac
4-Aug	Bravo Zn	2 pt/ac
9-Aug	Dithane	2.0 lb/ac
14-Aug	Bravo Zn	2 pt/ac
19-Aug	Dithane	2.0 lb/ac
25-Aug	Bravo Weather Stik	1.75 pt/ac
2-Sep	Dithane	2.0 lb/ac
13-Sep	Bravo Zn	1.75 pt/ac

Table 2. Nitrogen treatment dates and rates for potato cultivars at the Oakes Irrigation Research Site in 2010.

	------lbs N/acre------			
Soil N	14	14	14	14
6-Apr	28	28	28	28
25-May	50	50	50	50
21-Jun		20	40	40
28-Jun	20	20	20	40
6-Jul		20	20	40
12-Jul		20	20	40
20-Jul	10		20	20
26-Jul		10	20	20
2-Aug			10	10
Total Rate	122	182	242	302

RESULTS

Although fertilizer nitrogen(N) rate didn't significantly affect yield, Russet Burbank and Dakota Trailblazer showed a trend of increasing yield with increasing fertilizer N and Bannock Russet showed a trend of decreasing yields with increasing fertilizer N rate Tables 3-5. Averaging the two varieties that responded to fertilizer N, Russet Burbank and Dakota Trailblazer, gives a clearer picture, Figure 1. There was only 20 cwt per acre difference between the 180 lb/ac N rate and the 300 lb/ac N rate. Chlorophyll meter readings on July 23 and multi-spectral canopy measurements of normalized difference red edge (NDRE) on August 14 and 25, were significantly affected by N rates. Petioles for nitrate-N analysis were composited from two replications so were not statistically analyzed. Petiole nitrate-N versus the critical value for given dates are shown in Figure 2. Except for the 240 lb N rate on August 24, the nitrate-N in petioles exceeded the critical value at the 240 and 300 lb N rates on all sampling dates.

Figure 3. Shows the relationship among petiole nitrate-N, chlorophyll meter readings and NDRE values on August 11. Chlorophyll meter readings and NDRE values were normalized by dividing the value recorded on each date by the highest value on that date.

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Table 3. Russet Burbank

Fertilizer N Rate	0-4 oz	4-6 oz	6-12 oz	>12 oz	Total	US # 2	Culls	Specific Gravity[1]	Hollow Heart[2]	Brown Center[2]
lb/ac	----------	----------	----------	cwt/ac	----------	----------	----------		#	#
120	87	124	158	27	396	0	24	1.087	1.5	0
180	74	116	204	63	456	0	34	1.088	2.0	0
240	81	100	169	82	432	0	47	1.086	1.3	0
300	84	90	199	87	460	0	27	1.084	1.0	0
Mean	81	107	183	65	436	0	33	1.086	1.4	0
CV%	22.3	18.7	17.6	29.5	10.8		40.7	0.3	64.7	
LSD.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Russet Burbank continued.

Fertilizer	Chlorophyll Meter				NDRE Value - Holland Sensor[3]			Leaf Petiole Nitrate-N			
N Rate	7/23	7/29	8/11	8/24	8/4	8/14	8/25	7/23	7/29	8/11	8/24
lb/ac								----------	ppm	----------	----------
120	32.3	31.6	27.5	22.4	0.255	0.220	0.169	1054	882	263	215
180	36.6	33.7	31.3	27.7	0.277	0.272	0.224	3154	4950	1568	136
240	38.4	36.2	37.1	33.7	0.305	0.313	0.280	11887	12441	5463	3902
300	41.1	41.5	38.0	36.4	0.313	0.326	0.304	17739	17549	9704	4140
Mean	37.1	35.7	33.5	30.0	0.288	0.283	0.244	8459	8956	4250	2098
CV%	2.1	1.6	1.1	5.1	1.4	3.1	4.9				
LSD.05	2.5	1.9	1.2	4.8	0.013	0.028	0.038				

[1]Specific gravity = [Weight in air/(Weight in air - Weight in water)] of ten 4-6, 6-8, 8-10, and over 10 oz tubers, respectively.
[2]Ten tubers were checked.
[3]A vegetative index value (NDRE).

Table 4. Bannock Russet

Fertilizer N Rate	0-4 oz	4-6 oz	6-12 oz	>12 oz	Total	US # 2	Culls	Specific Gravity[1]	Hollow Heart[2]	Brown Center[2]
lb/ac	----------	----------	----------	cwt/ac	----------	----------	----------		#	#
120	23	64	207	117	411	0	8	1.095	3.0	0.0
180	22	40	185	151	398	0	16	1.093	4.5	0.0
240	16	35	185	157	392	0	12	1.094	2.8	0.0
300	20	33	137	195	385	16	4	1.088	2.8	0.3
Mean	20	43	178	155	397	4	10	1.092	3.3	0.1
CV%	29.6	32.3	21.0	21.3	5.5	231.4	14.7	0.3	33.8	282.8
LSD.05	NS	NS	NS	NS	NS	NS	5	NS	NS	NS

Table 4. Bannock Russet continued.

Fertilizer N Rate	Chlorophyll Meter 7/23	7/29	8/11	8/24	NDRE Value - Holland Sensor[3] 8/4	8/14	8/25	Leaf Petiole Nitrate-N 7/23	7/29	8/11	8/24
lb/ac								--------------------ppm--------------------			
120	33.9	34.6	32.0	27.6	0.301	0.286	0.264	3154	3326	1217	267
180	35.7	36.3	34.2	31.0	0.310	0.320	0.298	4920	10277	2183	2023
240	36.9	36.2	37.0	32.9	0.326	0.342	0.324	14527	13650	9243	3124
300	38.6	38.7	38.0	35.6	0.328	0.354	0.343	16038	18386	11114	9130
Mean	36.3	36.4	35.3	31.7	0.316	0.326	0.307	9660	11410	5939	3636
CV%	2.5	4.9	5.1	5.2	2.5	3.7	4.1				
LSD.05	2.9	NS	NS	NS	NS	0.039	0.040				

[1]Specific gravity = [Weight in air/(Weight in air - Weight in water)] of ten 4-6, 6-8, 8-10, and over 10 oz tubers, respectively.
[2]Ten tubers were checked.
[3]A vegetative index value (NDRE).

Table 5. Dakota Trailblazer.

Fertilizer N Rate	0-4 oz	4-6 oz	6-12 oz	>12 oz	Total	US # 2	Culls	Specific Gravity[1]	Hollow Heart[2]	Brown Center[2]
lb/ac	------------------------------cwt/ac------------------------------								#	#
120	12	58	210	99	380	0	15	1.113	6	0
180	11	50	247	109	418	0	13	1.114	4	0
240	20	37	215	150	422	0	10	1.114	2	0
300	11	22	206	197	436	0	17	1.109	3	0
Mean	14	42	219	139	414	0	14	1.112	4	0
CV%	44.0	34.1	23.8	41.5	3.1		74.9	0.6	33.3	
LSD.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 5. Dakota Trailblazer continued.

Fertilizer N Rate	Chlorophyll Meter 7/23	7/29	8/11	8/24	NDRE Value - Holland Sensor[3] 8/4	8/14	8/25	Leaf Petiole Nitrate-N 7/23	7/29	8/11	8/24
lb/ac								--------------------ppm--------------------			
120	37.2	35.8	31.4	25.9	0.267	0.253	0.225	3039	982	470	241
180	39.7	36.3	32.9	29.7	0.274	0.280	0.259	2377	6515	690	398
240	39.3	38.7	38.3	35.9	0.289	0.331	0.313	12864	15108	8275	4679
300	42.1	41.0	40.5	39.0	0.306	0.337	0.325	17390	17577	12295	6837
Mean	39.6	37.9	35.8	32.6	0.284	0.300	0.280	8918	10046	5433	3039
CV%	0.8	3.4	1.5	3.2	2.8	1.5	4.0				
LSD.05	1.0	NS	1.7	3.3	0.025	0.015	0.036				

[1]Specific gravity = [Weight in air/(Weight in air - Weight in water)] of ten 4-6, 6-8, 8-10, and over 10 oz tubers, respectively.
[2]Ten tubers were checked.
[3]A vegetative index value (NDRE).

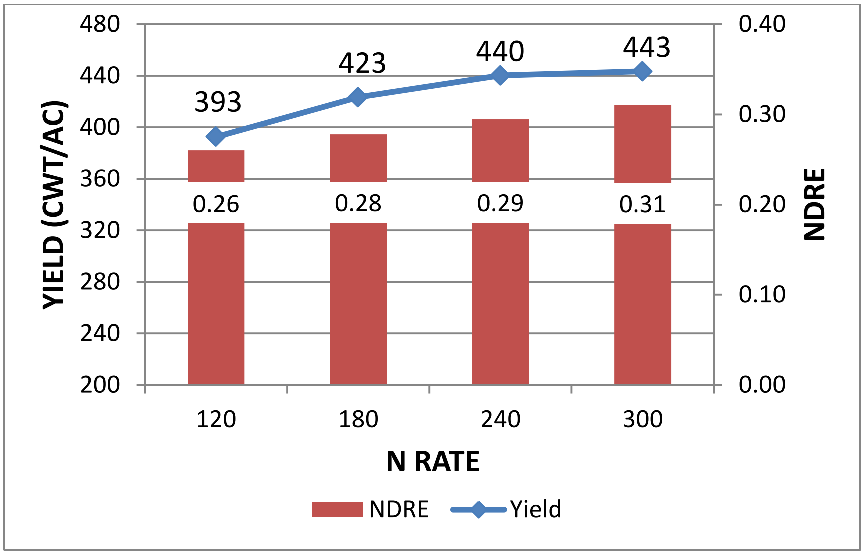


Figure 1. The mean yield for Russet Burbank and Dakota Trailblazer and mean value for NDRE versus N rate at the Oakes Research Site in 2010.

Figure 2. Petiole nitrate-N vs critical values for Russet Burbank, Bannock Russet and Dakota Trailblazer potatoes at the Oakes Irrigation Research Site in 2010.

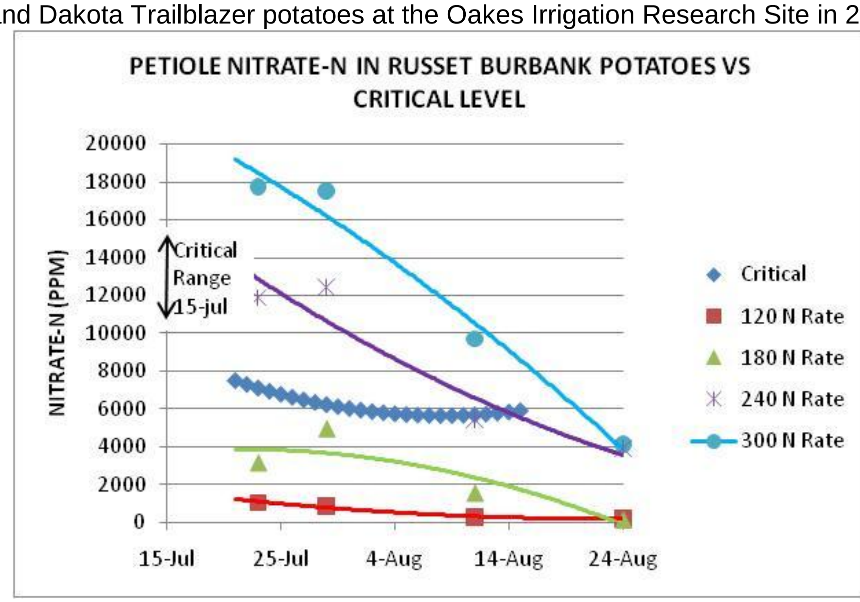
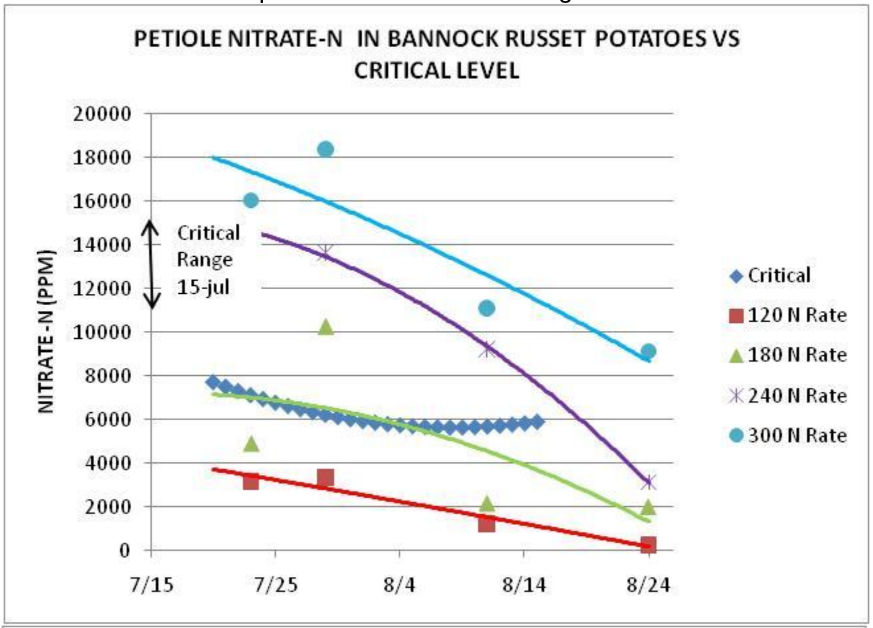


Figure 2. Petiole nitrate-N vs critical values for Russet Burbank, Bannock Russet and Dakota Trailblazer potatoes at the Oakes Irrigation Research Site in 2010.



