Langdon Research Extension Center

NORTH DAKOTA STATE UNIVERSITY

Annual Research Report No. 94

December 2019

NDSU NORTH DAKOTA STATE UNIVERSITY

NDSU Research and Extension Faculty and Staff Involved with the Langdon Research Extension Center

Randy Mehlhoff	Director
Bryan Hanson	Research Agronomist
Dr. Venkat Chapara	Assistant Research Professor/Plant Pathology
Naeem Kalwar	Extension Soil Health Specialist
Lesley Lubenow	Extension Cropping Systems Specialist
Sara Schuchard-McGregor	Administrative Assistant
Travis Hakanson	Research Specialist/Agronomy
Lawrence Henry	Research Specialist/Agronomy
James Chaput	Research Technician/Foundation Seed
Amanda Arens	Research Specialist/Plant Pathology
Carmen Ewert	Research Technician/Foundation Seed
Jeremiah Halley	Farm Business Management Instructor, LRSC
Dr. Anitha Chirumamilla	Cavalier County Extension Agent
Macine Lukach	Cavalier County Extension Agent (retired May 2019)

2019 Seasonal/Temporary Employees

Ben Girodat	Triton Kaercher	Hulda Mbe	Jayden Romfo	Natalie Eversvik	
Traci Murphy	Jolena Lowery	Jacob Kram	Nancy Feil	Janet Hall	Logan Feil

Langdon Research Extension Center Advisory Board

Dr. Anitha Chirumamilla	Cavalier County Extension Agent
Reily Bata	Producer, Langdon, ND
Jon Iverson	Producer, Langdon, ND
Shannon Duerr	Cavalier County JDA
Leon Hiltner	Producer, Wales, ND
Janet Jacobson	Producer, Wales, ND
Bruce Lewallen	Producer, Bisbee, ND
David Monson	Producer, Osnabrock, ND, ND District 10 Representative
Scott Nelson	Producer, Lakota, ND
Chuck Damschen	Producer, Hampden, ND, ND District 10 Representative
Kent Schluchter	Producer, Cavalier, ND
Aaron Johnson	Producer, Edmore, ND, NDCISA NE District Board Member
Julie Zikmund	SBARE Member
Janne Myrdal	Producer, Edinburg, ND, ND District 10 Senator
Cameron Mickelson	Producer, Rolla, ND

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NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

NDSU | EXTENSION

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*Corn and sunflower trials were not harvested due to snow damage. Please see our website for prior years' data: https://www.ag.ndsu.edu/langdonrec/archived-variety-performance-data1 .

The 2019 annual research report is intended to provide producers information to aid in selecting varieties and/or hybrids. Variety information and research reports on crop disease and production can also be found on our website www.ag.ndsu.edu/langdonrec/. Variety trial results from all NDSU Research Extension Centers and the Main Station at Fargo, along with crop extension bulletins, can be accessed on the web at www.ag.ndsu.edu/varietytrials/.

Choosing a variety is one of the most important decisions a producer makes in successful crop production. Characteristics to consider in selecting a variety may include yield potential, disease resistance, protein content, straw strength, plant height, test weight, yield stability across years and locations, quality and economic profitability. A variety's performance may differ from year to year and from location to location within a year due to varying environmental conditions. When selecting a variety to grow, it is best to consider a variety's performance over several years and locations.

The agronomic data presented in this publication are from replicated research plots using experimental designs that enable the use of statistical analysis. The trials are designed so that "real" yield and agronomic differences can be statistically separated from differences that occur by chance. The least significant difference (LSD) values given in the report are used for this purpose. For example, if the LSD 10% is five bushels, then if the difference between any two varieties is greater than five bushels they are said to be significantly different from one another 90 times out of 100 under those growing conditions. If the difference between two varieties is less than five bushels, they are not significantly different from one another. If there is a "NS" for the LSD 10% value it means there was no real difference between any varieties or the trial was too variable to detect a real difference. The CV stands for coefficient of variation and is expressed as a percentage. The CV is a measure of variability in the trial. Large CVs mean that a large amount of variation could not be attributed to differences in the varieties or agronomic characteristic.

The NDSU Langdon Research Extension Center, in addition to its on-station research program, conducted variety research trials at several locations in 2019. Trial locations were at Cavalier, Park River, Pekin, and Cando. These locations are in cooperation with a local farmer, NDSU Extension, and the County Crop Improvement Association.

2019 Weather Summary

The 2019 growing season precipitation averaged 103 percent of normal across NE North Dakota. The northern counties along the Canadian border had below normal precipitation in April and May. Some areas along this region continued to have lower precipitation levels thru August resulting in lower yields in some crops. Stored subsoil moisture in 2018 varied but was generally lower than normal. Fall recharge at Langdon for September through October 2018 was 4.02 inches, 0.72 inches above normal. Precipitation from November 2018 through March 2019 was 3.59 inches, 0.13 inches below normal. Snowfall for 2018-2019 was 52.6 inches, 17 inches above normal. Winter temperatures averaged 7.7^{o} F, 4.3^{o} F below normal. Accumulated growing degree days averaged 75 and 147 below normal for corn and small grains, respectively, across NDAWN locations in the region. Disease levels were generally lower this year with the drier conditions. Yields for small grains, canola, soybeans and other crops were generally average or below depending on rainfall. Harvesting in September and October posed monumental problems for producers with high rainfall, cold temperatures and a blizzard on October 10-13 resulting in 20 plus inches of snow in many areas. Soybean harvest was delayed, in many instances, until the ground was frozen. There were many quality issues for the crops and a number of fields were left unharvested before winter set in.

2019 Crop Management - Langdon					
Field Trial	**Previous Crop**	**Seeding Rate Unit/Acre**	**Planting Date**	**Harvest Date**	**Row Spacing**
Barley	soybean	1.25 million pls	May 7	Aug. 21	6
Canola - LL, CL, SU	barley	610,000 pls	May 17	Sept. 6	6
Canola - RR	barley	610,000 pls	May 17	Sept. 6	6
Corn	barley	28,000 thinned	May 14	*	30
Durum	soybean	1.50 million pls	May 7	Aug. 21	6
Dry Bean	barley	70,000-90,000 pls	May 20	Oct. 9	30
Faba Bean	barley	192,000 pls	May 8	Aug. 29	6
Field Pea	barley	300,000 pls	May 8	Aug. 16	6
Flax	barley	2.8 million pls	May 14	Sept. 16	6
HRSW	soybean	1.50 million pls	May 7	Aug. 22	6
HRWW	canola	1.25 million pls	Sept. 10, 2018	Aug. 19	6
Hemp	barley	522,000 pls	May 28	Sept. 18	12
Oats	soybean	1.0 million pls	May 7	Aug. 21	6
Rye	canola	1.0 million pls	Sept. 18, 2018	Aug. 19	6
Soybean – Conv./LL	barley	200,000 pls	May 20	Oct. 9	6
Soybean – RR, Xtend, E3	barley	200,000 pls	May 20	Oct. 9	6
Sunflower - Confection	wheat	17,000 thinned	May 15	*	30
Sunflower - Oil	wheat	20,000 thinned	May 15	*	30

pls=pure live seed emergence
*Trial not harvested due to snow damage.

Special thanks to our local cooperators and Extension Agents for their efforts in our off-station variety testing.

Darin Weisz - Cando
Lindy Berg - Towner County Extension Agent
Dave Hankey - Park River
Brad Brummond - Walsh County Extension Agent
Kent Schluchter - Cavalier
Doug Stein - McVille
Katelyn Hain - Nelson County Extension Agent
Lesley Lubenow - LREC Extension Cropping Systems Specialist

2019 Crop Management – Off-Station					
Location (County/Field Trial)	**Previous Crop**	**Seeding Rate Unit/Acre**	**Planting Date**	**Harvest Date**	**Row Spacing**
Cavalier (Pembina)					
HRSW	corn	1.50 million pls	May 10	Aug. 20	6
Soybean	corn	200,000 pls	May 23	Nov. 5	6
Park River (Walsh)					
HRSW	cover crop	1.50 million pls	May 3	Aug. 20	6
Soybean	wheat	200,000 pls	May 21	Nov. 7	6
Pekin (Nelson)					
HRSW	soybean	1.50 million pls	May 13	Aug. 30	6
Soybean	wheat	200,000 pls	May 23	Oct. 31	6
Cando (Towner)					
HRSW	soybean	1.50 million pls	May 9	Aug. 29	6
Durum	soybean	1.50 million pls	May 9	Aug. 29	6

Location	**Soil Type**
Cavalier	Fargo silty clay
Park River	Glyndon silt loam, soybean – Bearden silty clay loam
Pekin	Svea-Cresbard loam
Cando	Great Bend Overly silt loam

pls = pure live seeds

Record of Climatological Observation
Langdon, ND

	Precipitation		Dep. from		Temperature		Dep. from
	Normal*	2019	Normal		Normal*	2019	Normal
April	1.22	0.82	-0.4	April	38.1	37.8	-0.3
May	2.28	1.75	-0.53	May	51.6	48.3	-3.3
June	3.26	3.03	-0.23	June	60.9	61.7	+0.8
July	2.9	2.22	-0.68	July	66.2	67.0	+0.8
August	2.59	3.64	1.05	August	64.5	63.1	-1.4
September	2.10	6.51	+4.41	September	54.5	55.7	+1.2
Total	14.35	17.97	+3.62	Total	56.0	55.6	-0.4

*118 year average

Monthly Growing Degree Days and Normals-Langdon

	Wheat Growing Degree Days			Corn Growing Degree Days			Sunflower Growing Degree Days		
	2019	Normal	Deviation	2019	Normal	Deviation	2019	Normal	Deviation
April	255	274	-19	--	--	--	--	--	--
May	539	613	-74	182	219	-37	274	314	-40
June	864	875	-11	398	356	+42	564	519	+45
July	1034	1018	+16	523	499	+24	705	685	+20
August	905	962	-57	420	457	-37	582	642	-60
September	657	671	-14	232	255	-23	355	358	-3
Total	4254	4413	-159	1755	1786	-31	2480	2518	-38

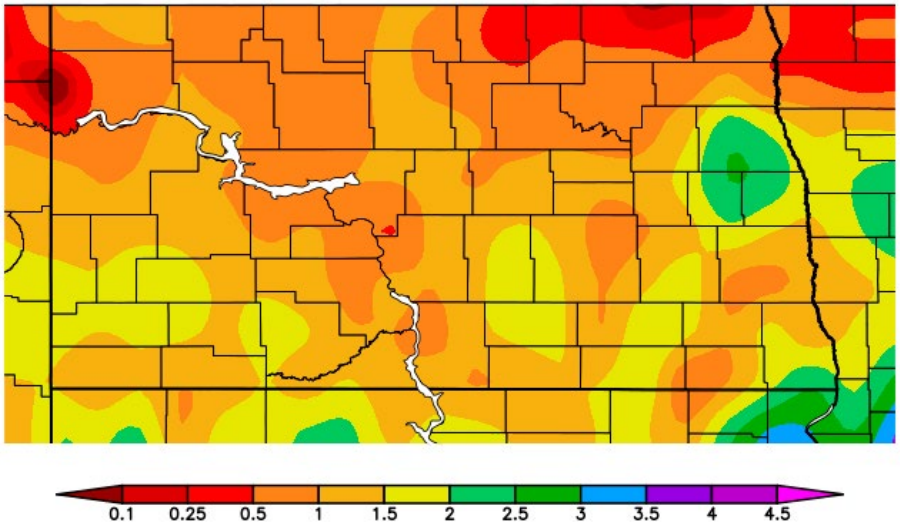
Frost Dates-Langdon and Selected Cities

	Last Spring Frost		First Fall Frost		Frost Free Days	
Langdon	32°F	28°F	32°F	28°F	32°F	28°F
Normal	20-May	9-May	19-Sep	29-Sep	122	143
2019	17-May	17-May	3-Oct	10-Oct	139	146
Cavalier						
Normal	16-May	5-May	24-Sep	5-Oct	131	153
2019	17-May	10-May	10-Oct	24-Oct	146	167
Park River						
Normal	8-May	30-Apr	30-Sep	10-Oct	145	163
2019	10-May	10-May	10-Oct	24-Oct	153	167
Pekin						
Normal	18-May	3-May	22-Sep	30-Sep	127	150
2019	20-May	10-May	2-Oct	11-Oct	135	154

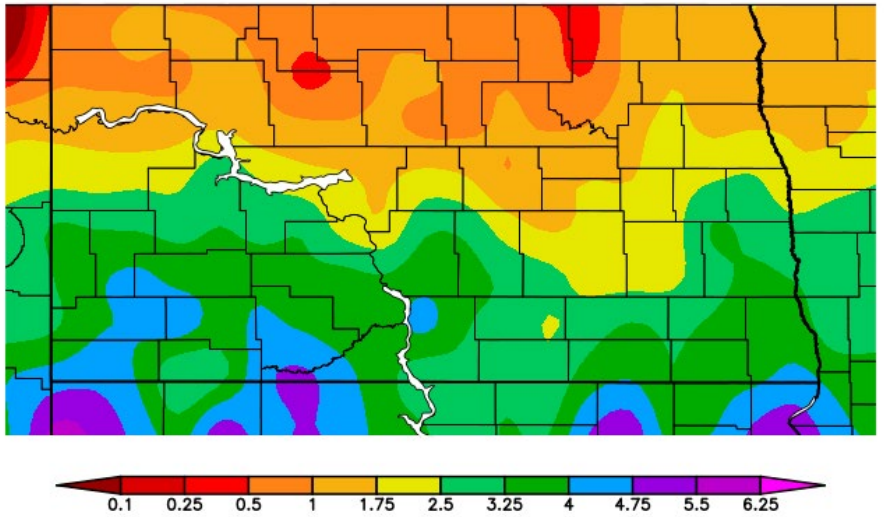
Normals are from the NWS. The 2019 frost dates are from the nearest reporting NDAWN station.