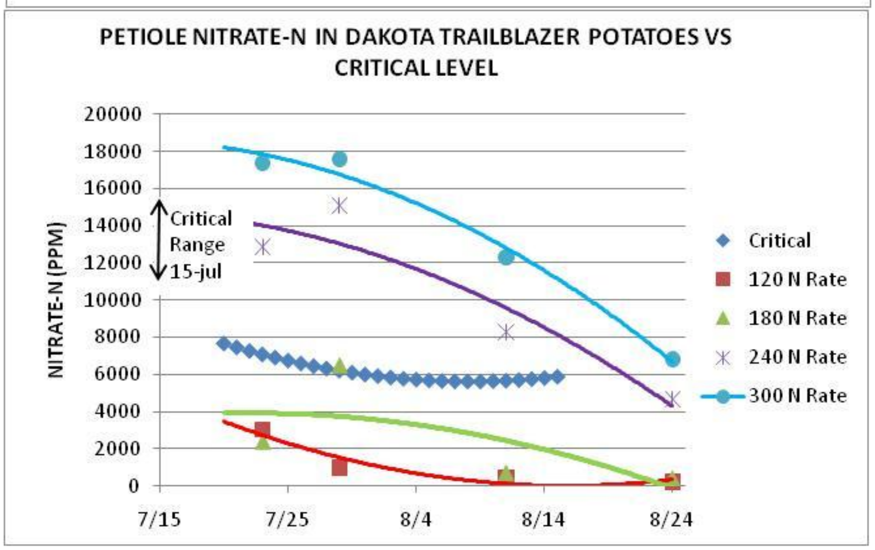
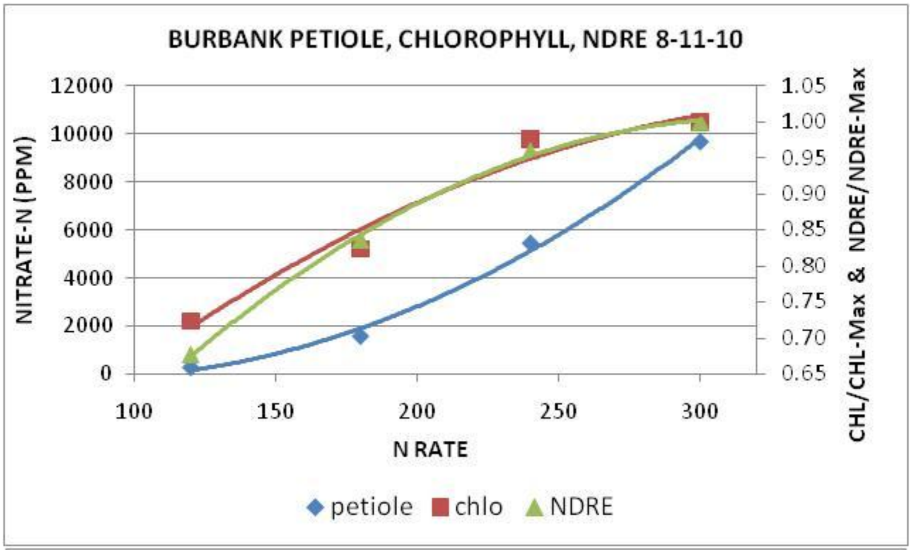
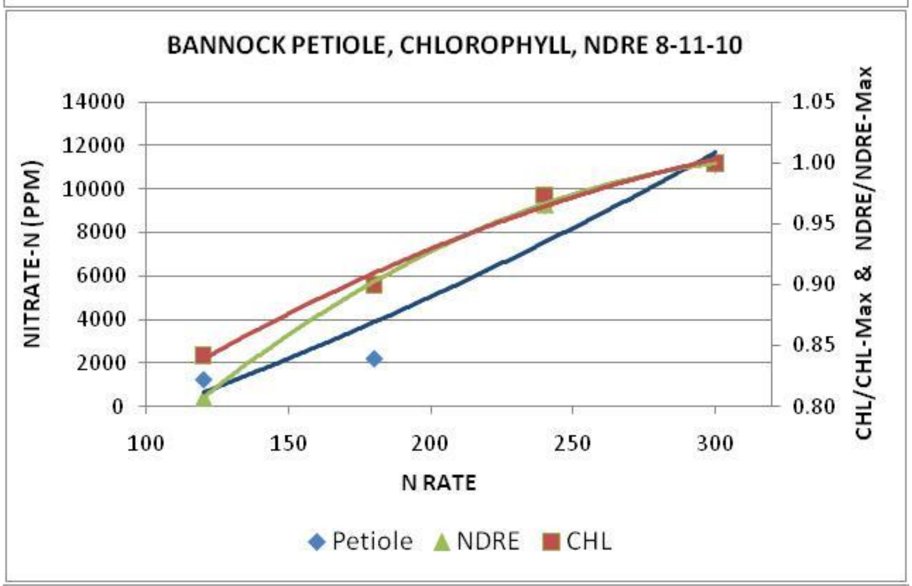
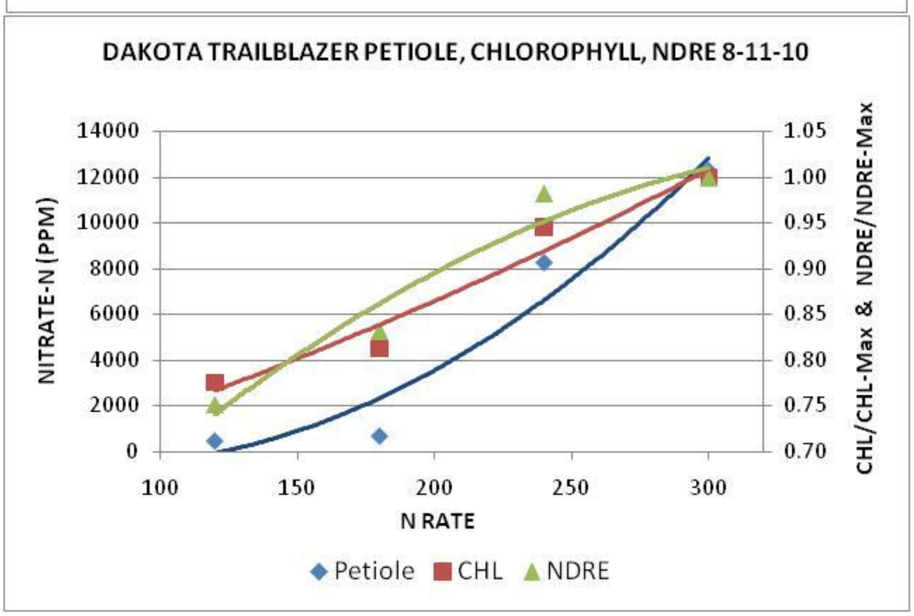


Figure 3. The relationship among chlorophyll meter reading, canopy vegetation index (NDRE) and petiole nitrate-N on August 11, 2010 at the Oakes Irrigation Research Site.







Strip-Till, Corn on Corn, Nitrogen Rate Study

W. Albus, L. Besemann and H. Eslinger

Corn grain production has made amazing increases in both yield and number of acres planted ND in the past 14 years. Figure 1 shows the corn acres planted and total bushels harvested in ND from 1997-2010. We are currently planting about 2.05 million acres of corn and producing about 254 million bushels annually.

Current estimates show ND producing 348 million gallons of ethanol in 2010. At an efficiency of 2.8 gal/bu of corn this ethanol production requires 128 million bushels of corn annually, which is one half of the corn grown in the state. Although corn for several of these plants comes from out of State, corn acres must increase in ND to meet future demand. This will require more continuous corn in crop rotations.

It is the objectives of this study to grow continuous corn in a strip-till system that eliminates full width tillage and to find efficient nitrogen placement and rates. Plots are spring strip-tilled. Fertilizer N is applied in two split applications, the first by planting and the second at side-dress. Placement is addressed by applying the planting time N application either with the strip-till operation prior to planting or dribbling three inches to the side of the seed furrow at planting. Determining nitrogen sufficiency in time is important to achieve N efficiency. Remote sensing utilizing aerial photography (light reflectance), a Holland Crop Circle ACS 430 active canopy sensor (normalized difference red edge – NDRE) and a Minolta SPAD 502 chlorophyll meter were tested to determine ability to measure N sufficiency.

MATERIALS AND METHODS

Soil:	Embden sandy loam and Helca sandy loam; 2.5% organic matter; soil-N average 17 lbs/acre; soil-P and soil-K was high; soil-S was medium.
Previous crop:	2009 - field corn; 2008 - field corn; 2007 - field corn.
Seedbed preparation:	Strip-till April 21 with an Orthman strip-till machine.
Hybrid:	Dekalb DKC42-72
Planting:	Planted May 3 in 30-inch rows @ 34,800 seeds/acre.
Plots:	Plots were 137 ft long by 20 ft (8 rows) wide. There were four reps.
Fertilizer:	April 21 all plots received 12 lbs N/acre and 40 lbs P_2O_5 as 10-34-0 via strip-till. The 20 lb/ac plots received 8 lbs N/acre and 17 lbs S/acre as 12-0-0-26 sprayed in a 5-inch band after planting. All plots, except the 20 lb/ac N rate treatments, received 45 lbs N/acre as 28-0-0, 8 lbs N/acre and 17 lbs S/acre as 12-0-0-26 via strip till or dribble at planting (May 3). Sidedress N treatments June 9; the 200 lb treatments received 135 lbs N/acre and 150 treatments received 85 lbs N/acre as 28-0-0 (three inches deep).
Irrigation:	Hand move sprinkler irrigation as needed.
Pest control:	Applied Harness (2 pt/acre) May 3, Laudis (3 oz/acre) + Atrazine (0.5 lbs ai/acre) + MSO (1% v/v) June 4 and Roundup Power Max (22 oz/acre) + AMS (1lb/10 gal) June 7.
Harvest:	October 14 with a JD 4400 combine. Harvest area was the middle four rows of each plot 137 feet long.

RESULTS

Fertilizer nitrogen(N) rate and placement at planting and side-dress method in prior years resulted in subtle but apparent nitrogen deficiencies in the 150 and 200 treatments before side-dress N was accessible to the corn plants. It was postulated that the broadcast application of 50 lb N/ac as UAN (the first N split) at planting was being immobilized by the surface residue. The remaining N for the 150 and 200 lb N/ac treatments (second split) was applied as a side-dress application in every other row.

Placement and N rate issues were addressed in 2010 by increasing the initial application (first N split) of fertilizer N to 65 lb /ac (except for the low N rate) and knifing between every row in the side-dress treatments. All plots were spring strip-tilled at an eight-inch depth. Ten gal/ac of 10-34-0 was applied in this field operation which was 12 lb N/ac. The placement of the 10-34-0 was shallower than planned, about 2 inches deep and caused concern about possible detrimental effects on germination. Evidently the seed never got in contact with the fertilizer or it was diffused as there was no observed damage. The 20 lb N/ac treatments got another 8 lb N/ac sprayed in a 5-inch band over the seed row after planting as ammonium thiosulfate. The remainder of the first N split in the 150 and 200 lb N/ac treatments was applied at a six-inch depth with strip-till as 45 lb N/ac as UAN and 8 lb N/ac as ammonium thiosulfate. Note, ammonium thiosulfate must not get in contact with the seed. The previous 50 and 100 lb N/ac treaments in 2009 were changed to 150(150 d) and 200(200d) lb N/ac treatments with the remainder of the first split applied as 45 lb N/ac as UAN and 8 lb N/ac as ammonium thiosulfate applied in a surface dribble, three inches to the side of the seed row at planting. The second N split in the 150, 200, 150d and 200d treatments was applied as UAN at side-dress in-between every row at a three-inch depth.

Determining nitrogen sufficiency in time is important to achieve N efficiency. Remote sensing utilizing aerial photography (light reflectance), a Holland Crop Circle ACS 430 active canopy sensor (normalized difference red edge – NDRE) and a Minolta SPAD 502 chlorophyll meter were tested to determine ability to measure N sufficiency.

Increasing nitrogen rates (N) increased grain yield, chlorophyll meter readings, normalized difference red edge (NDRE) and grain protein. Light reflectance measurements decreased with increasing N because dark green plants absorb more red light that light green plants. Remote sensing by chlorophyll meter, Crop Circle Sensor or aerial photography did well in predicting corn N status, Figure 2. The trend for the 100d and 200d treatments to yield more than their 150 and 200 counter parts is due to their being planted on previous 50 and 100 lb treatment plots which had significantly less residue. This is verified in the light reflectance data taken on July 1, in which there is more difference between the placement, strip-till versus dribble, than there is between N rate.