North Dakota 2019 Precipitation (inches) Maps

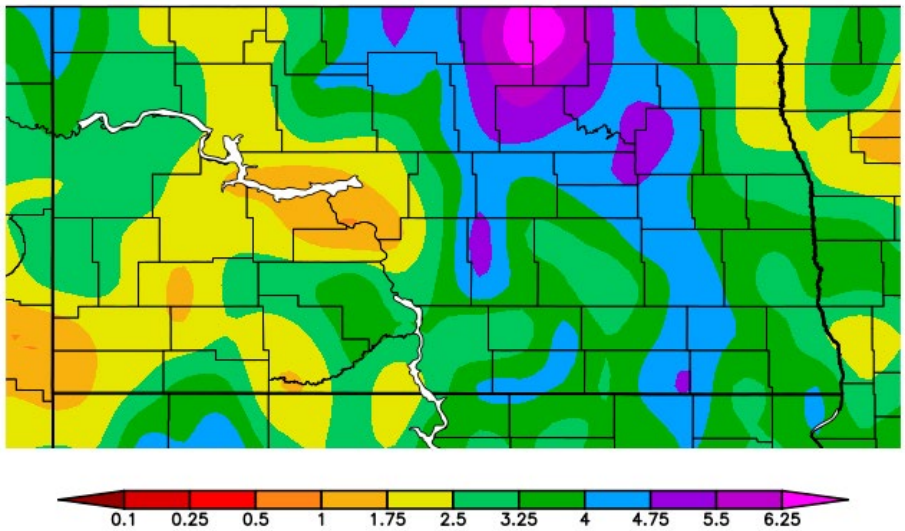
4/1/19 – 4/30/19



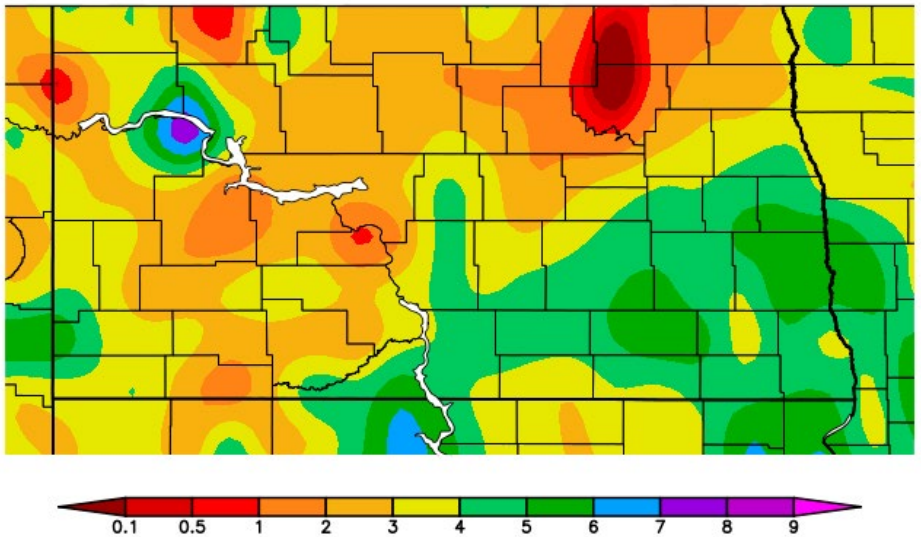
5/1/19 – 5/31/19



6/1/19 – 6/30/19

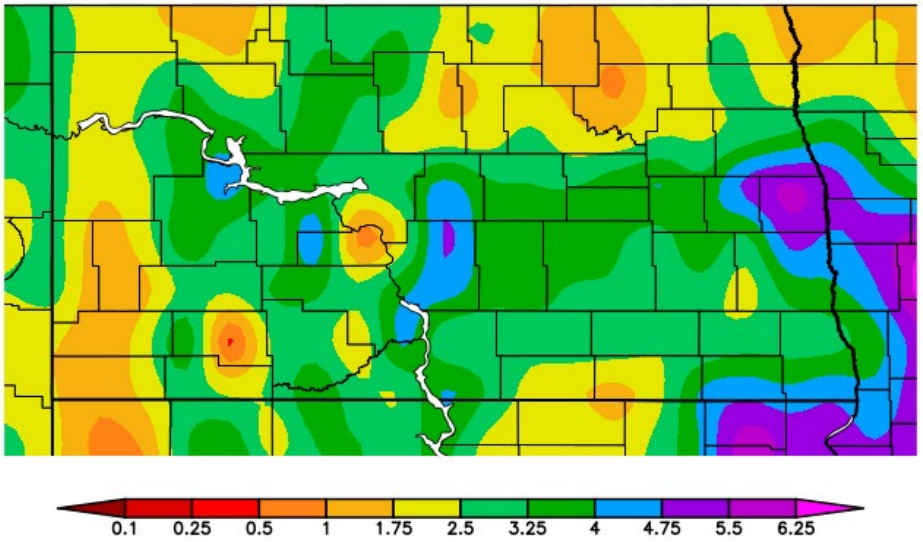


7/1/19 – 7/31/19

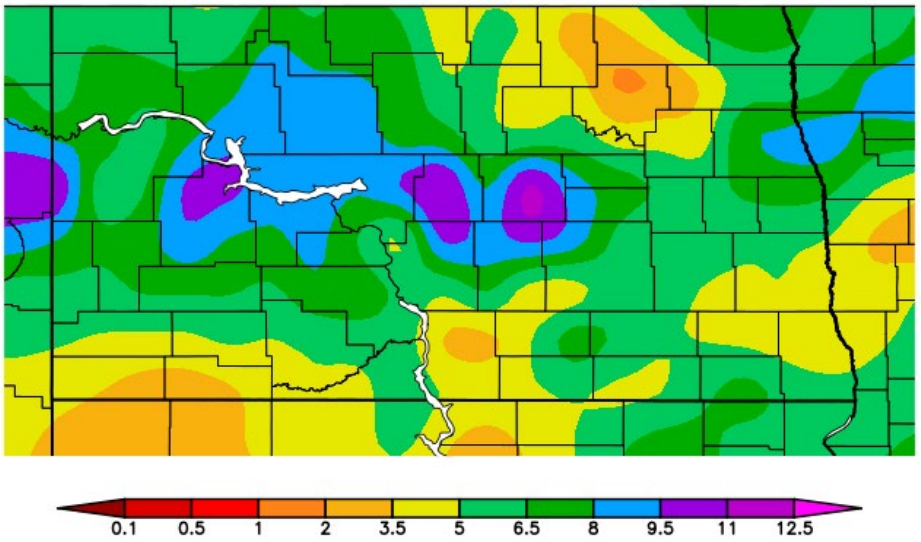


North Dakota 2019 Precipitation (inches) Maps Continued

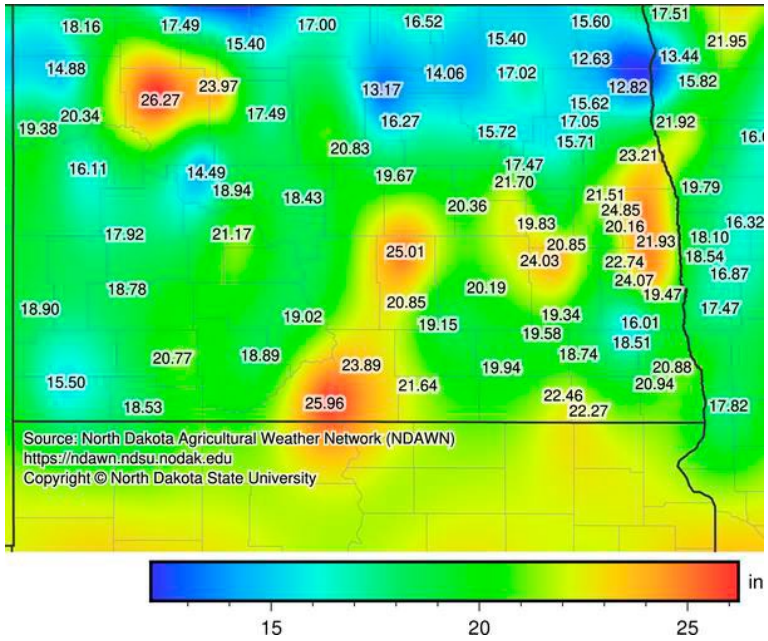
8/1/19 – 8/31/19

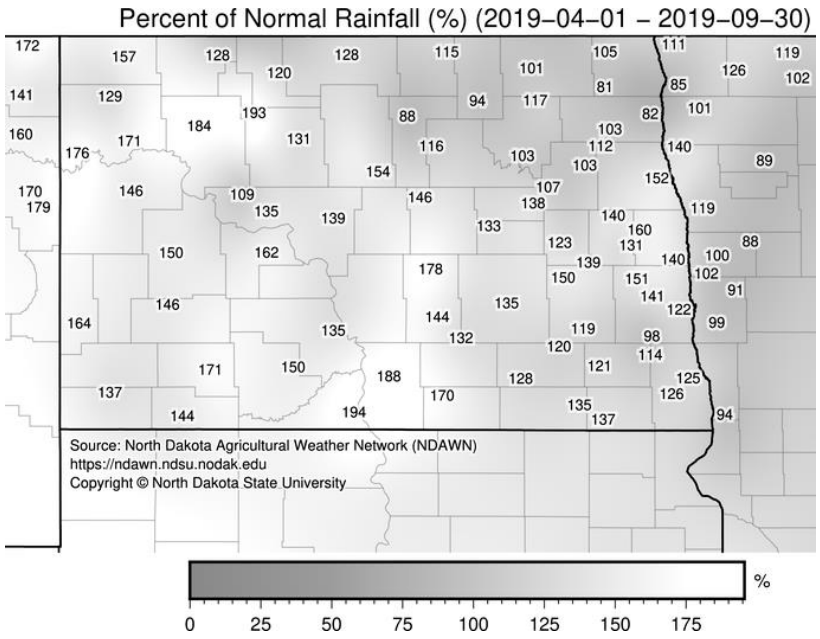


9/1/19 – 9/30/19

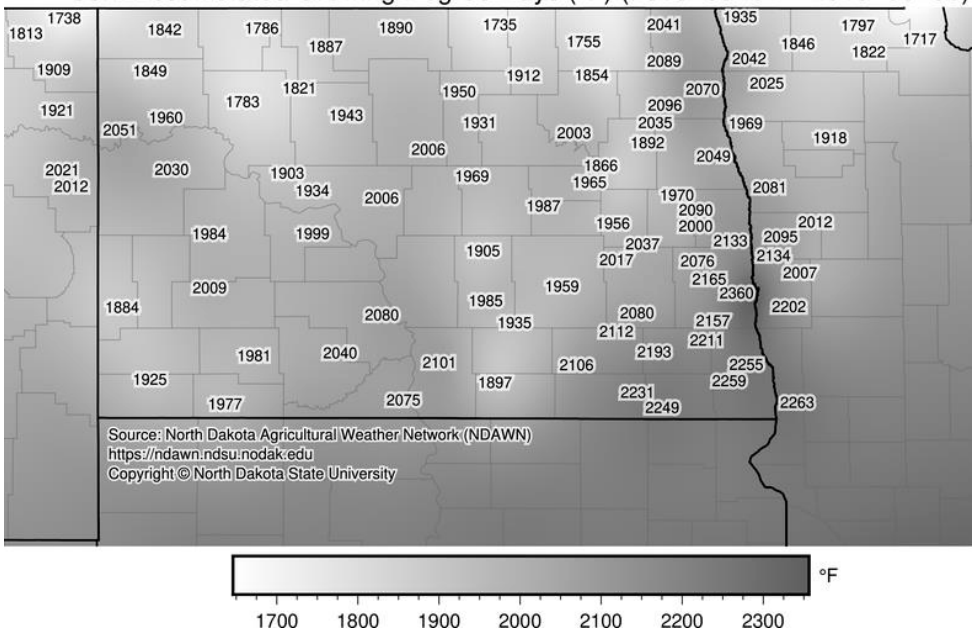


Growing Season 4/1/19 – 9/30/19

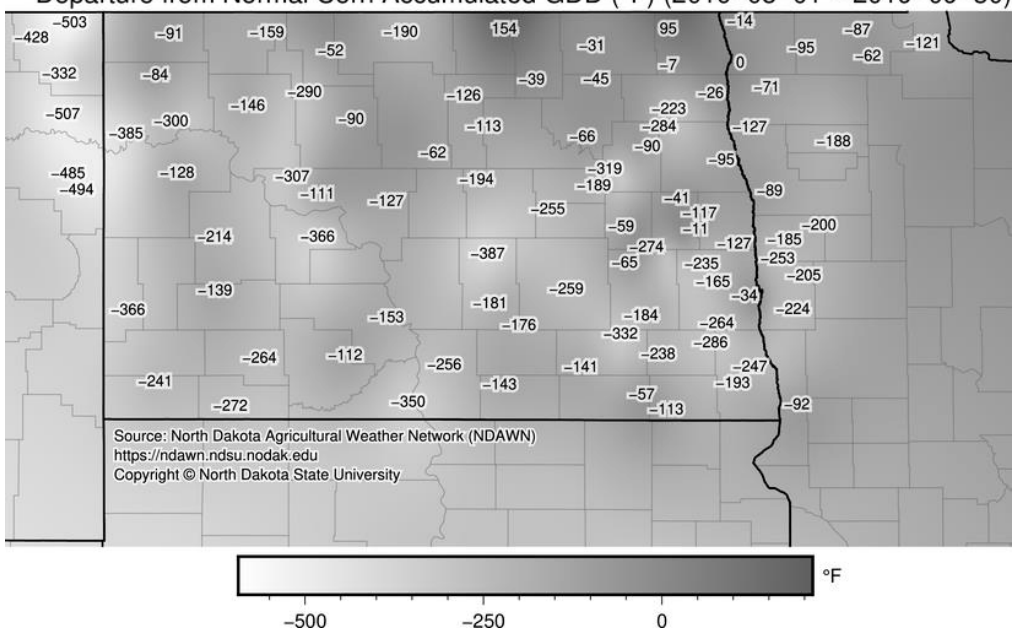




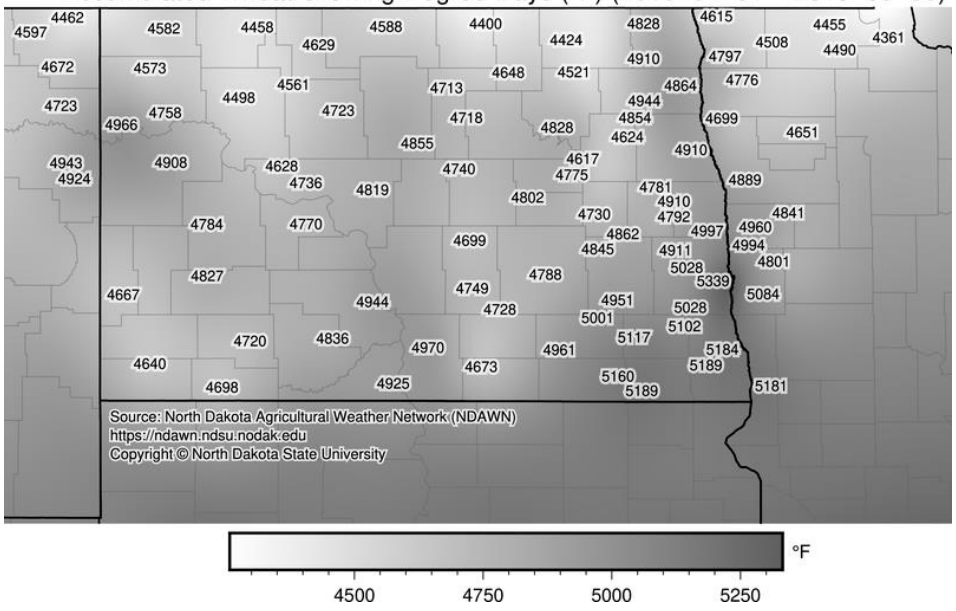
Corn Accumulated Growing Degree Days (°F) (2019–05–01 – 2019–09–30)



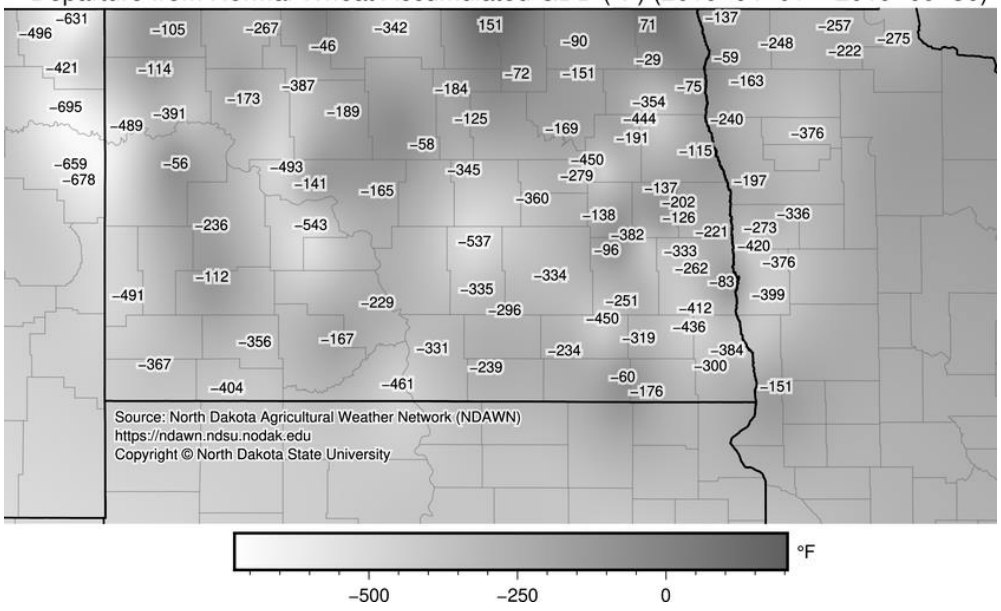
Departure from Normal Corn Accumulated GDD (°F) (2019–05–01 – 2019–09–30)



Accumulated Wheat Growing Degree Days (°F) (2019–04–01 – 2019–09–30)



Departure from Normal Wheat Accumulated GDD (°F) (2019–04–01 – 2019–09–30)



Durum Summary, Langdon 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Lodging (0-9)					Height (in)					Days to Head				
Variety	**15**	**16**	**17**	**18**	**19**	**5yr**	**15**	**16**	**17**	**18**	**19**	**5yr**	**11**	**15**	**16**	**17**	**4yr**	**16**	**17**	**18**	**19**	**4yr**	**16**	**17**	**18**	**19**	**4yr**
AC Commander	59	45	70	75	65	63	57.7	52.5	57.8	61.0	58.8	57.6	0.0	1.0	3.8	1.8	1.7	35	37	28	30	33	62	61	53	57	58
Alkabo	70	51	71	81	67	68	61.6	56.6	61.0	61.4	60.2	60.2	0.7	0.5	5.8	1.3	2.1	39	43	35	34	38	62	61	56	57	59
Ben	72	45	66	76	68	65	61.7	55.3	60.3	62.3	60.7	60.1	0.4	2.3	6.2	4.0	3.2	41	46	36	35	40	62	60	52	57	58
Grenora	77	41	69	87	70	69	61.3	54.2	59.7	62.1	59.1	59.3	1.1	0.8	6.7	5.8	3.6	39	43	33	32	37	62	60	52	56	58
Lebsock	72	53	78	77	70	70	61.7	57.2	61.3	63.0	61.1	60.9	0.3	3.8	5.7	3.8	3.4	40	45	33	33	38	61	60	52	56	57
Maier	74	37	77	80	69	67	61.5	53.7	60.5	61.5	60.9	59.6	0.2	0.5	5.0	4.8	2.6	38	44	33	34	37	62	61	52	57	58
Mountrail	80	38	81	87	68	71	60.7	54.4	60.0	62.3	58.5	59.2	0.1	2.0	7.2	5.0	3.6	41	44	34	34	38	63	60	52	58	58