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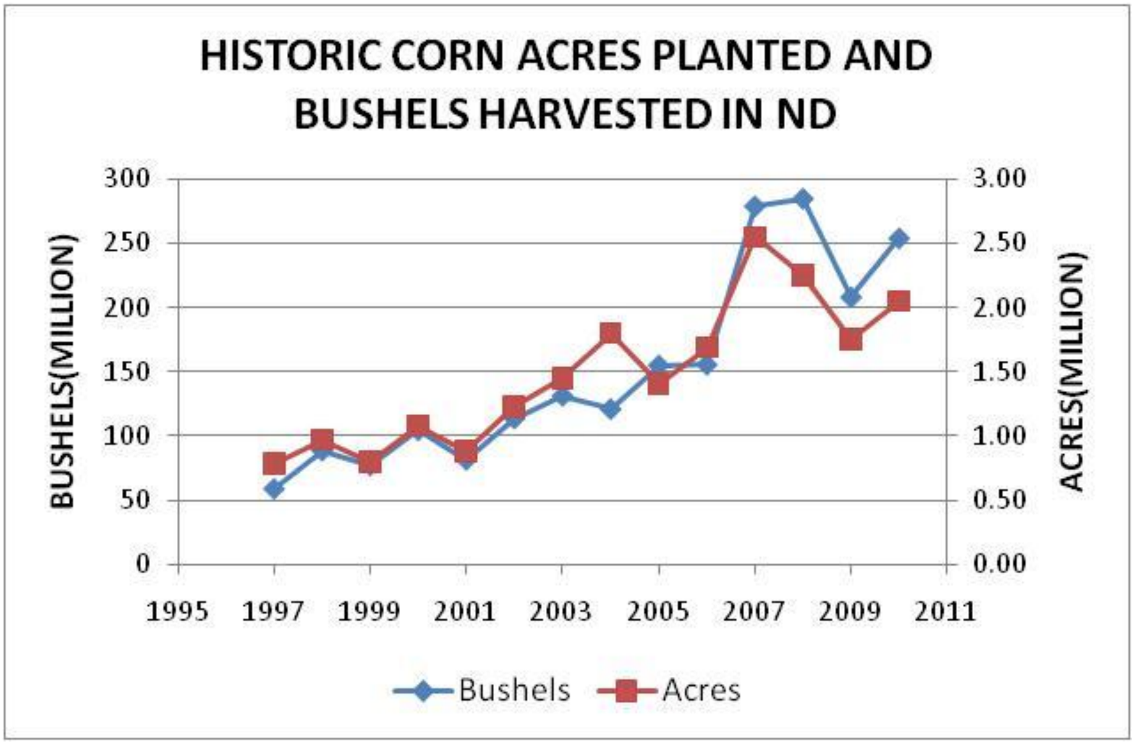

Figure 1. Acres planted to corn and total bushels harvested from 1997-2010 in North Dakota.

Table 1. Strip-till, corn on corn nitrogen rate study at the Oakes Irrigation Research Site in 2010.

Fertilizer N Rate	Grain Yield[1]	Harvest Moisture	Test Weight	Soil Nitrate-N Fall 2010	Soil Nitrate-N Fall 2009	Chloropyll Meter Reading 21-Jul	Chloropyll Meter Reading 4-Aug	Chloropyll Meter Reading 18-Aug	NDRE Reading[2] 4-Aug	NDRE Reading[2] 19-Aug	NDRE Reading[2] 20-Aug
lb/ac	bu/ac	%	lb/bu	lb/ac	lb/ac						
20	94.3	13.6	54.8	12	12	34.8	30.4	25.6	0.169	0.128	0.118
150d	195.2	14.1	56.9	19	18	57.4	57.4	54.4	0.317	0.288	0.298
200d	200.2	13.9	56.7	24	18	58.1	57.2	56.7	0.339	0.294	0.319
150	190.6	15.5	56.4	18	15	58.5	55.7	56.1	0.344	0.306	0.309
200	192.2	15.1	56.4	22	27	58.5	56.8	58.2	0.339	0.320	0.332
Mean	174.5	14.4	56.2	19	18	53.4	51.5	50.2	0.302	0.267	0.275
CV%	2.8	4.3	0.7	26	28	2.4	2.9	2.5	9.7	5.4	6.6
LSD.05	7.5	1.0	0.6	8	8	1.9	2.3	1.9	0.045	0.022	0.028

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Table 1. Strip-till, corn on corn nitrogen rate study (continued).

Fertilizer N Rate	Light reflectance 1-Jul	Plant Stand STDEV	Stalk Nitrate-N	Grain Oil	Grain Protein	Grain Starch	Emerge Date	Silk Date	Mature Date	Return to N Above Low N Rate
lb/ac			ppm	--------------%------------						$
20	85.9	1.8	26	3.0	6.4	74.8	5/22	7/18	9/17	
150d	70.3	1.8	71	2.5	7.4	75.0	5/22	7/15	9/15	395
200d	71.8	2.1	925	2.4	8.0	75.0	5/22	7/16	9/15	396
150	77.5	2.0	299	2.4	7.7	75.0	5/23	7/18	9/18	375
200	78.8	1.8	834	2.3	7.8	75.0	5/23	7/18	9/18	360
Mean	89.6	1.9	431	2.5	7.5	74.9				
CV%	3.0	32.1	32	7.0	4.1	0.5				
LSD.05	4.1	NS	212	0.3	0.5	NS				

[1]Yield adjusted to 15.5% moisture.

[2]A vegetative index value (NDRE).

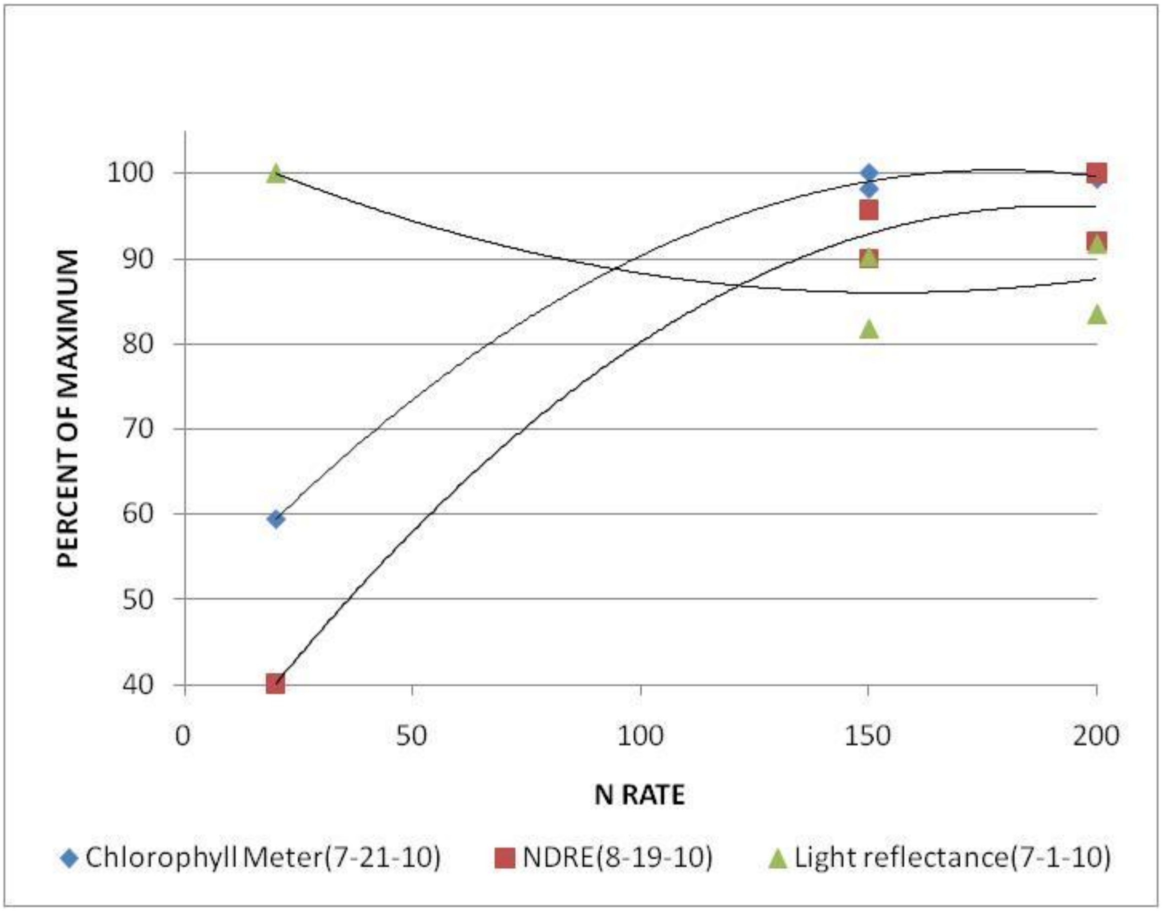

Figure 2. Relationship among chlorophyll meter readings, NDRE and light reflectance versus N rate at the Oakes Irrigation Research Site in 2010.

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Strip-Till, Corn on Soybean, Nitrogen Rate Study

W. Albus, L. Besemann and H. Eslinger

MATERIALS AND METHODS

Soil:	Embden sandy loam, Hecla sandy loam and Maddock sandy loam; 2.1 % organic matter; soil-N average 10 lbs/acre; soil-P was very high; soil-K was high; soil-S was very low.
Previous crop:	2009 – soybean; 2008 – field corn; 2007 – soybean.
Seedbed Preparation:	Strip-till April 23 with an Orthman strip-till machine.
Hybrid:	Pioneer 38A57
Planting:	Planted April 27 @ 33,000 plants per acre in 30 inch rows.
Plots:	Plots were 37 ft long by 15 ft (6 rows) wide. There were four reps.
Fertilizer:	April 21 all plots received 12 lbs N/acre and 40 lbs P_2O_5 as 10-34-0 via strip-till. The 20 lb/ac plots received 8 lbs N/acre and 17 lbs S/acre as 12-0-0-26 sprayed in a 5-inch band after planting. All plots, except the 20 lb/ac N rate treatments, received 45 lbs N/acre as 28-0-0, 8 lbs N/acre and 17 lbs S/acre as 12-0-0-26 via strip till or dribble at planting (May 3). Sidedress N treatments June 15; the 200 lb treatments received 135 lbs N/acre, 150 treatments received 85 lbs N/acre and 100 treatments received 35 lbs N/acre as 28-0-0 (three inches deep).
Irrigation:	Overhead sprinkler irrigation as needed.
Pest control:	Applied Harness (2 pt/acre) April 27, Laudis (3 oz/acre) + Atrazine (0.5 lbs ai/acre) + MSO (1% v/v) June 4 and Roundup Power Max (28 oz/acre) + AMS (1lb/10 gal) June 7.
Harvest:	Hand harvest September 29. Harvest area was a ten-foot section from the two center rows from each plot (twenty feet of total row).

RESULTS

Placement issues and fertilizer N rate issues noted in past years were resolved by increasing the planting time application (first split) of fertilizer N to 65 lb /ac, applied in the spring strip-till operation for the 100, 150 and 200 lb treatments. The previous 50 lb N/ac treatment was changed to 100(100 d) lb N/ac treatment with 12 lb N/ac applied with the strip-till operation and 53 lb N/ac applied in a five-inch band over the seed row at planting for a total of 65 lb N/ac at planting. The remaining N in the 100, 150, 200 and 100d treatments (second split) was applied at side-dress in-between every row.

Increasing nitrogen rates (N) increased: grain yield, chlorophyll meter readings, normalized difference red edge (NDRE) and grain protein. Light reflectance measurements decreased with increasing N, because dark green plants absorb more red light that light green plants. Remote sensing by Crop Circle sensor and aerial photography performed well in predicting corn N status.

Table 1. Strip-till, corn on soybean, nitrogen rate study at the Oakes Irrigation Research Site in 2010.

Fertilizer N Rate	Grain Yield[1]	Harvest Moisture	Test Weight	Soil Nitrate-N Fall 2010	Soil Nitrate-N Fall 2009[2]	Chloropyll Meter 21-Jul	Chloropyll Meter 4-Aug	Chloropyll Meter 18-Aug	NDRE Reading[3] 5-Aug	NDRE Reading[3] 13-Aug
lb/ac	bu/ac	%	lb/bu	lb/ac	lb/ac					
20	112.9	23.9	57.3	10	8	37.0	35.0	30.4	0.252	0.261
100d	188.4	22.6	59.6	15	8	56.5	56.1	53.7	0.360	0.391
100	210.0	24.1	59.3	13	8	57.0	57.8	55.2	0.373	0.405
150	227.9	24.0	59.8	17	8	59.4	59.3	58.7	0.388	0.432
200	229.2	23.4	60.0	45	8	57.2	60.7	59.2	0.407	0.437
Mean	193.7	23.6	59.2	20		53.4	53.8	51.4	0.356	0.385
CV%	6.5	2.0	0.6	124.0		3.0	2.9	3.7	2.9	5.9
LSD.05	19.3	0.7	0.6	NS		2.4	2.4	2.9	0.016	0.035

Fertilizer N Rate	Red reflectance 1-Jul	Stalk Nitrate-N	Grain Oil	Grain Protein	Grain Starch	Return to N Above Low rate
lb/ac		ppm	------------	%----------------		$
20	54.9	23	2.5	5.5	75.7	
100d	47.4	42	2.4	6.7	75.2	304
100	51.3	27	2.5	6.9	75.1	401
150	50.1	69	2.5	7.8	74.6	459
200	50.1	286	2.4	7.9	74.6	442
Mean	50.9	89	2.5	6.9	75.0	
CV%	4.0	94	6.3	2.9	0.4	
LSD.05	3.1	130	NS	0.3	0.5	

[1]Yield adjusted to 15.5% moisture.
[2]Composite sample from entire plot area.
[3]A vegetative index value (NDRE).

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Optimum Corn Stover Removal for Biofuels and the Environment

W. Albus, L. Besemann and H. Eslinger

The 2007 US energy bill calls for 36 billion gallons of ethanol to be produced by 2020. In 2007 the US produced 6.5 billion gallons of ethanol. If corn grain was able to supply 15 billion gallons of ethanol, 21 billion gallons 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 US production agriculture annually, with 75 million tons coming from corn stover. 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 will providing this Country with a renewable energy source.

MATERIALS AND METHODS

Rotations	Block I: 2010 - field corn, 2009 - field corn, 2008 - field corn.
	Block II: 2010 - soybean, 2009 - field corn, 2008 - soybean.
	Block III: 2010 - field corn, 2009 - soybean, 2008 - field corn.
Soil:	Embden sandy loam, Hecla sandy loam and Maddock sandy loam.
	Block I: soil-N 16 lbs/acre; soil-P and soil-K were very high; soil-S was very low.
	Block II: soil-N 17 lbs/acre; soil-P and soil-K were very high; soil-S was very low.
	Block III: soil-N 9 lbs/acre; soil-P and soil-K were very high; soil-S was very low.
Seedbed preparation:	Strip-tilled April 22 with an Orthman strip-till machine.
Hybrid:	Corn: Dekalb DKC43-27.
Variety:	Soybean: Pioneer 91M51.
Planting:	Block I: Planted corn April 27 in 30-inch rows @ 33,000 seeds/acre.
	Block II: Planted soybean May 18 in 30-inch rows @ 205,000 seeds/acre.
	Block III: Planted corn April 27 in 30-inch rows @ 33,000 seeds/acre.

Fertilizer: Block I: April 22, during strip-till operation, band 12 lbs N/acre and 40 lbs P_2O_5 as 10-34-0. April 28, applied 8 lbs N/acre and 17 lbs S/acre as 12-0-0-26 and 45 lbs N/acre as 28-0-0 sprayed in a 5-inch band after planting. June 10 sidedress 155 lbs N/acre as 28-0-0.

Block II: April 22, during strip-till operation, band 12 lbs N/acre and 40 lbs P_2O_5 as 10-34-0.

Block III: April 22, during strip-till operation, band 12 lbs N/acre and 40 lbs P_2O_5 as 10-34-0. April 28, applied 8 lbs N/acre and 17 lbs S/acre as 12-0-0-26 and 45 lbs N/acre as 28-0-0 sprayed in a 5-inch band after planting. June 10 sidedress 115 lbs N/acre as 28-0-0.

Irrigation: Hand move sprinkler irrigation as needed.

Pest Control: Block I: Applied Harness (2 pt/acre) April 27, Roundup Power Max (28 oz/acre) + AMS (1 lb/10 gal) June 1 and Laudis (3 oz/acre) + Atrazine (0.5 lb/acre ai) + AMS (1 lb/10 gal) + MSO (1% v/v) June 4.

Block II: Applied Roundup Power Max (28 oz/acre) + AMS (1 lb/10 gal) June 1 and June 28. Endura (11 oz/acre) July 6 and Prothioconazole (5 oz/acre) July 13.

Block III: Applied Harness (2 pt/acre) April 27, Roundup Power Max (28 oz/acre) + AMS (1 lb/10 gal) June 1 and Laudis (3 oz/acre) + Atrazine (0.5 lb/acre ai) + AMS (1 lb/10 gal) + MSO (1% v/v) June 4.

Treatment Corn stover was removed from Block I and Block II on April 9 for the 2009 crop year according to the protocol (0%, 33%, 66% and 100% removal).

Fall Harvest: corn stover was removed from Block I and Block III on October 9 for the 2010 crop year according to the protocol (0%, 33%, 66% and 100% removal).

Harvest: Block I: Hand harvested a 10 ft section of rows 5, 6, 7 and 8 from each plot on September 28, combined remainder October 15 with 4400 JD using a 4 row head and recorded with a weigh wagon.

Block II: September 29 with a 4400 JD combine with a straight cutter head (60 rows 106 feet long, recorded with a weigh wagon).

Block III: Hand harvested a 10 ft section of rows 5, 6, 7 and 8 from each plot September 29, combined remainder October 15 with 4400 JD using a 4 row head and recorded with a weigh wagon.

RESULTS

Corn stover was removed at the 33, 67 and 100 percent removal rates in block I (corn/corn rotation) and block III (corn/soybean rotation). Amount of stover dry matter (DM) and nutrients in removed stover are listed in Tables 1 and 2. Figures 2-8, show the amount of stover DM removed, nutrients removed and their value from 2008 to 2010.

RESULTS BLOCK I (Corn/Corn)-2010

Although there was a trend for grain yield to increase as stover removal decreased it was not statistically significant. Despite the fact that corn matured four days earlier when 100 percent of the stover was removed compared to no removal, this did not translate into higher yields. Normalized difference red edge (NDRE) at the zero removal rate was higher than the other removal rates on 11-Aug. Ear height at the zero removal rate was higher than the 67 and 100 percent removal rates. This indicates a higher biomass production at the zero removal rate.

A major objective of this study is to determine the effect corn stover removal rates on soil organic matter. This will take some time to make definitive determinations. But we can measure nutrient loss in the removed stover and place a value on it. Nutrient value was based on a price of $690, $520, $475, and $305 per ton of 11-52-0, 0-0-60, 46-0-0 and 21-0-0-24, respectively. The cost of nutrient removal at the 0, 33, 67 and 100 percent removal rates was $35, $69 and $97 per acre, respectively, or about $21/ton.

RESULTS BLOCK III (Corn/Soybean)-2010

There was a tendency for yield to be higher and grain moisture higher at the lower rates of stover removal although not significant. Grain protein content was higher at the highest removal rate compared to the lowest. Silk date was delayed at the zero removal rate. The cost of nutrient removal at the 0, 33, 67 and 100 percent removal rates was $36, $65 and $88 per acre, respectively, or about $19/ton.

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Table 1. The effect of corn stover removal rates on grain yield and other agronomic parameters for corn on corn plots in 2010.

Stover Removal	Grain Yield[1]	Harvest Moisture	Test Weight	Stalk DM Removal 2010	Soil NO_3-N 0-24" Fall 2010	Chloropyll Meter 21-Jul	Chloropyll Meter 4-Aug	Chloropyll Meter 18-Aug	NDRE Reading[2] 5-Aug	NDRE Reading[2] 27-Aug	Plant Stand STDEV	Stalk Nitrate-N	Grain Oil	Grain Protein	Grain Starch
%	bu/ac	%	lb/bu	ton/ac	lb/ac							ppm	-----------%-----------		
0	220.1	22.1	58.3	0.0	29	60.6	59.5	58.3	0.395	0.294	2.9	2298	2.3	8.0	74.7
33	217.8	21.6	59.0	1.8	31	60.7	60.1	59.0	0.390	0.269	3.3	1569	2.2	8.0	75.1
67	215.0	21.1	58.6	3.3	33	59.8	60.3	58.6	0.390	0.275	2.7	1715	2.3	8.0	74.9
100	211.1	20.6	58.3	4.6	33	59.3	59.9	58.3	0.391	0.265	2.9	1794	2.4	8.1	74.6
Mean	216.0	21.3	58.5	2.4	31.5	60.1	59.9	58.5	0.392	0.276	2.9	1844	2.3	8.0	74.8
CV%	2.2	3.2	1.0	9.2	27.0	1.7	1.9	1.3	2.1	3.9	18.3	27.5	8.7	1.9	0.6
LSD.05	NS	NS	NS	0.4	NS	NS	NS	NS	NS	0.0172	NS	NS	NS	NS	NS

[1]Yield adjusted to 15.5% moisture.
[2]A vegetative index value (NDRE).

Stover Removal	Emerge Date	Silk Date	Mature Date	Ear Height	Nutrients in Stover - 2010 N	Nutrients in Stover - 2010 P	Nutrients in Stover - 2010 K	2010 Nutrient Value
%				inches	lb/ac	lb/ac	lb/ac	$/ac
0	5/23	7/16	9/17	35.7	0	0	0	$0
33	5/23	7/15	9/13	36.5	23	1	40	$35
67	5/23	7/14	9/14	33.5	50	3	76	$69
100	5/22	7/14	9/13	32.8	77	4	100	$97
Mean	5/23	7/15	9/14	34.6	38	2	54	50
CV%				3.4	21.4	37.2	25.4	21.0
LSD.05				1.9	13	1	22	17

Table 2. The effect of corn stover removal rates on grain yield and other agronomic parameters for corn on soybean plots (Block III) in 2010.

Stover Removal	Grain Yield[1]	Harvest Moisture	Test Wt.	Stalk DM Removal 2010	Soil NO-3-N 0-24" Fall 2010	Chloropyll Meter Reading 21-Jul	4-Aug	Grain Oil	Protein	Starch
%	bu/ac	%	lb/bu	ton/ac	lb/ac			-------------%----------		
0	219.4	21.6	56.7	0.0	15.0	59.4	60.4	2.2	7.6	75.1
33	214.7	21.3	56.5	1.9	14.0	58.5	59.7	2.4	7.7	74.9
67	213.1	20.1	57.3	3.2	13.0	57.5	58.4	2.2	7.5	75.2
100	213.0	20.3	57.5	4.8	14.0	58.7	59.9	2.4	8.0	74.6
Mean	215.0	20.8	57.0	2.5	14.0	58.5	59.6	2.3	7.7	74.9
CV%	2.6	4.1	0.7	5.4	31.6	2.2	2.0	9.7	2.6	0.6
LSD.05	NS	NS	0.7	0.2	NS	NS	NS	NS	0.2	NS

[1]Yield adjusted to 15.5%

Stover Removal	Silk Date	Ear Height	Ear/ Plant	Nutrients in Stover - 2010 N	P	K	2010 Nutrient Value
%				lb/ac	lb/ac	lb/ac	$/ac
0	7/16	34.7	1.01	0	0	0	$0
33	7/15	33.1	1.02	26	2	39	$36
67	7/14	33.7	1.01	42	3	75	$65
100	7/14	33.4	1.03	67	4	93	$88
Mean	7/15	33.7	1.02	34	2	51	47
CV%		3.4	2.31	10.9	27.1	29.1	19.1
LSD.05		NS	NS	6	1	24	14

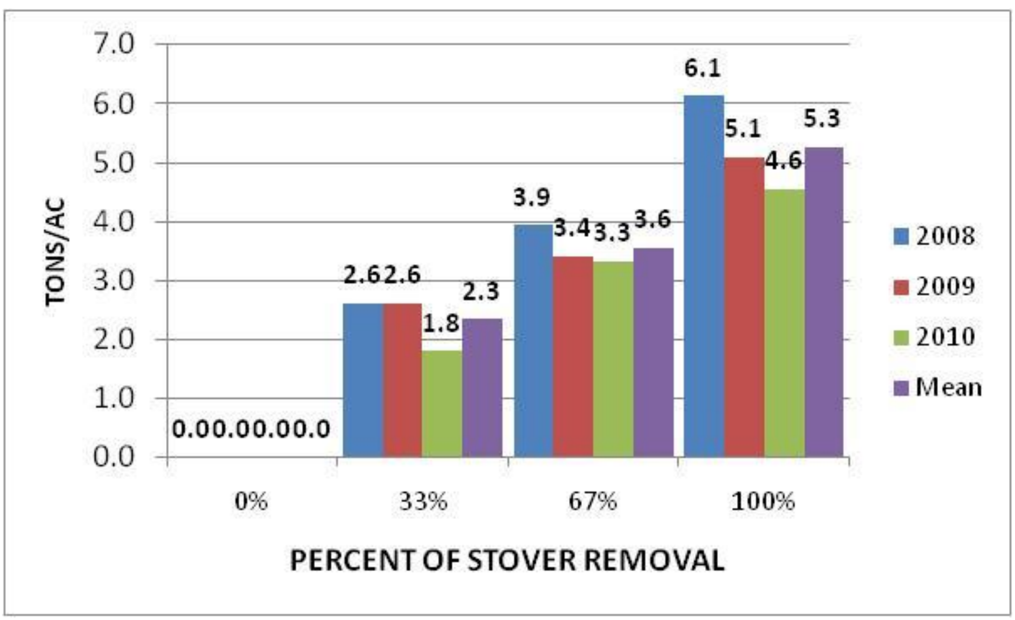

Figure 1. Stover removed in tons of DM per acre at four removal rates in continuous corn at the Oakes Irrigation Research site from 2008-2010.

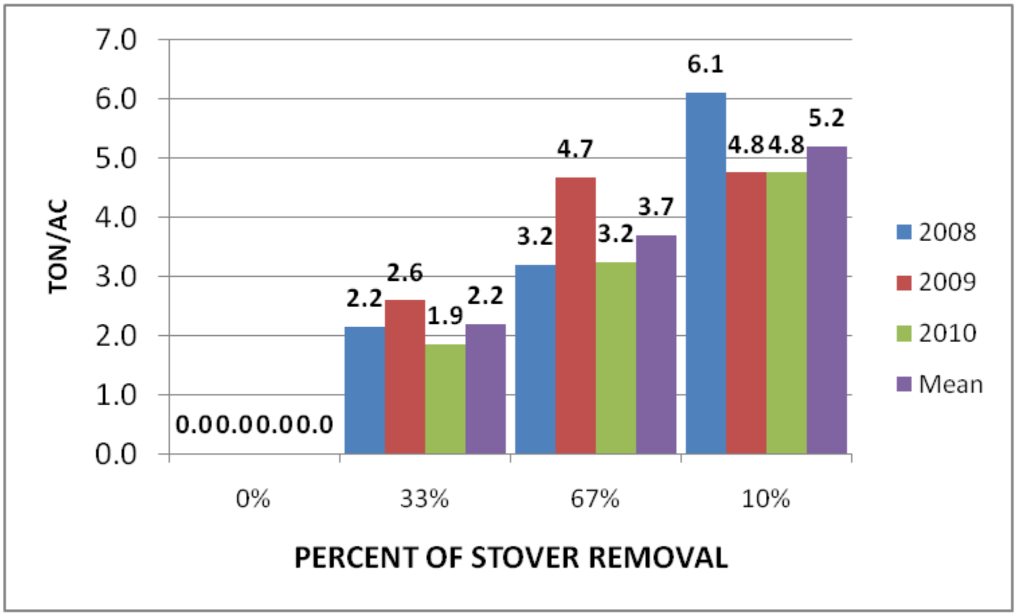

Figure 2. Stover removed at four removal rates in tons of DM per acre in a corn on soybean cropping system at the Oakes Irrigation Research site from 2008-2010.