Pierce	73	41	76	91	70	70	61.9	56.7	61.5	62.7	60.9	60.7	0.4	3.0	6.6	5.3	3.8	43	46	35	33	39	62	60	52	57	58
Strongfield	65	33	63	77	64	60	59.6	53.2	58.9	61.5	60.1	58.7	0.2	3.8	6.4	4.5	3.7	39	43	33	34	37	62	61	52	58	58
Tioga	76	37	70	89	69	68	61.5	53.2	60.3	62.2	60.5	59.5	1.2	0.3	6.4	6.0	3.5	41	48	37	36	41	63	61	54	57	59
Carpio	85	43	79	93	70	74	61.3	55.6	61.7	62.6	61.1	60.5	0.0	1.0	7.6	6.5	3.8	40	45	36	34	39	63	62	54	59	60
Alzada	61	37	47	55	59	52	57.6	51.4	55.3	59.9	58.7	56.6	0.3	0.0	3.0	0.3	0.9	34	36	28	29	32	57	56	52	56	55
Joppa	82	43	75	90	75	73	61.3	55.4	60.5	62.3	60.9	60.1	0.7	0.5	6.9	6.8	3.7	40	44	35	34	38	64	61	52	58	59
Divide	78	35	78	89	68	70	61.0	53.6	60.7	61.6	59.9	59.4	0.3	1.8	6.9	6.3	3.8	41	47	37	34	40	64	61	54	58	59
CDC Verona	70	36	72	80	67	65	59.8	55.5	60.8	61.7	60.2	59.6	0.4	0.8	5.7	6.0	3.2	41	45	34	34	39	64	62	53	58	59
Rugby	66	32	61	76	63	60	61.4	54.3	60.2	61.8	60.3	59.6	0.3	4.0	7.0	8.0	4.8	42	48	38	36	41	61	60	53	57	58
VT Peak	75	55	85	82	72	74	62.5	58.6	62.4	62.4	61.7	61.5	--	0.5	4.3	4.3	--	40	45	34	35	39	62	60	52	57	58
ND Grano	80	41	78	84	70	70	61.4	55.6	61.0	62.1	60.7	60.2	--	0.8	6.4	5.0	--	40	45	34	35	39	64	62	54	59	60
ND Riveland	78	53	88	89	71	76	61.3	56.4	61.5	62.0	60.3	60.3	--	1.8	5.9	3.3	--	43	46	36	35	40	63	61	53	58	59
TCG Webster	--	--	--	69	71	--	--	--	--	62.0	59.8	--	--	--	--	--	--	--	--	27	28	--	--	--	50	54	--
AC Navigator	52	35	69	--	--	--	58.0	52.9	59.9	--	--	--	0.5	0.8	4.1	2.8	2.1	35	41	--	--	--	60	61	--	--	--
Trial Mean	73	40	74	84	70		61.2	55.1	60.7	62.2	60.5		0.6	1.7	6.1	5.9		40	45	35	34		63	62	53	58	
C.V. %	7.5	11.1	7.0	8.4	5.6		1.0	1.5	1.1	0.8	0.8		168	114	14.9	31.8		4.1	4.0	5.1	3.5		1.1	1.6	2.9	1.0	
LSD 5%	7.6	6.3	7.2	9.8	5.5		0.9	1.2	0.9	0.7	0.7		1.4	NS	1.3	2.6		2.3	2.5	2.5	1.7		0.9	1.4	2.2	0.8	
LSD 10%	6.4	5.3	6.0	8.2	4.6		0.7	1.0	0.8	0.6	0.6		--	2.2	1.1	2.2		1.9	2.1	2.1	1.4		0.8	1.2	1.8	0.7	

2016 trial was severely damaged by Fusarium head blight.
No lodging in 2019 and disease pressure was minimal.