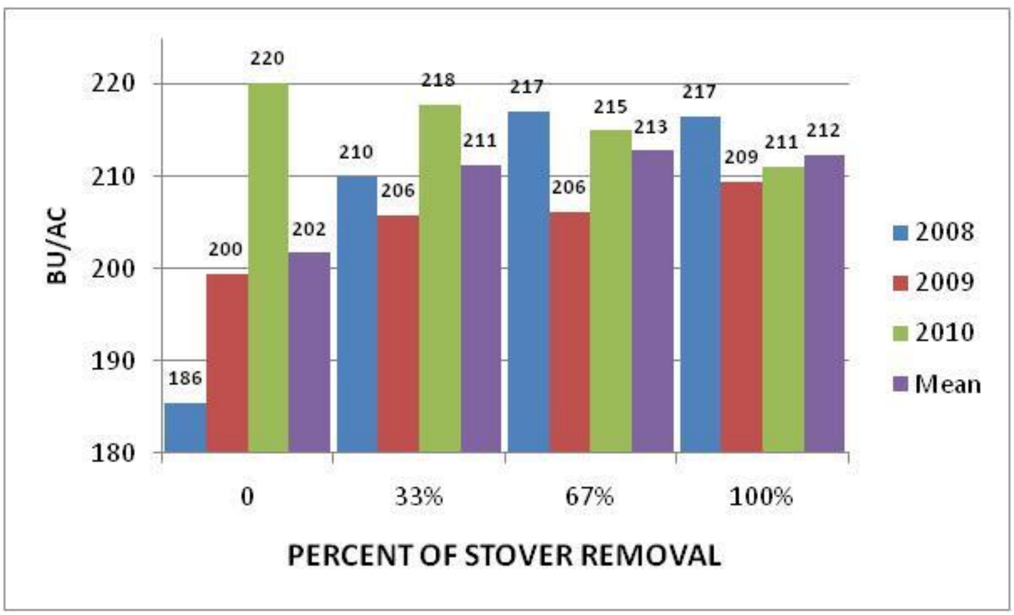

Figure 3. Yield vs corn stover removal in continuous corn at four removal rates at the Oakes Irrigation Research site from 2008-2010.

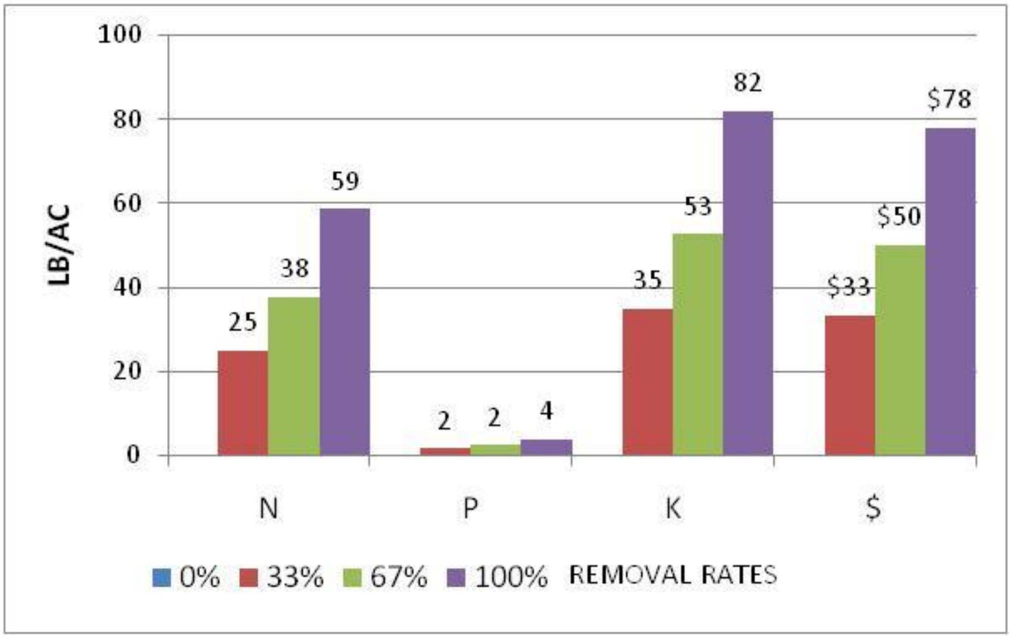

Figure 4. Amount of nutrients removed at four removal rates and nutrient value in continuous corn at the Oakes Irrigation Research site in 2008.

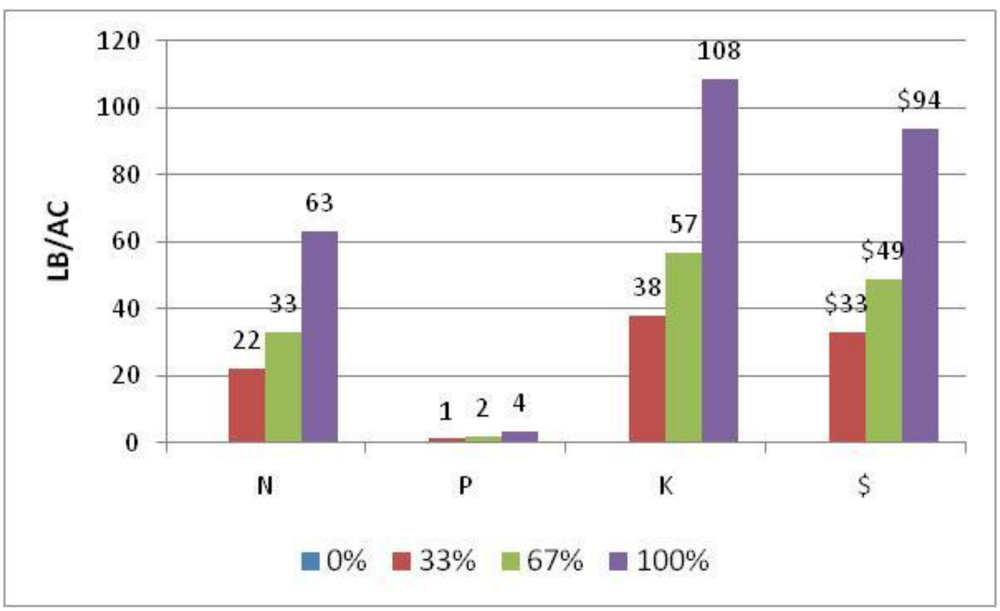

Figure 5. Amount of nutrients removed at four removal rates and nutrient value in a corn soybean rotation at the Oakes Irrigation Research site in 2008.

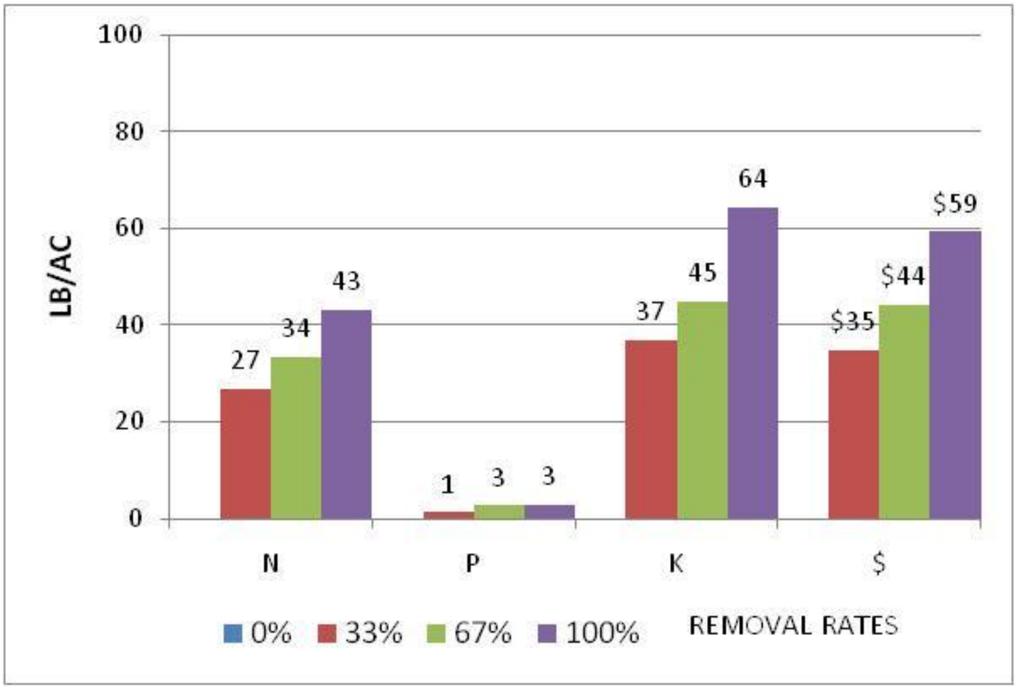

Figure 6. Amount of nutrients removed at four removal rates and nutrient value in continuous corn at the Oakes Irrigation Research site in 2009.

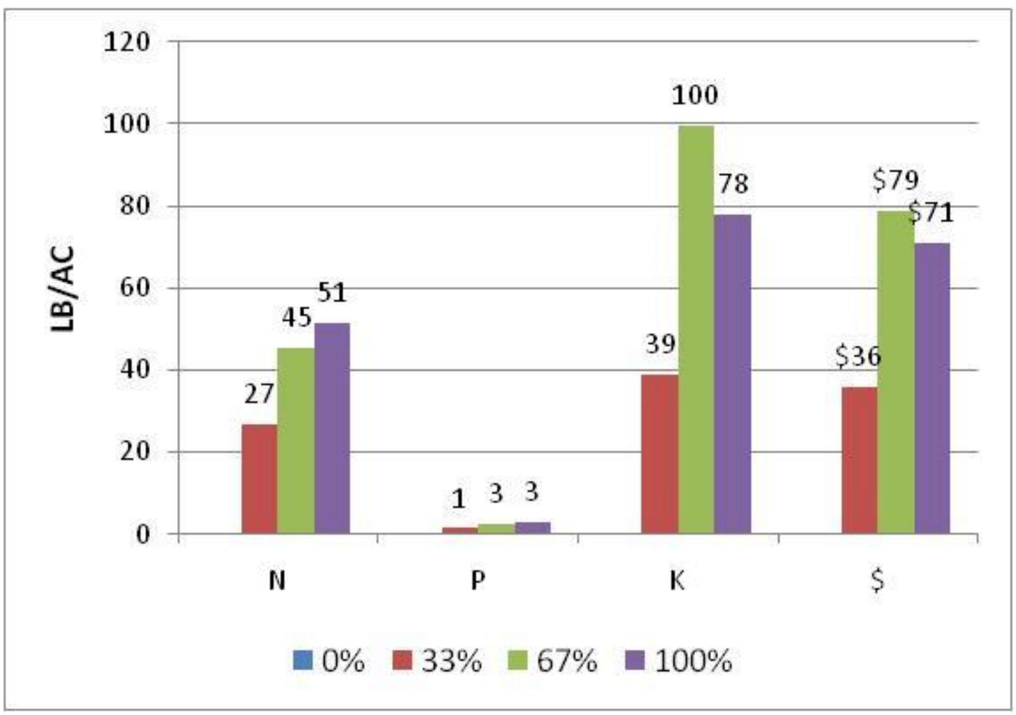

Figure 7. Amount of nutrients removed at four removal rates and nutrient value in a corn soybean rotation at the Oakes Irrigation Research site in 2009.

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FARM EXTENSION ACTIVITIES
Corn Nitrogen Rate Studies in Producer Fields
W. Albus, L. Besemann and H. Eslinger

Historically, low fertilizer nitrogen prices and less precise methods of fertilizer application resulted in higher than required applications of nitrogen (N) to manage risk. With current technology and nitrogen prices, this strategy in no longer relevant. Nitrogen rates and methods of determining N sufficiency were tested in a corn on corn rotation in 12 irrigated farm fields from 2006 to 2009 to demonstrate proper N rates. An additional out-come of these studies was the ability to compare the response to N at the field scale to N response at the research plot level. The plot research was conducted by North Dakota State University (NDSU) at the Oakes Irrigation Research Site (OIRS)[1], Northwest 29 Research Site (NW 29)[2] and the Oakes Newly Irrigated Site Study (ONISS)[3]. Methods to determine N sufficiency were also evaluated at the field scale.