Durum Summary, Towner County 2014-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Height (in)					Days to Head				
Variety	**14**	**15**	**16**	**18**	**19**	**3yr**	**14**	**15**	**16**	**18**	**19**	**3yr**	**15**	**16**	**18**	**19**	**3yr**	**15**	**16**	**18**	**19**	**3yr**
Alkabo	52	52	73	65	70	69	56.2	59.8	58.6	61.8	57.9	59.4	33	38	37	38	38	64	61	57	57	58
Tioga	50	57	63	68	75	69	55.1	59.1	54.8	61.6	58.1	58.2	37	41	37	40	39	66	61	57	59	59
Divide	51	61	64	62	70	65	55.6	59.7	56.2	61.5	58.5	58.7	36	39	37	39	38	65	62	58	59	60
Carpio	55	62	70	62	74	69	56.1	60.7	58.9	61.9	59.2	60.0	37	39	36	39	38	66	63	57	61	60
Joppa	56	60	73	69	77	73	55.4	59.9	56.8	62.0	58.1	59.0	35	37	35	39	37	64	61	57	58	59
ND Grano	--	--	71	67	72	70	--	--	58.2	62.6	57.7	59.5	--	39	35	38	37	--	63	56	59	59
ND Riveland	--	--	79	74	80	78	--	--	58.5	61.4	58.5	59.5	--	40	36	40	39	--	62	56	58	59
Lebsock	58	61	--	--	--	--	56.5	62.7	--	--	--	--	35	--	--	--	--	63	--	--	--	--
Trial Mean	54	59	72	67	74		55.8	60.3	57.7	61.8	58.3		35	39	36	39		64	62	57	59	
C.V. %	9.4	9.2	4.5	7.9	6.5		1.4	3.2	1.9	0.8	1.7		4.5	2.8	4.6	2.3		2.3	1.4	1.2	1.2	
LSD 5%	NS	NS	4.7	7.8	NS		NS	NS	1.6	0.7	NS		2.4	1.6	NS	1.3		2.3	NS	1.0	1.0	
LSD 10%	NS	NS	3.9	6.5	5.9		NS	NS	1.3	0.6	NS		2.0	1.3	NS	1.1		1.9	1.1	0.8	0.8	

Average Data by Crop and Year Across Sites

Durum	Yield (bu/a)						Test Weight (lbs/bu)						Height (in)						Days to Head					
No. Sites	**2**	**2**	**1**	**2**	**2**	**5**	**2**	**2**	**1**	**2**	**2**	**5**	**2**	**2**	**1**	**2**	**2**	**5**	**2**	**2**	**1**	**2**	**2**	**5**
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**
Alkabo	61	62	71	73	69	71	60.7	57.6	61.0	61.6	59.1	60.6	36	39	43	36	36	38	64	62	61	57	57	58
Tioga	67	50	70	79	72	74	60.3	54.0	60.3	61.9	59.3	60.5	39	41	48	37	38	41	65	62	61	56	58	58
Divide	70	50	78	76	69	74	60.4	54.9	60.7	61.6	59.2	60.5	38	40	47	37	37	40	65	63	61	56	59	59
Carpio	74	57	79	78	72	76	61.0	57.3	61.7	62.3	60.2	61.4	38	40	45	36	37	39	66	63	62	56	60	59
Joppa	71	58	75	80	76	77	60.6	56.1	60.5	62.2	59.5	60.7	38	39	44	35	37	39	64	63	61	55	58	58
ND Grano	--	--	78	76	71	75	--	--	61.0	62.4	59.2	60.9	--	--	45	35	37	39	--	--	62	55	59	59
ND Riveland	--	--	88	82	76	82	--	--	61.5	61.7	59.4	60.9	--	--	46	36	38	40	--	--	61	55	58	58
Lebsock	67	--	--	--	--	--	62.2	--	--	--	--	--	37	--	--	--	--	--	63	--	--	--	--	--

Average Data by Crop and Year Across Sites

HRSW	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)						Height (in)					Days to Head					Lodging			
No. Sites	5	5	5	4	5	14	5	5	5	4	5	14	5	5	5	4	5	14	5	4	4	5	13	4	4	4	5	13	5	3	4	12
Variety	15	16	17	18	19	3yr	15	16	17	18	19	3yr	15	16	17	18	19	3yr	16	17	18	19	3yr	16	17	18	19	3yr	16	17	19	3yr
Faller	60	76	84	86	85	85	58.2	59.4	60.7	61.8	59.5	60.7	13.9	13.6	12.9	13.6	13.9	13.5	36	36	33	33	34	55	55	51	55	54	2.7	1.3	2.2	1.8
Linkert	63	66	67	68	69	68	59.4	58.7	60.1	61.4	59.4	60.3	15.0	14.6	14.8	14.9	15.3	15.0	31	31	28	29	29	56	53	52	54	53	0.2	0.1	0.0	0.1
SY Ingmar	62	70	71	74	78	74	60.1	59.6	60.0	62.3	60.2	60.8	14.7	14.8	14.5	14.8	14.4	14.6	33	34	29	29	31	57	54	51	52	52	1.4	0.1	0.1	0.1
Bolles	55	64	73	70	73	72	58.3	58.5	60.2	61.1	59.2	60.2	15.8	15.7	15.4	15.5	15.9	15.6	34	35	32	31	33	58	56	53	55	55	1.8	0.0	0.9	0.5
SY Valda	62	75	81	86	80	82	58.8	59.4	60.1	61.6	59.5	60.4	14.0	13.9	13.5	13.6	13.5	13.5	34	34	29	29	31	57	53	51	53	52	1.8	0.6	1.6	1.1
CP3530	65	77	81	83	78	81	59.0	59.8	60.4	61.5	59.3	60.4	14.1	14.2	13.9	14.1	14.9	14.3	37	37	34	35	35	57	55	53	55	54	2.4	0.1	1.9	1.0
Shelly	--	73	82	80	79	80	--	58.7	61.5	62.1	59.5	61.0	--	13.9	13.5	13.6	14.0	13.7	33	34	30	30	31	58	54	52	55	54	1.3	0.1	0.9	0.5
ND VitPro	--	64	69	71	75	72	--	61.2	62.1	63.0	61.7	62.3	--	14.8	14.6	14.7	15.2	14.8	35	36	32	32	33	55	52	50	52	51	1.4	0.3	1.1	0.7
Lang-MN	--	--	74	74	74	74	--	--	62.4	61.9	60.6	61.6	--	--	14.9	14.8	15.4	15.0	--	39	34	34	36	--	56	53	55	55	--	0.1	3.0	--
LCS Rebel	--	--	79	78	79	79	--	--	62.0	62.6	60.7	61.8	--	--	13.8	14.1	14.6	14.2	--	38	33	33	35	--	52	49	52	51	--	1.3	2.2	--
CP3888	--	--	--	77	75	--	--	--	--	60.9	58.5	--	--	--	--	13.9	14.4	--	--	--	30	30	--	--	--	51	53	--	--	--	0.3	--
LCS Trigger	--	--	--	88	89	--	--	--	--	62.0	59.8	--	--	--	--	11.8	12.1	--	--	--	34	34	--	--	--	55	58	--	--	--	1.4	--
MS Barracuda	--	--	--	79	81	--	--	--	--	61.9	59.6	--	--	--	--	14.4	14.4	--	--	--	29	29	--	--	--	48	51	--	--	--	0.6	--
TCG-Climax	--	--	--	70	67	--	--	--	--	63.2	60.9	--	--	--	--	15.3	15.9	--	--	--	31	32	--	--	--	54	57	--	--	--	0.0	--
TCG-Spitfire	--	--	--	79	79	--	--	--	--	61.3	58.9	--	--	--	--	13.9	13.8	--	--	--	30	31	--	--	--	53	56	--	--	--	0.0	--
LCS Breakaway	57	69	72	--	74	--	56.8	60.4	61.1	--	60.6	--	14.6	14.3	14.0	--	14.5	--	32	34	--	29	--	55	52	--	52	--	1.4	0.4	1.2	0.8
MS Chevelle	--	--	83	--	82	--	--	--	60.2	--	59.1	--	--	--	12.8	--	13.2	--	--	34	--	31	--	--	52	--	52	--	--	1.2	2.0	--
CP3939	--	--	--	--	74	--	--	--	--	--	59.9	--	--	--	--	--	15.2	--	--	--	--	31	--	--	--	--	53	--	--	--	0.3	--
DG-Ambush	--	--	--	--	75	--	--	--	--	--	60.0	--	--	--	--	--	15.0	--	--	--	--	31	--	--	--	--	53	--	--	--	0.5	--
DG-Ballistic	--	--	--	--	88	--	--	--	--	--	59.3	--	--	--	--	--	13.9	--	--	--	--	33	--	--	--	--	54	--	--	--	1.4	--
DG-Commander	--	--	--	--	81	--	--	--	--	--	59.9	--	--	--	--	--	14.0	--	--	--	--	31	--	--	--	--	52	--	--	--	0.2	--
LCS Cannon	--	--	--	--	80	--	--	--	--	--	60.0	--	--	--	--	--	14.0	--	--	--	--	31	--	--	--	--	50	--	--	--	0.6	--
MN Washburn	--	--	--	--	73	--	--	--	--	--	59.6	--	--	--	--	--	14.5	--	--	--	--	30	--	--	--	--	55	--	--	--	0.1	--
SY McCloud	--	--	--	--	77	--	--	--	--	--	60.8	--	--	--	--	--	14.8	--	--	--	--	30	--	--	--	--	52	--	--	--	0.3	--
SY611CL2	--	--	--	--	79	--	--	--	--	--	60.7	--	--	--	--	--	14.0	--	--	--	--	28	--	--	--	--	52	--	--	--	0.2	--
TCG-Heartland	--	--	--	--	73	--	--	--	--	--	60.6	--	--	--	--	--	15.0	--	--	--	--	29	--	--	--	--	52	--	--	--	0.0	--
TCG-Stalwart	--	--	--	--	66	--	--	--	--	--	56.9	--	--	--	--	--	15.5	--	--	--	--	30	--	--	--	--	52	--	--	--	0.8	--
AP Murdock	--	--	--	--	80	--	--	--	--	--	58.8	--	--	--	--	--	14.0	--	--	--	--	30	--	--	--	--	53	--	--	--	1.1	--
Prosper	57	74	82	84	--	--	58.2	59.4	60.5	62.1	--	--	13.9	13.7	13.1	13.8	--	--	36	36	33	--	--	57	55	52	--	--	3.4	2.4	--	--
Rollag	63	68	73	69	--	--	60.1	59.9	61.4	61.9	--	--	15.2	14.8	14.7	15.1	--	--	33	33	30	--	--	55	54	51	--	--	1.2	0.1	--	--
CP3419	67	79	84	87	--	--	58.2	58.4	59.8	61.1	--	--	12.8	13.4	12.9	12.8	--	--	34	35	32	--	--	60	57	55	--	--	0.3	0.0	--	--
CP3504	65	69	72	80	--	--	56.9	57.3	57.9	60.6	--	--	13.3	13.5	13.5	13.1	--	--	32	32	29	--	--	57	55	52	--	--	0.5	0.0	--	--
CP3616	--	67	75	75	--	--	--	58.2	59.7	61.1	--	--	--	15.2	14.9	14.9	--	--	34	35	31	--	--	56	53	51	--	--	2.2	0.3	--	--
WB9590	--	--	73	80	--	--	--	--	59.6	62.0	--	--	--	--	14.2	14.4	--	--	--	30	27	--	--	--	52	50	--	--	--	0.1	--	--
WB9479	--	--	76	74	--	--	--	--	60.4	62.4	--	--	--	--	14.6	15.3	--	--	--	32	28	--	--	--	53	51	--	--	--	0.0	--	--
MS Camaro	--	--	70	70	--	--	--	--	60.4	61.6	--	--	--	--	13.8	14.1	--	--	--	32	28	--	--	--	53	50	--	--	--	0.6	--	--
WB9719	--	--	--	77	--	--	--	--	--	64.0	--	--	--	--	--	13.9	--	--	--	--	29	--	--	--	--	52	--	--	--	--	--	--
SY Soren	54	71	71	--	--	--	58.8	59.4	60.0	--	--	--	14.8	14.3	14.3	--	--	--	32	33	--	--	--	55	53	--	--	--	1.6	0.1	--	--
WB Mayville	55	60	66	--	--	--	58.1	57.5	58.9	--	--	--	14.7	14.6	14.4	--	--	--	31	32	--	--	--	55	52	--	--	--	0.5	0.0	--	--
Elgin-ND	59	67	78	--	--	--	58.2	58.8	60.6	--	--	--	14.4	14.5	14.0	--	--	--	38	41	--	--	--	56	52	--	--	--	2.1	1.0	--	--
SY Rowyn	61	72	79	--	--	--	59.3	59.5	60.4	--	--	--	14.0	13.9	13.4	--	--	--	33	33	--	--	--	55	53	--	--	--	2.3	2.0	--	--
Boost	--	63	76	--	--	--	--	58.6	60.3	--	--	--	--	14.9	14.1	--	--	--	35	37	--	--	--	59	56	--	--	--	3.1	1.3	--	--
Surpass	--	67	77	--	--	--	--	58.8	60.5	--	--	--	--	13.9	13.7	--	--	--	34	37	--	--	--	51	50	--	--	--	3.7	1.7	--	--
LCS Prime	--	69	82	--	--	--	--	59.7	61.3	--	--	--	--	13.2	12.5	--	--	--	35	37	--	--	--	54	52	--	--	--	2.8	0.8	--	--
CP3100	--	71	75	--	--	--	--	57.5	58.1	--	--	--	--	13.6	13.4	--	--	--	34	36	--	--	--	58	55	--	--	--	0.8	0.0	--	--