RESPONSE TO N RATE IN NDSU TRIALS
Nitrogen calibration work in continuous irrigated corn plots was conducted from 1979 to 1984 (OIRS), 1991 and 1994-95 (NW 29) and 1994-95 (ONISS). The three data sets were combined into one data set called Oakes. The Oakes data set showed yields were maximized at N rates from 205 to 245 lb/ac, (Figure 1). Assuming a N cost of $0.45/lb and a corn price of $4.50/bu the maximum return to N (MRTN) was between 185 and 225 lb/ac of fertilizer N, (Figure 2).

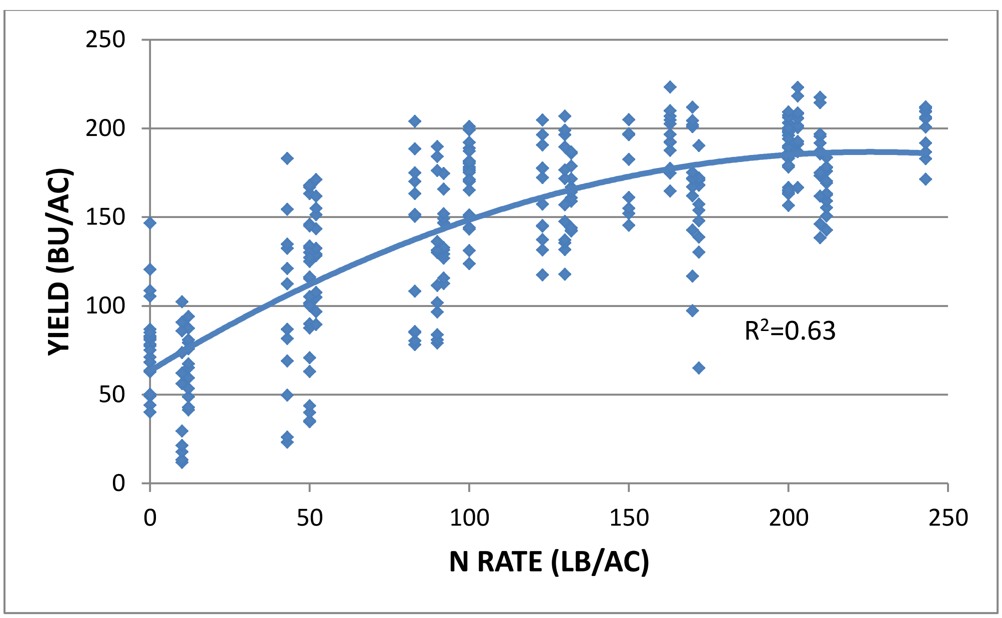

Figure 1. The yield for irrigated continuous corn for ten site years (Oakes data set) at N fertilizer rates.

[1]Zubriski, J.C. and R.Utter. Corn, water level, N rate and time of application trial. Oakes Irrigation Research Annual reports. 1979-84.
[2]Knighton, R.E and N. Derby. Unpublished data NW 29 Research Site. 1991 and 1994-95.
[3]Prunty, L.D. and L. Besemann. Unpublished data ONISS Research Site. 1994-95.

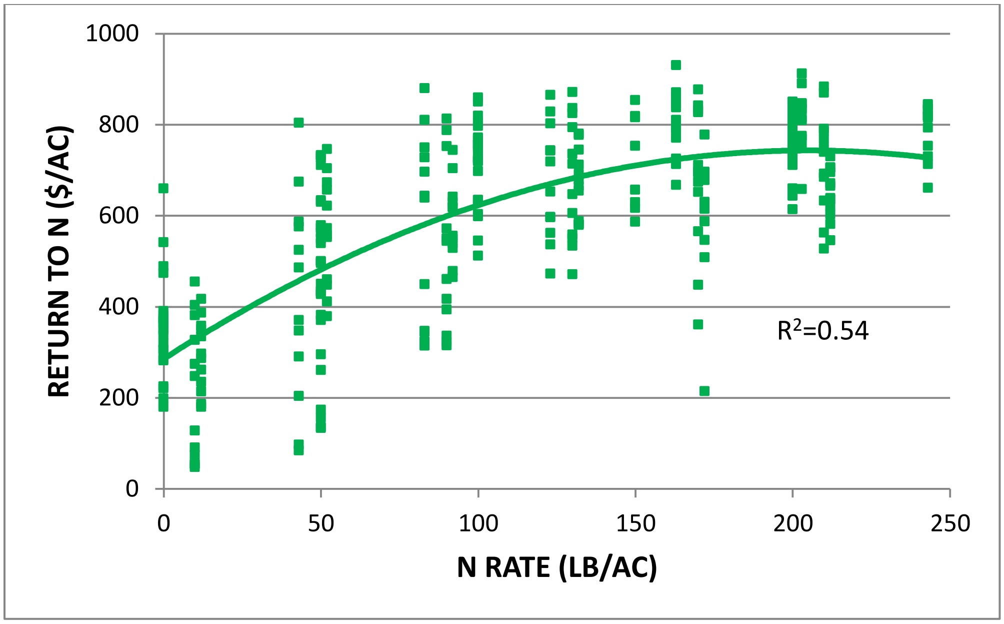

Figure 2. The return to fertilizer N for irrigated continuous corn for ten site years (Oakes data set).

RESPONSE TO N RATE IN FARM FIELDS

Soil-plant N relationships were studied from 2006 to 2009 in 12 irrigated fields in a corn on corn rotation. Return to fertilizer N for N rate means is shown in Figure 3. The data suggests that maximum return to N (MRTN) occurred at rates from 179 to 247 lb/ac. A basal stalk nitrate-N test (taken after plants are mature) of 1024 ppm indicated sufficient plant N at the 179 lb/ac N rate (Figure 4). The optimum range for this test is between 700 to 2000 ppm. Once plant N needs are met, the stalk nitrate-N raises rapidly as indicated in stalk tests of over 3000 ppm for the 208 and 247 N rate means. Chlorophyll meter readings over estimated N sufficiency as the reading at the 143 lb/ac N rate at silking was 98% of the maximum recorded. Typical a 98% value would indicate sufficient N at this stage. Grain protein at 7.8%, which was 0.5% less than the maximum protein content, was a better indicator of N sufficiency. Residual soil N is given in Figure 5. The residual soil N in farm fields was within five lb N/ac of the research plot data at any given N rate. The response to fertilizer N on these on farm trials mirrored that found in research plots. The challenge is that in even sizeable data sets from several years, there is a relatively large range of appropriate outcomes for an economic N rate. This is further borne out in Figure 6, where the range of yields within in a given N rate are greater than a 50 lb/ac N increment difference. Figure 7, shows the same data in terms of pounds of N required to produce a bushel of corn at N rates. With that said, these data sets would suggest that the MRTN will occur in a range of 180 to 225 lb/ac of fertilizer N in a corn on corn rotation on irrigated coarse textured soils in southeast ND. Optimum N rate is actually site specific and related to the cropping system employed. In this day in age of yield monitoring capabilities, producers may want to test N rates in their own fields especially if their rates are in the lower or higher end of the MTRN found in these studies.

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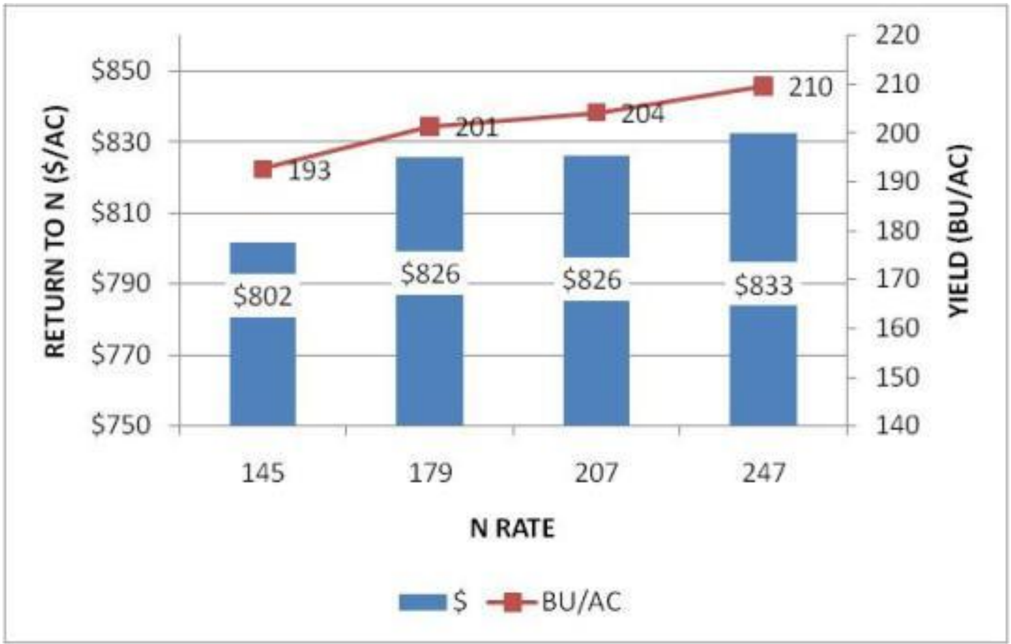

Figure 3. Yield and return to N fertilizer for N rate means from 2006 to 2009 in irrigated corn on corn in twelve farm fields at Oakes, ND.

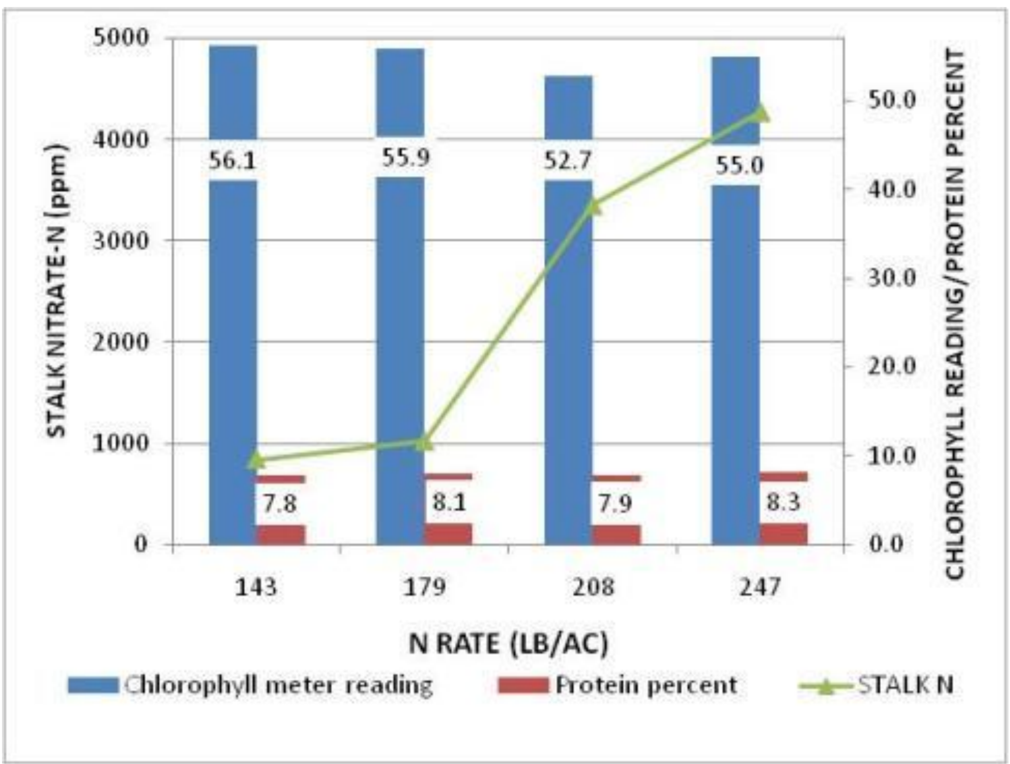

Figure 4. Chlorophyll meter readings, grain protein percent and basal stalk nitrate-N from 2006 to 2009 in irrigated corn on corn in twelve farm fields at Oakes, ND.

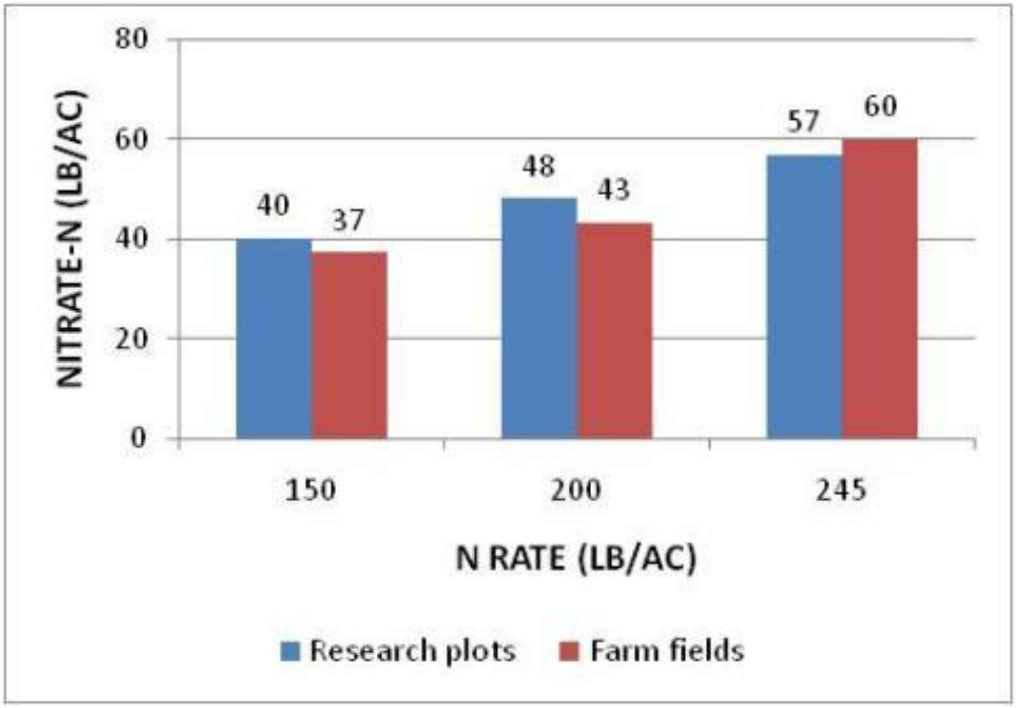

Figure 5. Residual soil nitrate-N for 0-2 or 0-3 feet depths for twelve farm fields from 2006 to 2009 and research plots (10 site years) from 1979-84, 1991 and 1994-95.