HRSW Summary, Langdon 2015-2019

	Days to Head						Height (in)						Lodging (0-9)		
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**16**	**17**	**2yr**
Barlow	61	55	56	46	55	52	36	35	41	34	32	36	3.9	1.8	2.9
Elgin-ND	61	57	58	48	55	54	38	39	43	36	33	37	2.6	0.0	1.3
Faller	62	57	59	50	57	55	36	38	39	33	31	34	3.7	0.0	1.9
Glenn	60	53	55	46	55	52	38	37	42	35	33	37	1.7	0.5	1.1
LCS Breakaway	60	55	56	46	54	52	33	33	35	30	27	31	1.8	0.0	0.9
SY Soren	61	56	58	48	55	54	32	33	34	28	27	30	1.9	0.0	1.0
Bolles	64	59	61	50	58	56	35	35	37	33	30	33	2.6	0.0	1.3
SY Ingmar	62	58	59	49	56	55	32	34	34	29	28	30	2.5	0.0	1.3
Linkert	62	57	58	50	56	55	31	32	31	29	27	29	0.6	0.0	0.3
MS Chevelle	60	54	57	46	55	53	34	34	37	31	31	33	2.8	0.0	1.4
Boost	63	59	60	51	59	57	36	35	38	33	31	34	3.5	0.0	1.8
SY Valda	62	57	58	49	56	54	33	35	35	30	27	31	0.8	0.0	0.4
CP3530	64	58	60	50	57	56	39	39	39	34	33	35	2.1	0.0	1.1
CP3504	62	58	60	50	57	56	33	32	34	30	29	31	0.8	0.0	0.4
Shelly	63	59	59	51	58	56	33	34	36	30	28	31	2.6	0.0	1.3
CP3616	--	57	58	49	56	54	--	34	35	31	30	32	2.6	0.0	1.3
TCG-Spitfire	--	61	60	51	59	57	--	33	34	31	30	32	1.2	0.0	0.6
Surpass	--	52	54	45	54	51	--	34	40	32	30	34	4.2	3.0	3.6
ND VitPro	--	56	57	48	55	53	--	35	37	33	31	34	2.0	0.0	1.0
Lang-MN	--	--	60	51	58	56	--	--	41	35	33	36	--	0.0	--
MS Camaro	--	--	58	48	54	53	--	--	33	28	27	29	--	0.0	--
LCS Rebel	--	--	57	46	55	53	--	--	41	34	31	35	--	0.0	--
LCS Trigger	--	--	62	53	61	59	--	--	39	35	32	35	--	0.0	--
TCG-Climax	--	--	63	52	60	58	--	--	38	31	31	33	--	0.0	--
DG-Ambush	--	--	56	47	54	52	--	--	36	31	30	32	--	0.0	--
SY McCloud	--	--	--	49	55	--	--	--	--	29	29	--	--	--	--
SY611CL2	--	--	--	49	55	--	--	--	--	29	28	--	--	--	--
MS Barracuda	--	--	--	45	54	--	--	--	--	29	28	--	--	--	--
CP3888	--	--	--	49	55	--	--	--	--	31	29	--	--	--	--
LCS Cannon	--	--	--	44	53	--	--	--	--	30	29	--	--	--	--
CP3910	--	--	--	--	54	--	--	--	--	--	27	--	--	--	--
CP3915	--	--	--	--	55	--	--	--	--	--	29	--	--	--	--
CP3939	--	--	--	--	55	--	--	--	--	--	30	--	--	--	--
DG-Ballistic	--	--	--	--	56	--	--	--	--	--	31	--	--	--	--
DG-Commander	--	--	--	--	55	--	--	--	--	--	30	--	--	--	--
TCG-Heartland	--	--	--	--	54	--	--	--	--	--	28	--	--	--	--
TCG-Stalwart	--	--	--	--	56	--	--	--	--	--	30	--	--	--	--
MN-Washburn	--	--	--	--	57	--	--	--	--	--	29	--	--	--	--
Mott	--	--	--	--	56	--	--	--	--	--	35	--	--	--	--
SY Longmire	--	--	--	--	56	--	--	--	--	--	29	--	--	--	--
SY Rockford	--	--	--	--	58	--	--	--	--	--	31	--	--	--	--
AP Murdock	--	--	--	--	56	--	--	--	--	--	28	--	--	--	--
Prosper	63	57	58	50	--	--	36	36	38	33	--	--	4.6	0.3	2.5
Rollag	61	56	58	49	--	--	32	35	35	29	--	--	1.8	0.0	0.9
CP3419	64	61	61	53	--	--	35	34	37	33	--	--	0.4	0.0	0.2
WB9653	62	58	59	49	--	--	32	31	34	29	--	--	1.8	0.0	0.9
CP3100	--	58	58	50	--	--	--	35	38	30	--		1.4	0.0	0.7
WB9479	--	--	57	49	--	--	--	--	33	28	--	--	--	0.0	--
WB9590	--	--	56	49	--	--	--	--	30	28	--	--	--	0.0	--
WB9719	--	--	59	51	--	--	--	--	34	30	--	--	--	0.0	--
DG-Caliber	--	--	60	50	--	--	--	--	30	26	--	--	--	0.0	--
AAC Brandon	--	--	--	49	--	--	--	--	--	32	--	--	--	--	--
AAC Penhold	--	--	--	51	--	--	--	--	--	29	--	--	--	--	--
AC Goodwin	--	--	--	49	--	--	--	--	--	32	--	--	--	--	--
TCG-Glenville	--	--	--	47	--	--	--	--	--	28	--	--	--	--	--
Prevail	60	56	56	--	--	--	35	37	39	--	--	--	1.3	0.0	0.7
WB Mayville	60	55	57	--	--	--	31	33	32	--	--	--	0.9	0.0	0.5
SY Rowyn	61	55	58	--	--	--	34	34	34	--	--	--	3.6	0.0	1.8
LCS Nitro	63	59	60	--	--	--	34	34	36	--	--	--	3.0	0.0	1.5
LCS Prime	60	55	56	--	--	--	36	35	38	--	--	--	2.4	0.0	1.2
LCS Anchor	--	57	57	--	--	--	--	32	34	--	--	--	2.7	0.0	1.4
TCG-Cornerstone	--	58	59	--	--	--	--	33	35	--	--	--	1.3	0.0	0.7
AKF-Astro	--	--	60	--	--	--	--	--	37	--	--	--	--	0.0	--
Trial Mean	61	57	58	49	56		35	36	37	31	30		2.6	0.1	
C.V. %	0.8	1.2	1.7	1.7	1.4		3.1	4.4	3.7	3.3	3.9		41.7	350	
LSD 5%	0.7	0.9	1.3	1.1	1.1		1.5	2.2	1.9	1.5	1.7		1.5	0.7	
LSD 10%	0.6	0.8	1.1	1.0	0.9		1.3	1.8	1.6	1.2	1.4		1.3	0.6	

No lodging in trial. Disease levels were minimal.

HRSW Summary, Langdon 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)					
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**
Barlow	74	60	74	85	76	78	62.1	60.0	61.5	62.6	62.3	62.1	14.1	14.8	13.8	14.2	14.4	14.1
Elgin-ND	73	65	81	89	81	84	60.8	59.2	61.1	61.7	60.7	61.2	13.6	14.9	13.5	13.6	13.9	13.7
Faller	74	79	82	98	84	88	60.5	60.8	61.5	62.3	60.4	61.4	12.3	13.6	11.7	12.7	13.7	12.7
Glenn	75	64	71	76	75	74	64.5	63.0	63.8	62.9	63.2	63.3	14.3	14.7	14.3	14.4	15.0	14.6
LCS Breakaway	74	71	75	85	76	79	62.2	61.7	61.8	63.0	62.1	62.3	13.7	14.1	13.2	14.0	14.4	13.9
SY Soren	74	69	76	80	78	78	61.8	60.6	61.3	61.5	61.5	61.4	13.8	14.5	13.6	13.4	14.4	13.8
Bolles	73	63	74	82	73	76	60.9	60.2	61.2	61.3	60.3	60.9	15.1	15.9	15.0	14.9	15.3	15.1
SY Ingmar	74	70	74	91	81	82	61.5	60.9	61.1	62.9	61.5	61.8	13.9	15.1	14.1	14.2	14.2	14.2
Linkert	76	63	64	75	69	69	61.1	59.7	60.8	61.0	60.5	60.8	14.5	15.1	14.7	14.3	15.1	14.7
MS Chevelle	80	68	86	94	85	88	60.5	58.5	61.3	62.3	61.0	61.5	12.5	13.4	12.2	12.6	12.6	12.5
Boost	72	61	79	88	75	80	60.6	58.5	60.7	61.9	60.1	60.9	13.5	15.0	13.3	13.7	14.2	13.7
SY Valda	79	78	85	100	80	88	60.7	60.5	60.3	62.3	60.6	61.1	13.0	13.9	12.8	13.1	13.0	13.0
CP3530	77	78	79	99	78	85	60.3	60.8	61.3	62.2	60.1	61.2	12.8	14.3	12.7	13.0	14.2	13.3
CP3504	85	73	77	92	82	84	58.2	58.2	59.0	61.4	59.5	60.0	12.7	13.4	12.8	12.9	13.0	12.9
Shelly	80	71	81	88	82	84	62.0	59.7	61.9	62.2	61.1	61.7	13.0	14.0	13.0	13.1	13.5	13.2
CP3616	--	66	76	81	77	78	--	59.4	61.5	61.2	60.3	61.0	--	15.3	14.3	14.4	14.9	14.5
TCG-Spitfire	--	58	76	92	79	82	--	59.0	59.8	61.7	60.2	60.6	--	14.2	13.2	12.9	13.6	13.2
Surpass	--	59	80	91	79	83	--	59.4	60.9	62.2	60.5	61.2	--	14.2	12.9	13.6	14.0	13.5
ND VitPro	--	63	72	78	73	74	--	62.1	62.7	63.2	63.0	63.0	--	15.1	14.2	14.1	14.8	14.4
Lang-MN	--	60	78	79	77	78	--	61.0	63.3	61.9	61.4	62.2	--	15.5	14.7	14.3	15.0	14.7
MS Camaro	--	--	67	77	82	75	--	--	61.6	62.0	61.2	61.6	--	--	13.6	13.7	14.4	13.9
LCS Rebel	--	--	84	93	81	86	--	--	62.4	63.1	61.7	62.4	--	--	13.2	13.6	14.4	13.7
LCS Trigger	--	--	98	110	87	98	--	--	62.3	62.6	60.5	61.8	--	--	11.0	11.1	11.9	11.3
TCG-Climax	--	--	72	82	69	75	--	--	62.8	63.8	61.8	62.8	--	--	15.1	14.6	15.9	15.2
DG-Ambush	--	--	72	88	76	79	--	--	61.5	63.2	61.5	62.1	--	--	13.8	14.2	14.9	14.3
SY McCloud	--	--	--	83	78	--	--	--	--	62.9	61.8	--	--	--	--	13.7	14.7	--
SY611CL2	--	--	--	84	83	--	--	--	--	61.6	62.3	--	--	--	--	13.3	13.6	--
MS Barracuda	--	--	--	93	83	--	--	--	--	62.9	61.3	--	--	--	--	14.2	14.3	--
CP3888	--	--	--	87	82	--	--	--	--	61.6	60.1	--	--	--	--	13.8	14.0	--
LCS Cannon	--	--	--	90	81	--	--	--	--	63.5	61.8	--	--	--	--	13.7	13.8	--
CP3910	--	--	--	--	76	--	--	--	--	--	60.9	--	--	--	--	--	13.7	--
CP3915	--	--	--	--	78	--	--	--	--	--	61.7	--	--	--	--	--	14.3	--
CP3939	--	--	--	--	76	--	--	--	--	--	61.5	--	--	--	--	--	14.9	--
DG-Ballistic	--	--	--	--	90	--	--	--	--	--	60.7	--	--	--	--	--	13.5	--
DG-Commander	--	--	--	--	80	--	--	--	--	--	61.2	--	--	--	--	--	13.7	--
TCG-Heartland	--	--	--	--	75	--	--	--	--	--	61.9	--	--	--	--	--	14.7	--
TCG-Stalwart	--	--	--	--	71	--	--	--	--	--	59.5	--	--	--	--	--	14.9	--
MN-Washburn	--	--	--	--	76	--	--	--	--	--	60.7	--	--	--	--	--	14.3	--
Mott	--	--	--	--	80	--	--	--	--	--	60.7	--	--	--	--	--	14.5	--
SY Longmire	--	--	--	--	79	--	--	--	--	--	61.5	--	--	--	--	--	14.0	--
SY Rockford	--	--	--	--	81	--	--	--	--	--	59.3	--	--	--	--	--	13.9	--
AP Murdock	--	--	--	--	82	--	--	--	--	--	60.5	--	--	--	--	--	14.1	--
Prosper	71	78	83	98	--	--	60.4	60.9	60.8	62.7	--	--	12.6	13.8	11.9	13.2	--	--
Rollag	75	71	76	78	--	--	61.5	61.3	62.4	62.0	--	--	14.0	14.8	14.4	14.2	--	--
CP3419	83	79	92	101	--	--	60.6	59.1	61.6	62.2	--	--	12.5	13.3	12.3	11.6	--	--
WB9653	74	76	83	93	--	--	58.1	58.5	58.8	61.7	--	--	12.5	13.4	12.6	13.0	--	--
CP3100	--	70	75	87	--	--	--	58.1	60.1	61.3	--	--	--	13.7	13.0	13.4	--	--
WB9479	--	--	75	89	--	--	--	--	61.0	63.0	--	--	--	--	13.9	14.5	--	--
WB9590	--	--	72	92	--	--	--	--	60.4	62.5	--	--	--	--	13.3	13.7	--	--
WB9719	--	--	70	89	--	--	--	--	61.9	63.8	--	--	--	--	13.1	13.1	--	--
DG-Caliber	--	--	63	76	--	--	--	--	59.8	60.8	--	--	--	--	14.7	14.5	--	--
AAC Brandon	--	--	--	86	--	--	--	--	--	62.5	--	--	--	--	--	13.7	--	--
AAC Penhold	--	--	--	88	--	--	--	--	--	62.7	--	--	--	--	--	13.3	--	--
AC Goodwin	--	--	--	89	--	--	--	--	--	63.1	--	--	--	--	--	14.1	--	--
TCG-Glenville	--	--	--	71	--	--	--	--	--	61.9	--	--	--	--	--	14.2	--	--
Prevail	74	66	76	--	--	--	61.7	59.3	61.4	--	--	--	13.0	14.3	13.5	--	--	--
WB Mayville	66	57	58	--	--	--	60.3	58.9	58.5	--	--	--	13.9	14.7	13.9	--	--	--
SY Rowyn	78	67	86	--	--	--	61.8	60.1	62.0	--	--	--	12.7	14.1	12.3	--	--	--
LCS Nitro	75	78	92	--	--	--	60.5	60.0	62.2	--	--	--	12.0	13.3	11.2	--	--	--
LCS Prime	78	69	88	--	--	--	61.6	60.9	61.4	--	--	--	11.9	13.5	11.8	--	--	--
LCS Anchor	--	60	69	--	--	--	--	59.3	61.8	--	--	--	--	14.7	13.7	--	--	--
TCG-Cornerstone	--	58	64	--	--	--	--	59.5	58.9	--	--	--	--	14.5	13.6	--	--	--
AKF-Astro	--	--	56	--	--	--	--	--	54.3	--	--	--	--	--	12.3	--	--	--
Trial Mean	73	67	76	87	79		61.2	60.2	61.3	62.2	61.2		13.3	14.4	13.4	13.7	14.2	
C.V. %	5.8	8.7	5.9	4.1	4.7		0.9	1.1	0.9	0.7	0.8		2.4	2.8	2.9	2.8	2.4	
LSD 5%	5.9	8.1	6.3	4.9	5.2		0.8	1.0	0.8	0.6	0.7		0.4	0.6	0.5	0.5	0.5	
LSD 10%	5.0	6.8	5.3	4.1	4.4		0.6	0.8	0.7	0.5	0.6		0.4	0.5	0.5	0.4	0.4	

HRSW Summary, Nelson County 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)						Lodging (0-9)		
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**18**	**19**	**2yr**
Faller	60	71	94	93	86	91	57.6	57.2	62.1	61.5	58.1	60.6	13.0	14.0	13.1	13.9	14.1	13.7	0.8	5.2	3.0
Linkert	70	66	73	72	64	69	60.2	56.8	61.5	60.6	56.5	59.5	15.0	14.3	14.7	14.9	15.1	14.9	0.0	0.0	0.0
SY Ingmar	62	74	79	82	76	79	60.2	59.0	61.8	61.7	58.5	60.7	14.2	14.4	14.1	14.8	14.6	14.5	0.0	0.0	0.0
Bolles	54	64	81	74	73	76	58.1	56.2	61.8	60.7	57.4	60.0	15.2	15.9	15.3	15.5	15.6	15.5	0.0	3.3	1.7
CP3530	63	80	92	93	79	88	58.4	58.6	62.2	61.0	57.6	60.3	13.2	14.2	14.4	13.6	15.2	14.4	0.0	4.0	2.0
SY Valda	64	79	91	96	79	88	58.1	59.1	61.6	61.2	58.4	60.4	13.2	14.0	13.1	13.8	13.9	13.6	0.0	3.2	1.6
Shelly	--	72	90	91	82	88	--	56.6	62.4	61.2	57.4	60.3	--	14.4	13.3	13.5	13.8	13.5	0.0	2.8	1.4
ND VitPro	--	66	71	80	71	74	--	60.4	62.9	62.9	60.2	62.0	--	14.5	14.5	14.9	15.4	14.9	0.0	2.2	1.1
Lang-MN	--	--	71	73	71	72	--	--	62.5	60.9	58.9	60.8	--	--	14.9	15.3	15.9	15.4	2.0	6.3	4.2
LCS Rebel	--	--	85	85	76	82	--	--	63.4	62.4	58.5	61.4	--	--	14.1	14.1	15.1	14.4	0.0	5.0	2.5
CP3888	--	--	--	82	62	--	--	--	--	60.3	55.9	--	--	--	--	13.8	15.1	--	0.8	1.0	0.9
LCS Trigger	--	--	--	91	91	--	--	--	--	61.4	58.7	--	--	--	--	11.7	12.3	--	0.5	3.5	2.0
MS Barracuda	--	--	--	90	81	--	--	--	--	61.0	57.7	--	--	--	--	14.6	14.8	--	0.0	2.0	1.0
TCG-Climax	--	--	--	72	66	--	--	--	--	62.4	59.4	--	--	--	--	15.6	16.0	--	0.0	0.0	0.0
TCG-Spitfire	--	--	--	86	74	--	--	--	--	60.6	56.6	--	--	--	--	13.7	13.9	--	0.0	0.0	0.0
CP3939	--	--	--	--	69	--	--	--	--	--	57.6	--	--	--	--	--	15.5	--	--	1.0	--
DG-Ambush	--	--	--	--	72	--	--	--	--	--	57.7	--	--	--	--	--	15.0	--	--	0.3	--
DG-Ballistic	--	--	--	--	87	--	--	--	--	--	57.1	--	--	--	--	--	13.9	--	--	4.0	--
DG-Commander	--	--	--	--	80	--	--	--	--	--	58.2	--	--	--	--	--	13.9	--	--	0.0	--
LCS Cannon	--	--	--	--	83	--	--	--	--	--	58.5	--	--	--	--	--	14.0	--	--	1.5	--
MN Washburn	--	--	--	--	67	--	--	--	--	--	58.1	--	--	--	--	--	15.0	--	--	0.0	--
SY McCloud	--	--	--	--	74	--	--	--	--	--	58.7	--	--	--	--	--	14.9	--	--	0.0	--
SY611CL2	--	--	--	--	76	--	--	--	--	--	58.6	--	--	--	--	--	14.3	--	--	0.5	--
TCG-Heartland	--	--	--	--	68	--	--	--	--	--	58.8	--	--	--	--	--	15.0	--	--	0.0	--
TCS-Stalwart	--	--	--	--	51	--	--	--	--	--	53.6	--	--	--	--	--	15.8	--	--	0.5	--
LCS Breakaway	59	73	79	--	69	--	59.5	58.8	63.0	--	58.6	--	13.6	14.4	13.8	--	14.8	--	--	3.0	--
MS Chevelle	--	--	88	--	74	--	--	--	61.8	--	56.5	--	--	--	12.7	--	13.8	--	--	4.0	--
AP Murdock	--	--	--	--	83	--	--	--	--	--	57.3	--	--	--	--	--	13.8	--	--	2.5	--
Prosper	59	75	86	92	--	--	58.0	58.0	61.9	61.5	--	--	13.0	13.9	13.1	14.0	--	--	1.3	--	--
Rollag	74	63	78	74	--	--	60.9	57.9	62.6	61.0	--	--	15.0	15.0	14.6	15.1	--	--	0.0	--	--
CP3419	71	71	86	88	--	--	57.6	56.3	61.8	60.0	--	--	12.6	14.4	12.9	13.1	--	--	0.0	--	--
CP3504	58	72	81	86	--	--	54.7	56.1	60.7	59.7	--	--	12.8	13.9	13.4	13.0	--	--	0.0	--	--
CP3616	--	69	78	85	--	--	--	56.9	60.6	60.7	--	--	--	14.7	15.0	14.5	--	--	0.0	--	--
WB9590	--	--	90	95	--	--	--	--	62.0	61.5	--	--	--	--	14.2	14.0	--	--	0.0	--	--
MS Camaro	--	--	76	77	--	--	--	--	61.5	61.0	--	--	--	--	14.3	13.9	--	--	0.0	--	--
WB9479	--	--	88	88	--	--	--	--	62.8	62.0	--	--	--	--	14.8	14.6	--	--	0.0	--	--
WB9719	--	--	--	87	--	--	--	--	--	63.8	--	--	--	--	--	13.6	--	--	0.0	--	--
SY Soren	50	72	78	--	--	--	57.4	58.0	61.4	--	--	--	14.1	13.6	14.0	--	--	--	--	--	--
WB Mayville	59	66	79	--	--	--	58.9	57.0	61.6	--	--	--	14.1	14.3	14.6	--	--	--	--	--	--
Elgin-ND	63	64	76	--	--	--	58.7	57.0	61.5	--	--	--	13.6	14.7	13.9	--	--	--	--	--	--
SY Rowyn	63	78	85	--	--	--	58.8	59.2	61.7	--	--	--	13.1	13.7	13.2	--	--	--	--	--	--
CP3100	--	73	85	--	--	--	--	56.9	60.6	--	--	--	--	13.6	13.5	--	--	--	--	--	--
Boost	--	72	78	--	--	--	--	58.8	61.1	--	--	--	--	15.0	14.2	--	--	--	--	--	--
Surpass	--	75	81	--	--	--	--	57.8	61.4	--	--	--	--	14.0	13.4	--	--	--	--	--	--
LCS Prime	--	75	89	--	--	--	--	58.9	62.1	--	--	--	--	13.1	12.6	--	--	--	--	--	--
Prevail	70	70	--	--	--	--	60.7	57.8	--	--	--	--	13.2	13.5	--	--	--	--	--	--	--
WB9507	56	81	--	--	--	--	56.1	56.9	--	--	--	--	12.8	14.0	--	--	--	--	--	--	--
CP3361	52	72	--	--	--	--	56.4	56.6	--	--	--	--	12.2	13.3	--	--	--	--	--	--	--
Focus	70	63	--	--	--	--	61.4	59.5	--	--	--	--	13.0	14.1	--	--	--	--	--	--	--
WB9653	54	73	--	--	--	--	53.5	56.2	--	--	--	--	12.4	13.9	--	--	--	--	--	--	--
LCS Anchor	--	67	--	--	--	--	--	57.5	--	--	--	--	--	14.1	--	--	--	--	--	--	--
TCG-Cornerstone	--	59	--	--	--	--	--	57.1	--	--	--	--	--	14.2	--	--	--	--	--	--	--
Barlow	63	--	--	--	--	--	59.5	--	--	--	--	--	14.0	--	--	--	--	--	--	--	--
LCS Iguacu	62	--	--	--	--	--	60.2	--	--	--	--	--	11.7	--	--	--	--	--	--	--	--
LCS Nitro	66	--	--	--	--	--	58.1	--	--	--	--	--	11.9	--	--	--	--	--	--	--	--
Trial Mean	62	71	82	84	74		58.6	57.8	61.9	61.3	57.8		13.5	14.2	14.0	14.2	14.7		0.2	2.0	
C.V. %	5.0	5.7	5.7	5.8	4.9		1.4	1.0	0.5	0.8	1.1		2.9	1.7	1.5	4.4	2.0		349	45	
LSD 5%	4.4	5.7	6.6	6.9	5.1		1.1	0.8	0.5	0.7	0.9		0.6	0.3	0.4	0.9	0.4		1.0	1.3	
LSD 10%	3.7	4.8	5.5	5.7	4.3		0.9	0.6	0.4	0.6	0.7		0.5	0.3	0.3	0.7	0.4		0.8	1.1	