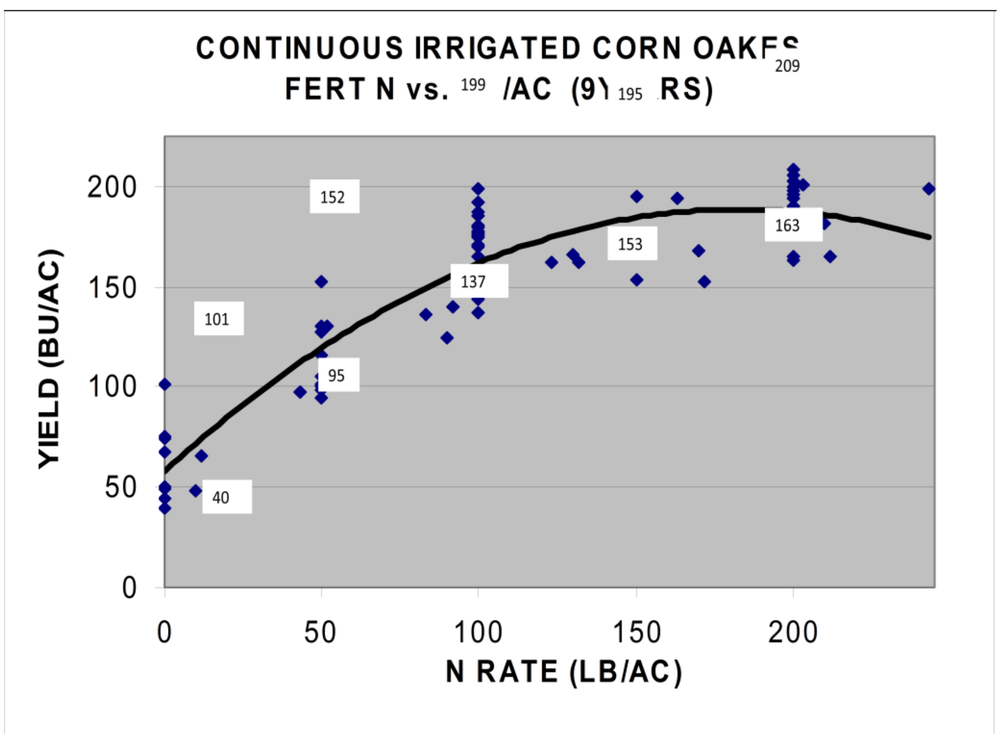

Figure 6. The yield range at N rates for continuous irrigated corn for nine years at Oakes.

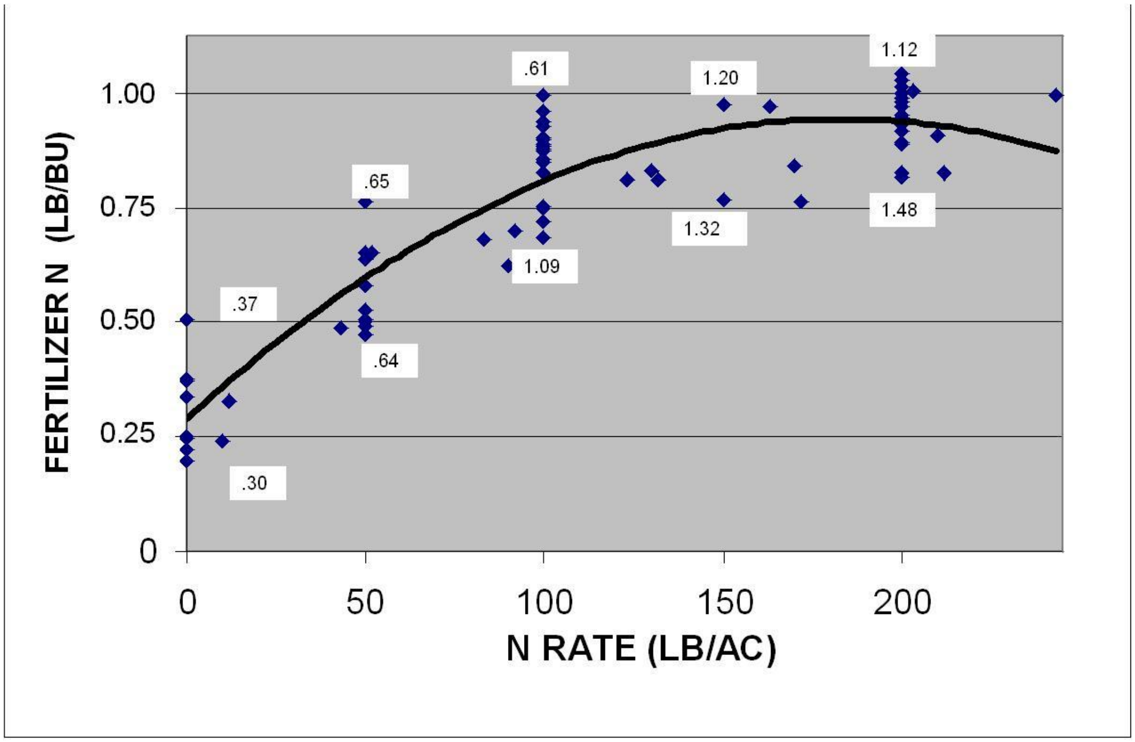

Figure 7. Nitrogen effeciency in lb/bu for continuous irrigated corn for nine site years at Oakes.

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FOCUS OF 2010 AND FUTURE RESEARCH ACTIVITIES

Many factors effect N efficiency including: rate, placement, timing, precipitation and temperature. These also effect soil N mineralization from soil organic matter which plays a major role in N efficiency. Some of these we can control, some we cannot. The objective of this work is to devise methods/technologies that allow producers to choose N rates based on best economic returns, yet prevent yield losses in years when either soil mineralization is low or N is lost to deep percolation or de-nitrification.

To accomplish this goal, nitrogen sufficiency needs to be an assessed at a pre-determined growth stage so remedial action can occur before any real or potential yield loss has occurred. Although young corn plants don't require a large quantity, N supply is critical at this time as agronomic parameters such as ear size are set by the six leaf stage. Therefore proper N strategy will prevent any measureable deficiency at this time. The effective uptake of applied fertilizer N after silking declines rapidly, so N deficiencies need to be corrected promptly at the tassel to silk period. A high N reference strip is required for each corn hybrid with a significant presence in the field to determine N sufficiency. The ratio of green color in the field to the green color in the reference strip determines if N is limiting. The overall goal is to reduce the risk of N deficiency when the N strategy is compromised by unanticipated environmental conditions.

Nitrogen sufficiency in past studies at Oakes has been estimated by direct measurements; chlorophyll meter and basal stalk N test and remotely by images from aerial photography. Chlorophyll meters are labor intensive making it almost impossible to map fields. Aerial images are subject to plane availability and require clear skies. In 2010 we began taking multi-spectral canopy measurements with a Crop Circle 430 (Holland Scientific) instrument. It calculates normalized difference red edge (NDRE) measurement from the crop canopy that is an indicator of green color and biomass. Other brands of multi-spectral meters are available. Multi-spectral canopy meters have the capability of being carried by an individual or attached to equipment. It has its own light source so is unaffected by daylight. A high clearance vehicle or airplane would allow field mapping and turn over time could be as little as 24 hours.

ON FARM RESEARCH 2010

Testing with a multi-spectral canopy meter in corn began in 2010 in farm field 1 where the stalks had been removed from the previous corn crop. The maximum return to N (MTRN) (Figure 9) was at a N rate 167 lb/ac less than the N rate the maximum yield was recorded, (Figure 8). The basal stalk nitrate-N content was significantly below the lower critical optimum level of 700 ppm at the 171 lb/ac N rate, (Figure 10). Corn was a very efficient user of N drawing the basal stalk nitrate-N levels below the critical level and yet produced high yields. This is supported by the fact that adding the next 30 lb/ac of N resulted in the stalk test exceeding the upper critical level of 2,000 ppm. NDRE was strongly related to N rate (Figure 11). This relationship didn't help to determine N sufficiency as the NDRE value at the 171 lb/ac N rate was only 77% of its maximum value. This low percentage would suggest a N deficiency. The high yields at the low N rate in this study were probably due to the corn stalks being removed the previous fall. Figure 12 shows that NDRE gives a larger range of measurement compared to normalized difference vegetative index (NDVI). Further studies in 2011 will help us determine whether NDRE measurements can be used to determine N sufficiency.

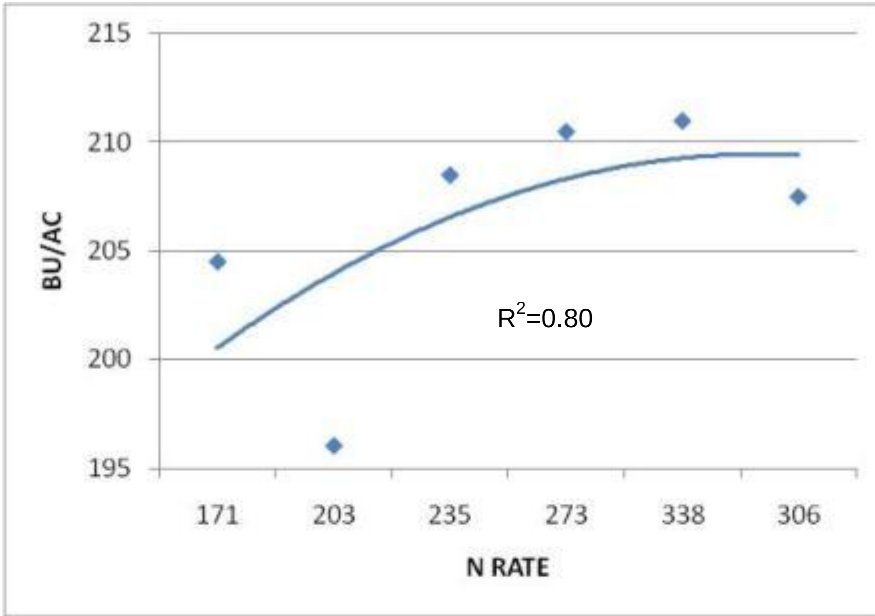

Figure 8. Field harvested corn yield versus N rate in field 1 at Oakes, ND in 2010.

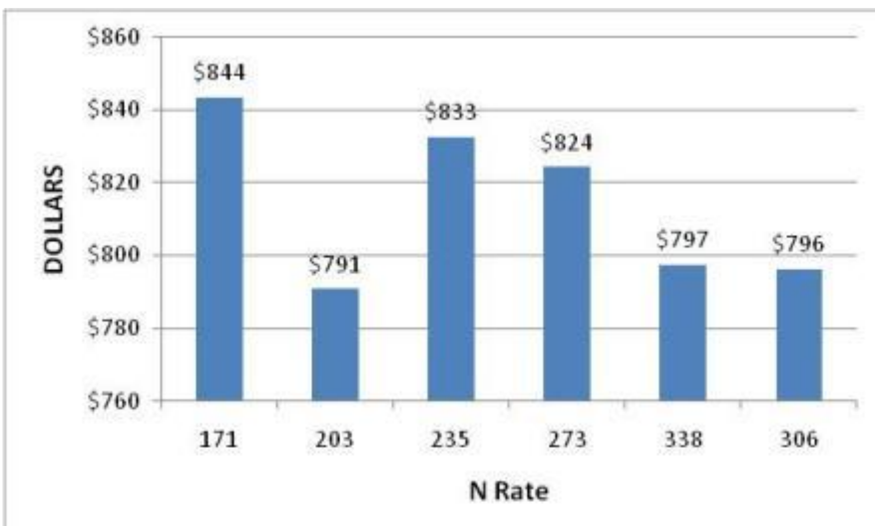

Figure 9. Return to N versus N rate in field 1 at Oakes, ND, in 2010.