HRSW Summary, Pembina County 2014-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)						Lodging (0-9)		
Variety	**14**	**15**	**16**	**17**	**19**	**3yr**	**14**	**15**	**16**	**17**	**19**	**3yr**	**14**	**15**	**16**	**17**	**19**	**3yr**	**17**	**19**	**2yr**
Faller	88	50	61	96	88	82	61.7	56.0	60.1	62.5	61.0	61.2	13.8	14.8	13.8	13.0	14.2	13.7	0.6	0.5	0.6
Linkert	66	53	56	69	72	66	60.9	56.9	59.3	61.0	61.9	60.7	15.5	14.9	14.7	14.3	15.8	14.9	0.1	0.0	0.1
LCS Breakaway	63	44	46	74	73	64	62.8	55.5	60.0	61.6	61.9	61.2	15.3	15.3	14.7	13.8	15.1	14.5	0.0	0.0	0.0
SY Ingmar	67	56	55	78	75	69	62.2	57.9	59.9	61.3	61.8	61.0	15.2	14.8	14.9	14.1	14.5	14.5	0.0	0.0	0.0
Bolles	--	44	48	76	73	66	--	56.0	57.9	61.4	61.2	60.2	--	15.9	15.9	15.3	17.0	16.1	0.0	0.0	0.0
SY Valda	--	47	59	86	78	74	--	55.6	59.2	60.6	60.9	60.2	--	15.0	13.9	13.3	13.7	13.6	1.3	0.0	0.7
CP3530	--	62	57	88	78	74	--	57.8	59.3	61.3	60.5	60.4	--	14.0	14.4	14.0	15.3	14.6	0.0	0.5	0.3
Shelly	--	--	51	88	80	73	--	--	58.8	62.7	61.5	61.0	--	--	13.8	13.2	14.6	13.9	0.1	0.0	0.1
ND VitPro	--	--	50	73	80	68	--	--	61.4	63.0	62.5	62.3	--	--	15.0	14.4	15.9	15.1	0.1	2.3	1.2
Lang-MN	--	--	--	80	78	--	--	--	--	63.0	61.7	--	--	--	--	14.6	15.5	--	0.2	1.3	0.8
LCS Rebel	--	--	--	83	78	--	--	--	--	62.1	62.0	--	--	--	--	13.8	14.8	--	1.6	0.5	1.1
MS Chevelle	--	--	--	84	86	--	--	--	--	61.1	60.8	--	--	--	--	12.5	13.3	--	0.5	0.0	0.3
CP3888	--	--	--	--	81	--	--	--	--	--	60.7	--	--	--	--	--	14.7	--	--	0.0	--
CP3939	--	--	--	--	75	--	--	--	--	--	61.5	--	--	--	--	--	15.8	--	--	0.0	--
DG-Ambush	--	--	--	--	77	--	--	--	--	--	62.0	--	--	--	--	--	15.2	--	--	0.0	--
DG-Ballistic	--	--	--	--	88	--	--	--	--	--	63.2	--	--	--	--	--	14.1	--	--	0.0	--
DG-Commander	--	--	--	--	83	--	--	--	--	--	61.7	--	--	--	--	--	14.2	--	--	0.0	--
LCS Cannon	--	--	--	--	85	--	--	--	--	--	62.2	--	--	--	--	--	14.2	--	--	0.0	--
LCS Trigger	--	--	--	--	87	--	--	--	--	--	61.1	--	--	--	--	--	12.2	--	--	0.5	--
MN Washburn	--	--	--	--	72	--	--	--	--	--	60.7	--	--	--	--	--	14.7	--	--	0.0	--
MS Barracuda	--	--	--	--	85	--	--	--	--	--	61.4	--	--	--	--	--	14.7	--	--	0.0	--
SY McCloud	--	--	--	--	75	--	--	--	--	--	62.5	--	--	--	--	--	15.2	--	--	0.0	--
SY611CL2	--	--	--	--	80	--	--	--	--	--	62.4	--	--	--	--	--	14.4	--	--	0.0	--
TCG-Climax	--	--	--	--	69	--	--	--	--	--	62.2	--	--	--	--	--	16.2	--	--	0.0	--
TCG-Heartland	--	--	--	--	77	--	--	--	--	--	62.2	--	--	--	--	--	15.4	--	--	0.0	--
TCG-Spitfire	--	--	--	--	79	--	--	--	--	--	60.5	--	--	--	--	--	13.9	--	--	0.0	--
TCG-Stalwart	--	--	--	--	73	--	--	--	--	--	59.5	--	--	--	--	--	15.6	--	--	0.0	--
AP Murdock	--	--	--	--	80	--	--	--	--	--	60.7	--	--	--	--	--	14.3	--	--	0.0	--
Prosper	80	49	57	93	--	--	61.9	55.7	59.3	62.1	--	--	13.7	14.8	13.9	13.3	--	--	1.5	--	--
Rollag	72	50	58	82	--	--	62.3	57.6	60.4	62.4	--	--	14.9	15.6	14.6	14.3	--	--	0.0	--	--
SY Soren	66	46	54	78	--	--	61.3	56.8	59.4	61.3	--	--	15.0	15.0	14.8	13.7	--	--	0.0	--	--
WB Mayville	64	45	43	67	--	--	61.2	54.7	57.0	59.4	--	--	14.2	15.1	14.9	13.8	--	--	0.0	--	--
SY Rowyn	66	53	56	86	--	--	61.4	57.5	59.9	61.7	--	--	14.4	14.3	14.2	12.9	--	--	1.0	--	--
Elgin-ND	75	44	53	80	--	--	61.3	55.0	58.5	61.1	--	--	14.5	15.0	14.6	13.8	--	--	0.5	--	--
CP3419	87	60	68	94	--	--	59.6	56.0	58.8	60.7	--	--	12.2	13.2	13.1	12.5	--	--	0.0	--	--
CP3504	--	51	57	75	--	--	--	55.2	57.9	59.6	--	--	--	13.7	13.2	13.1	--	--	0.0	--	--
Boost	--	--	44	78	--	--	--	--	58.2	60.0	--	--	--	--	14.6	14.1	--	--	2.7	--	--
Surpass	--	--	46	79	--	--	--	--	59.0	61.6	--	--	--	--	14.1	13.6	--	--	2.5	--	--
LCS Prime	--	--	46	86	--	--	--	--	59.4	62.5	--	--	--	--	13.1	12.6	--	--	0.0	--	--
CP3616	--	--	50	79	--	--	--	--	58.0	60.6	--	--	--	--	15.5	14.6	--	--	0.0	--	--
CP3100	--	--	61	79	--	--	--	--	58.6	59.9	--	--	--	--	13.7	12.9	--	--	0.0	--	--
WB9590	--	--	--	79	--	--	--	--	--	60.6	--	--	--	--	--	13.8	--	--	0.0	--	--
WB9479	--	--	--	77	--	--	--	--	--	60.6	--	--	--	--	--	14.4	--	--	0.0	--	--
MS Camaro	--	--	--	73	--	--	--	--	--	61.3	--	--	--	--	--	13.6	--	--	0.1	--	--
Prevail	79	47	55	--	--	--	61.2	55.1	58.3	--	--	--	13.8	14.5	13.7	--	--	--	--	--	--
WB9507	78	45	57	--	--	--	60.3	52.9	57.7	--	--	--	15.0	14.6	14.2	--	--	--	--	--	--
CP3361	81	58	64	--	--	--	60.6	56.7	58.0	--	--	--	14.3	12.8	13.8	--	--	--	--	--	--
Focus	--	50	44	--	--	--	--	58.3	60.9	--	--	--	--	14.4	14.2	--	--	--	--	--	--
WB9653	--	42	62	--	--	--	--	54.0	57.7	--	--	--	--	14.6	13.3	--	--	--	--	--	--
LCS Anchor	--	--	45	--	--	--	--	--	58.9	--	--	--	--	--	14.7	--	--	--	--	--	--
TCG-Cornerstone	--	--	44	--	--	--	--	--	57.6	--	--	--	--	--	14.7	--	--	--	--	--	--
Barlow	75	43	--	--	--	--	61.4	56.3	--	--	--	--	14.3	15.2	--	--	--	--	--	--	--
LCS Iguacu	75	62	--	--	--	--	61.8	59.0	--	--	--	--	11.9	11.9	--	--	--	--	--	--	--
LCS Nitro	77	49	--	--	--	--	60.0	55.2	--	--	--	--	12.2	13.5	--	--	--	--	--	--	--
Trial Mean	74	49	53	80	79		61.4	56.2	59.0	61.4	61.6		14.1	14.6	14.3	13.7	14.9		0.4	0.2	
C.V. %	8.0	10.3	7.8	3.3	5.2		0.6	1.8	1.1	0.7	1.3		2.5	3.8	1.9	1.7	1.1		89.4	375	
LSD 5%	8.3	7.2	5.9	3.7	5.8		0.5	1.5	0.9	0.6	1.1		0.5	0.8	0.4	0.3	0.2		1.1	NS	
LSD 10%	6.9	6.0	4.9	3.1	4.8		0.4	1.2	0.7	0.5	0.9		0.4	0.7	0.3	0.3	0.2		0.9	0.9	

No trial data from 2018.

HRSW Summary, Towner County 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)						Lodging (0-9)		
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**16**	**19**	**2yr**
Faller	56	88	59	66	77	67	59.6	60.2	57.1	61.0	57.0	58.4	14.1	13.7	14.3	15.0	13.8	14.4	2.9	0.5	1.7
SY Ingmar	51	76	43	63	75	60	60.9	59.2	54.4	61.8	57.9	58.0	15.0	15.3	15.4	15.3	14.2	15.0	1.2	0.0	0.6
Linkert	50	75	48	58	64	56	59.9	59.4	55.7	61.9	56.7	58.1	14.9	14.9	15.5	15.3	15.1	15.3	0.0	0.0	0.0
Bolles	46	77	50	60	66	59	59.0	59.9	55.6	60.7	56.3	57.5	16.4	16.0	16.3	16.9	15.7	16.3	2.5	0.0	1.3
SY Valda	56	83	54	66	75	65	60.8	59.7	56.3	60.8	56.4	57.8	13.9	14.6	14.7	14.4	13.6	14.2	1.4	2.3	1.9
CP3530	57	92	51	62	71	62	60.3	60.5	55.5	60.4	57.7	57.9	14.8	14.5	15.0	15.6	14.5	15.0	2.5	0.3	1.4
Shelly	--	87	63	67	67	66	--	59.8	59.4	62.1	56.3	59.3	--	14.1	14.3	14.7	14.2	14.4	1.4	0.7	1.1
ND VitPro	--	73	49	58	73	60	--	61.1	59.0	62.1	60.4	60.5	--	15.0	15.0	15.6	15.0	15.2	2.2	0.0	1.1
Lang-MN	--	--	58	68	72	66	--	--	60.4	61.8	59.4	60.5	--	--	15.4	15.1	15.2	15.2	--	1.3	--
LCS Rebel	--	--	60	64	78	67	--	--	59.5	61.5	58.7	59.9	--	--	14.0	15.4	14.3	14.6	--	0.5	--
CP3888	--	--	--	64	69	--	--	--	--	60.1	55.6	--	--	--	--	15.0	14.2	--	--	0.0	--
LCS Trigger	--	--	--	66	84	--	--	--	--	61.4	57.4	--	--	--	--	13.6	12.4	--	--	0.0	--
MS Barracuda	--	--	--	62	74	--	--	--	--	60.9	56.2	--	--	--	--	15.3	14.5	--	--	0.0	--
TCG-Climax	--	--	--	60	58	--	--	--	--	63.1	58.6	--	--	--	--	15.8	15.9	--	--	0.0	--
TCG-Spitfire	--	--	--	63	79	--	--	--	--	61.6	56.9	--	--	--	--	14.7	13.6	--	--	0.1	--
LCS Breakaway	49	78	49	--	72	--	48.9	61.5	56.8	--	58.5	--	14.9	14.5	15.2	--	14.4	--	1.5	0.0	0.8
MS Chevelle	--	--	68	--	75	--	--	--	57.3	--	56.5	--	--	--	13.5	--	13.4	--	--	0.0	--
CP3939	--	--	--	--	73	--	--	--	--	--	57.9	--	--	--	--	--	15.0	--	--	0.0	--
DG-Ballistic	--	--	--	--	77	--	--	--	--	--	55.2	--	--	--	--	--	14.2	--	--	1.0	--
DG-Commander	--	--	--	--	75	--	--	--	--	--	57.2	--	--	--	--	--	14.2	--	--	0.0	--
DG-Ambush	--	--	--	--	69	--	--	--	--	--	57.6	--	--	--	--	--	15.1	--	--	0.0	--
LCS Cannon	--	--	--	--	67	--	--	--	--	--	56.1	--	--	--	--	--	14.5	--	--	0.0	--
MN Washburn	--	--	--	--	67	--	--	--	--	--	57.6	--	--	--	--	--	14.1	--	--	0.0	--
SY McCloud	--	--	--	--	75	--	--	--	--	--	59.0	--	--	--	--	--	14.4	--	--	0.0	--
SY611CL2	--	--	--	--	76	--	--	--	--	--	58.4	--	--	--	--	--	14.2	--	--	0.0	--
TCG-Heartland	--	--	--	--	68	--	--	--	--	--	58.2	--	--	--	--	--	14.9	--	--	0.0	--
TCG-Stalwart	--	--	--	--	55	--	--	--	--	--	52.2	--	--	--	--	--	15.7	--	--	0.0	--
AP Murdock	--	--	--	--	74	--	--	--	--	--	55.7	--	--	--	--	--	14.1	--	--	0.0	--
Prosper	55	83	58	67	--	--	60.4	59.8	57.2	61.4	--	--	13.9	14.0	14.3	14.8	--	--	2.7	--	--
Rollag	54	73	49	58	--	--	61.3	60.2	57.6	61.8	--	--	15.0	15.3	15.7	15.8	--	--	1.0	--	--
CP3419	53	93	48	70	--	--	58.9	59.8	54.5	60.1	--	--	12.3	13.5	14.3	14.2	--	--	0.3	--	--
CP3504	62	75	43	66	--	--	59.3	57.1	51.8	60.0	--	--	13.3	13.8	14.7	14.1	--	--	0.6	--	--
CP3616	--	77	58	64	--	--	--	58.8	56.1	60.2	--	--	--	15.9	15.4	16.2	--	--	3.0	--	--
WB9590	--	--	42	63	--	--	--	--	54.1	61.2	--	--	--	--	15.9	15.3	--	--	--	--	--
WB9479	--	--	57	60	--	--	--	--	55.9	61.6	--	--	--	--	15.7	16.0	--	--	--	--	--
MS Camaro	--	--	48	61	--	--	--	--	57.5	61.3	--	--	--	--	14.7	15.1	--	--	--	--	--
WB9719	--	--	--	65	--	--	--	--	--	64.1	--	--	--	--	--	14.7	--	--	--	--	--
SY Soren	45	82	42	--	--	--	59.8	60.0	54.8	--	--	--	15.0	14.8	15.5	--	--	--	2.1	--	--
WB Mayville	47	69	43	--	--	--	59.5	57.6	53.8	--	--	--	15.2	14.7	15.3	--	--	--	0.4	--	--
Elgin-ND	59	76	61	--	--	--	60.2	60.1	57.3	--	--	--	14.4	14.9	14.3	--	--	--	2.3	--	--
SY Rowyn	50	81	47	--	--	--	60.3	60.1	55.8	--	--	--	14.4	14.3	15.0	--	--	--	2.2	--	--
Boost	--	68	60	--	--	--	--	59.1	58.4	--	--	--	--	15.7	14.8	--	--	--	4.1	--	--
Surpass	--	82	57	--	--	--	--	60.0	58.6	--	--	--	--	14.1	13.9	--	--	--	3.1	--	--
LCS Prime	--	80	55	--	--	--	--	60.3	58.3	--	--	--	--	13.6	13.2	--	--	--	3.9	--	--
CP3100	--	79	51	--	--	--	--	57.3	53.8	--	--	--	--	14.1	14.6	--	--	--	0.8	--	--
Prevail	55	83	--	--	--	--	59.7	59.6	--	--	--	--	13.6	13.8	--	--	--	--	1.2	--	--
CP3361	50	80	--	--	--	--	58.6	57.6	--	--	--	--	13.7	14.2	--	--	--	--	0.5	--	--
WB9507	54	84	--	--	--	--	58.2	58.1	--	--	--	--	14.2	13.5	--	--	--	--	2.7	--	--
Focus	58	86	--	--	--	--	61.8	61.5	--	--	--	--	13.8	13.9	--	--	--	--	1.2	--	--
WB9653	61	74	--	--	--	--	58.5	56.6	--	--	--	--	13.5	13.9	--	--	--	--	2.2	--	--
LCS Anchor	--	78	--	--	--	--	--	59.8	--	--	--	--	--	15.0	--	--	--	--	1.2	--	--
TCG-Cornerstone	--	62	--	--	--	--	--	58.5	--	--	--	--	--	14.6	--	--	--	--	0.3	--	--
Barlow	47	--	--	--	--	--	60.8	--	--	--	--	--	14.6	--	--	--	--	--	--	--	--
LCS Iguacu	45	--	--	--	--	--	60.4	--	--	--	--	--	12.7	--	--	--	--	--	--	--	--
LCS Nitro	53	--	--	--	--	--	58.9	--	--	--	--	--	12.7	--	--	--	--	--	--	--	--
Trial Mean	53	79	53	63	71		60.1	59.6	56.7	61.4	57.3		14.3	14.5	14.9	15.1	14.5		1.8	0.2	
C.V. %	8.8	6.1	10.3	6.2	5.4		0.9	1.1	2.3	0.7	1.0		2.4	2.3	2.0	1.9	2.4		59.7	282	
LSD 5%	6.6	6.9	11.3	5.5	5.4		0.8	0.9	2.8	0.6	0.8		0.5	0.5	0.6	0.4	0.5		1.5	1.0	
LSD 10%	5.5	5.7	9.4	4.6	4.5		0.7	0.8	2.3	0.5	0.7		0.4	0.4	0.5	0.3	0.4		1.3	0.8	