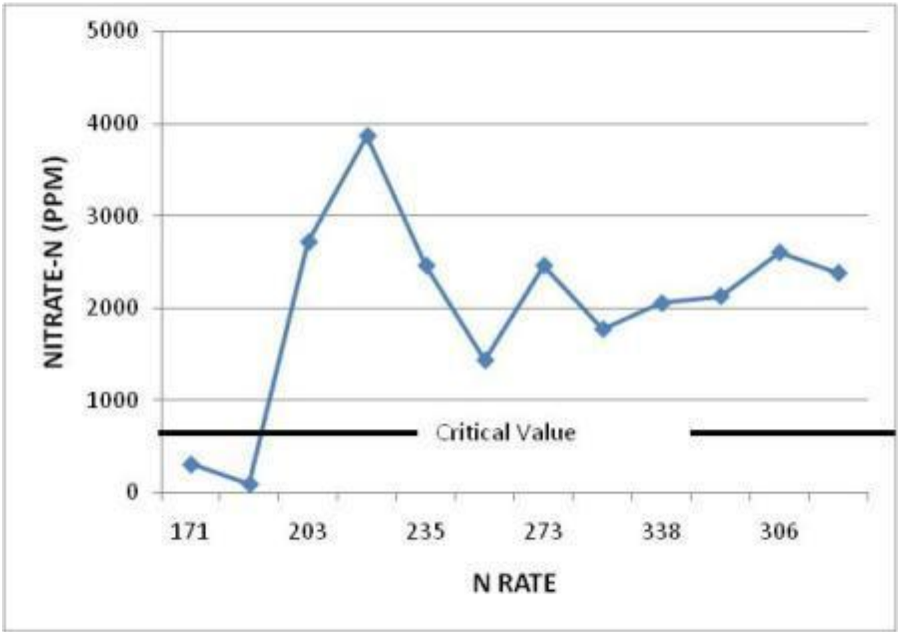

Figure 10. Basal stalk nitrate-N versus N rate in field 1 at Oakes, ND, in 2010

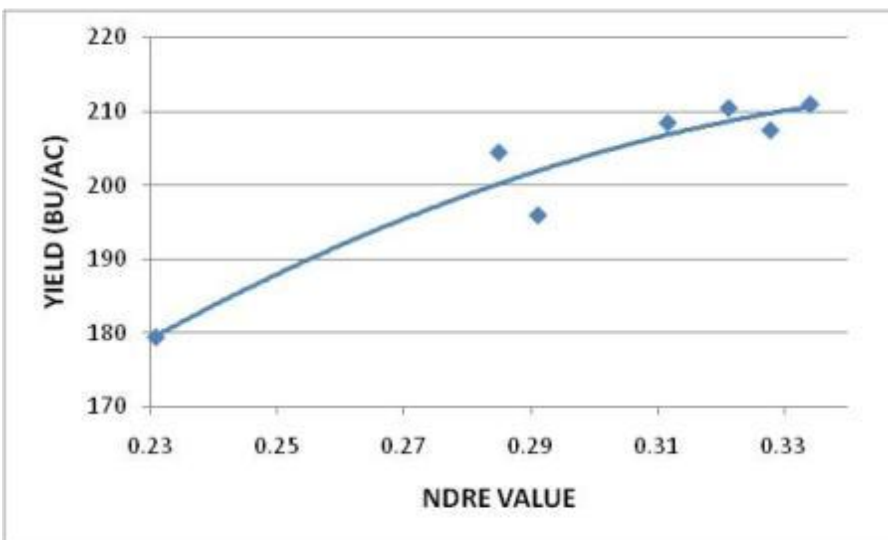

Figure 11. The relationship between yield and NDRE in field 1 at Oakes, ND, in 2010.

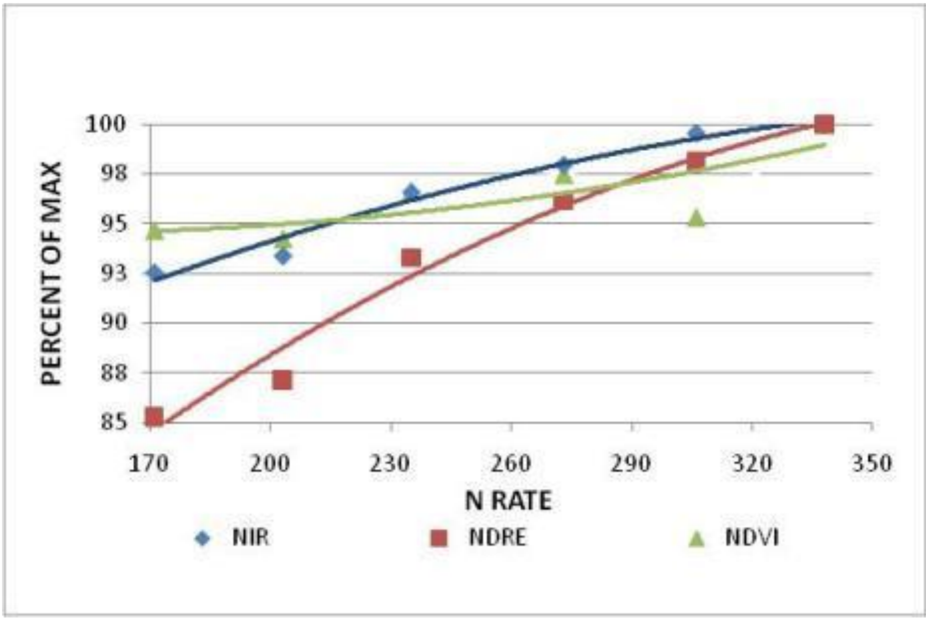

Figure 12. The percent of red edge, near infrared (NIR), normalized Difference red edge (NDRE) and normalized difference vegetative index (NDVI) compared to N rate in field 1 at Oakes, ND, in 2010.

APPENDIX A

Sources of vegetable seeds

Seed Company	Company Name
BE	Bejo Seeds
CR	Crookham Seeds
NU	Nunhems Seeds
SM	Seminis Seeds
SO	Solar Seeds

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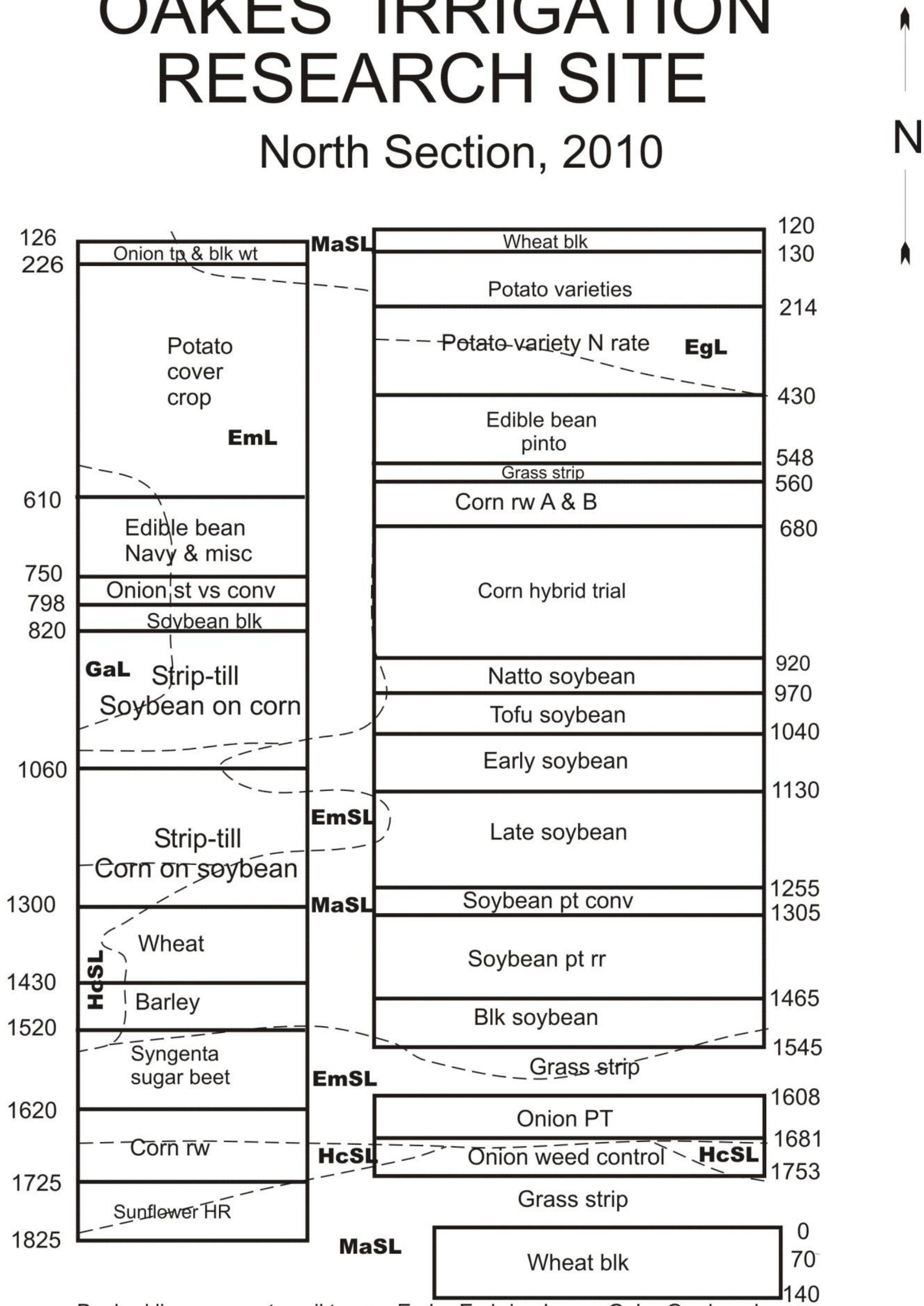
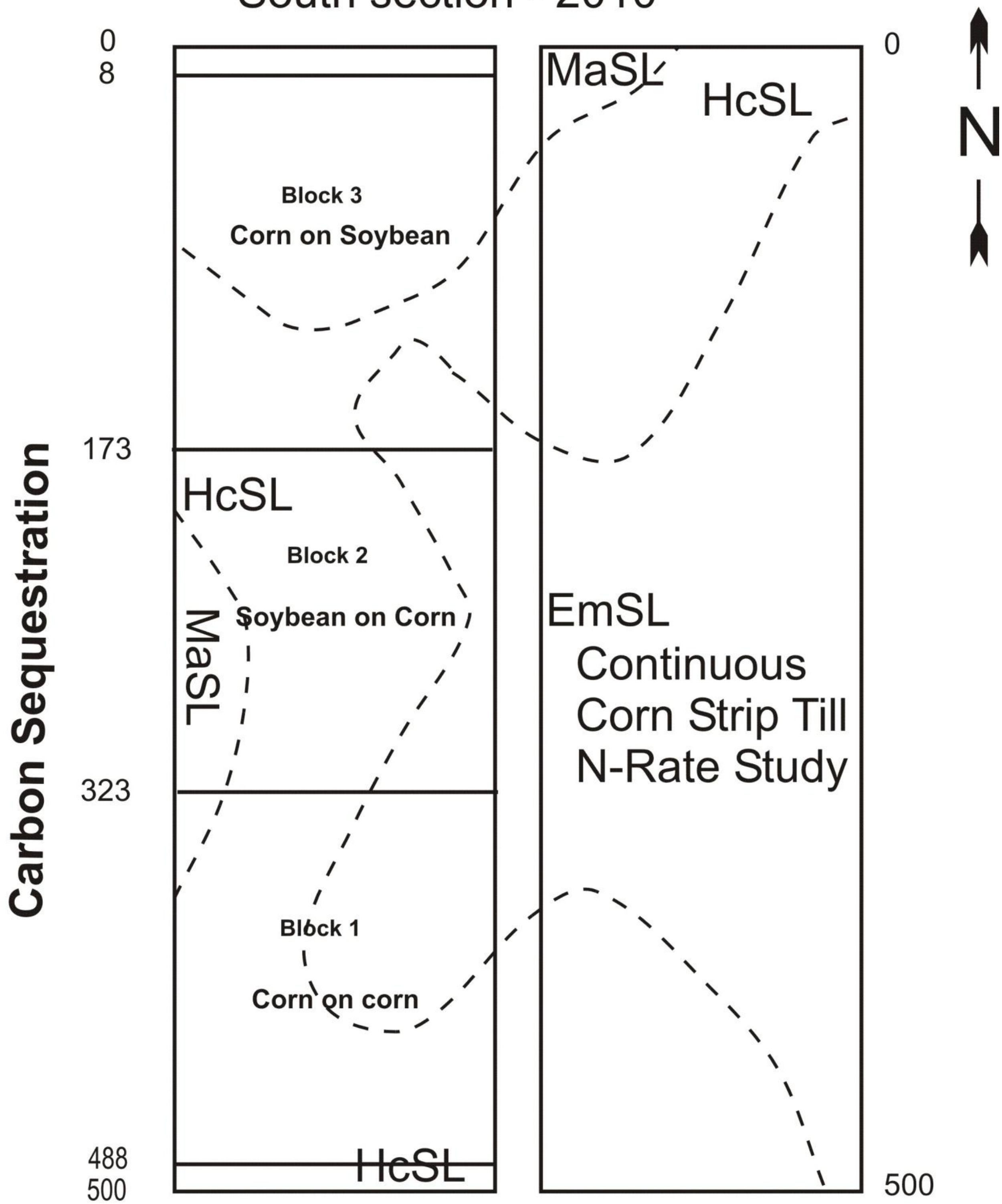
OAKES IRRIGATION RESEARCH SITE

North Section, 2010



Dashed lines separate soil types. EmL - Embden Loam; GaL - Gardena Loam; EmSL - Embden Sandy Loam; EgL - Egeland Loam; HcSL - Hecla Sandy Loam; MaSL - Maddock Sandy Loam

OAKES IRRIGATION RESEARCH SITE
South section - 2010



Dashed lines separate soil types. MaSL - Maddock Sandy Loam; HcSL - Hecla Sandy Loam; EmSL - Embden Sandy Loam.

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