HRSW Summary, Walsh County 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)						Lodging (0-9)					
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**14**	**15**	**16**	**17**	**19**	**3yr**
Faller	62	81	89	85	91	88	57.3	58.9	60.3	62.5	61.0	61.3	15.2	13.0	12.5	12.8	13.6	13.0	0.0	6.5	2.2	1.1	2.5	1.9
Linkert	65	71	82	67	75	74	58.7	58.3	61.3	62.2	61.2	61.6	15.9	14.2	14.7	14.9	15.2	14.9	0.0	0.0	0.0	0.0	0.0	0.0
SY Ingmar	68	74	80	61	82	74	60.0	59.2	61.6	62.6	61.2	61.8	15.4	14.1	14.6	14.8	14.3	14.6	0.0	0.9	1.2	0.1	0.2	0.5
Bolles	59	69	86	64	82	77	57.3	58.3	60.9	61.5	60.8	61.1	16.6	14.9	14.9	14.6	15.7	15.1	--	5.7	0.4	0.0	0.3	0.2
SY Valda	66	78	90	81	86	86	58.9	58.4	61.7	62.1	61.0	61.6	14.9	13.3	13.5	12.9	13.5	13.3	--	3.8	2.0	0.0	0.8	0.9
CP3530	67	80	94	77	82	84	58.3	59.8	61.7	62.3	60.6	61.5	15.6	13.5	13.4	14.0	15.1	14.2	--	7.2	2.7	0.1	2.7	1.8
Shelly	--	82	87	73	85	82	--	58.7	61.1	62.9	61.1	61.7	--	13.1	13.4	13.1	13.8	13.4	--	--	0.3	0.1	0.2	0.2
ND VitPro	--	69	80	66	76	74	--	61.1	62.8	63.8	62.5	63.0	--	14.3	14.9	14.0	15.0	14.6	--	--	0.8	0.0	0.0	0.3
Lang-MN	--	--	82	74	74	77	--	--	62.9	62.8	61.5	62.4	--	--	15.0	14.4	15.2	14.9	--	--	--	0.0	3.2	--
LCS Rebel	--	--	84	71	84	80	--	--	62.5	63.3	62.5	62.8	--	--	13.7	13.2	14.3	13.7	--	--	--	1.7	2.7	--
LCS Trigger	--	--	--	83	95	--	--	--	--	62.4	61.3	--	--	--	--	10.9	11.7	--	--	--	--	--	1.5	--
MS Barracuda	--	--	--	70	80	--	--	--	--	62.7	61.3	--	--	--	--	13.6	13.9	--	--	--	--	--	0.5	--
SY McCloud	--	--	--	68	84	--	--	--	--	63.1	61.8	--	--	--	--	14.8	14.7	--	--	--	--	--	1.3	--
SY611CL2	--	--	--	71	82	--	--	--	--	62.6	61.9	--	--	--	--	13.5	13.6	--	--	--	--	--	0.1	--
TCG-Climax	--	--	--	67	73	--	--	--	--	63.5	62.4	--	--	--	--	15.0	15.5	--	--	--	--	--	0.0	--
TCG-Spitfire	--	--	--	74	82	--	--	--	--	61.4	60.4	--	--	--	--	14.1	13.8	--	--	--	--	--	0.0	--
CP3888	--	--	--	73	83	--	--	--	--	61.6	60.0	--	--	--	--	13.1	14.2	--	--	--	--	--	0.1	--
LCS Breakaway	57	75	83	--	80	--	58.0	60.0	62.2	--	62.1	--	15.6	13.6	13.9	--	14.0	--	0.0	4.3	1.0	0.1	1.7	0.9
MS Chevelle	--	--	88	--	90	--	--	--	59.4	--	60.6	--	--	--	12.9	--	13.1	--	--	--	--	0.8	3.8	--
CP3939	--	--	--	--	79	--	--	--	--	--	61.0	--	--	--	--	--	14.9	--	--	--	--	--	0.2	--
DG-Ambush	--	--	--	--	80	--	--	--	--	--	61.2	--	--	--	--	--	14.9	--	--	--	--	--	1.7	--
DG-Ballistic	--	--	--	--	98	--	--	--	--	--	60.5	--	--	--	--	--	13.7	--	--	--	--	--	0.7	--
DG-Commander	--	--	--	--	89	--	--	--	--	--	61.2	--	--	--	--	--	14.1	--	--	--	--	--	0.7	--
LCS Cannon	--	--	--	--	85	--	--	--	--	--	61.5	--	--	--	--	--	13.7	--	--	--	--	--	0.8	--
MN Washburn	--	--	--	--	81	--	--	--	--	--	61.1	--	--	--	--	--	14.5	--	--	--	--	--	0.3	--
TCG-Stalwart	--	--	--	--	79	--	--	--	--	--	59.5	--	--	--	--	--	15.4	--	--	--	--	--	2.5	--
TCG-Heartland	--	--	--	--	77	--	--	--	--	--	62.1	--	--	--	--	--	14.9	--	--	--	--	--	0.0	--
AP Murdock	--	--	--	--	84	--	--	--	--	--	59.7	--	--	--	--	--	13.8	--	--	--	--	--	2.0	--
Prosper	53	79	91	80	--	--	56.6	59.1	60.7	62.8	--	--	15.0	13.1	12.7	13.0	--	--	0.3	7.4	1.7	2.5	--	--
Rollag	62	74	81	67	--	--	59.3	59.9	62.2	62.7	--	--	16.5	14.3	14.4	15.1	--	--	0.0	2.1	0.4	0.0	--	--
CP3419	68	83	98	87	--	--	57.8	58.1	60.6	61.9	--	--	13.2	12.5	12.5	12.2	--	--	0.0	0.6	0.0	0.0	--	--
CP3504	70	69	82	76	--	--	57.1	55.6	58.3	61.2	--	--	14.2	13.2	13.3	12.4	--	--	--	2.6	0.5	0.0	--	--
CP3616	--	73	86	69	--	--	--	57.8	59.7	62.4	--	--	--	14.8	15.1	14.5	--	--	--	--	2.2	0.1	--	--
WB9590	--	--	84	70	--	--	--	--	60.9	62.6	--	--	--	--	13.9	14.4	--	--	--	--	--	0.1	--	--
WB9479	--	--	83	60	--	--	--	--	61.5	62.9	--	--	--	--	14.4	16.0	--	--	--	--	--	0.1	--	--
MS Camaro	--	--	86	64	--	--	--	--	59.9	62.2	--	--	--	--	12.7	13.8	--	--	--	--	--	1.1	--	--
WB9719	--	--	--	68	--	--	--	--	--	64.3	--	--	--	--	--	14.0	--	--	--	--	--	--	--	--
SY Rowyn	63	76	89	--	--	--	58.0	58.3	60.9	--	--	--	15.4	13.3	13.6	--	--	--	0.3	5.0	2.3	2.1	--	--
SY Soren	55	76	82	--	--	--	58.1	58.9	61.4	--	--	--	15.9	13.9	14.5	--	--	--	0.2	1.1	1.8	0.2	--	--
WB Mayville	56	65	83	--	--	--	57.0	57.1	61.3	--	--	--	15.0	14.2	14.4	--	--	--	0.0	0.4	0.2	0.0	--	--
Elgin-ND	56	77	90	--	--	--	56.4	59.1	61.9	--	--	--	15.5	13.6	14.3	--	--	--	0.5	6.5	0.4	2.3	--	--
Boost	--	69	86	--	--	--	--	58.2	61.2	--	--	--	--	14.2	14.1	--	--	--	--	--	2.5	0.0	--	--
Surpass	--	73	89	--	--	--	--	57.8	60.1	--	--	--	--	13.0	14.5	--	--	--	--	--	4.6	0.7	--	--
LCS Prime	--	76	94	--	--	--	--	59.1	62.0	--	--	--	--	12.6	12.5	--	--	--	--	--	2.6	0.5	--	--
CP3100	--	71	83	--	--	--	--	56.4	59.9	--	--	--	--	13.0	13.2	--	--	--	--	--	0.9	0.0	--	--
Prevail	65	79	--	--	--	--	57.5	57.9	--	--	--	--	14.7	13.3	--	--	--	--	2.7	6.3	2.5	--	--	--
CP3361	66	72	--	--	--	--	57.1	57.0	--	--	--	--	13.8	12.9	--	--	--	--	0.0	2.1	1.3	--	--	--
WB9507	59	80	--	--	--	--	54.2	57.1	--	--	--	--	15.5	12.5	--	--	--	--	0.0	7.1	2.1	--	--	--
Focus	62	69	--	--	--	--	59.2	59.8	--	--	--	--	15.4	13.2	--	--	--	--	--	5.8	3.5	--	--	--
WB9653	69	70	--	--	--	--	57.0	55.7	--	--	--	--	14.0	12.7	--	--	--	--	--	2.3	0.4	--	--	--
LCS Anchor	--	61	--	--	--	--	--	57.3	--	--	--	--	--	14.3	--	--	--	--	--	--	0.8	--	--	--
TCG-Cornerstone	--	60	--	--	--	--	--	57.9	--	--	--	--	--	14.2	--	--	--	--	--	--	0.4	--	--	--
Barlow	59	--	--	--	--	--	59.0	--	--	--	--	--	15.6	--	--	--	--	--	1.8	5.7	--	--	--	--
LCS Iguacu	71	--	--	--	--	--	59.6	--	--	--	--	--	12.7	--	--	--	--	--	0.1	4.0	--	--	--	--
LCS Nitro	65	--	--	--	--	--	56.7	--	--	--	--	--	13.8	--	--	--	--	--	0.3	3.7	--	--	--	--
Trial Mean	62	74	86	72	82		57.9	58.4	61.2	62.5	61.2		15.2	13.5	13.9	13.8	14.4		0.5	4.4	1.5	0.5	1.1	
C.V. %	9.6	4.9	4.8	8.5	4.2		1.4	0.9	0.9	0.7	0.6		2.6	2.3	2.6	5.4	2.6		110	28.3	88	190	87	
LSD 5%	8.4	5.1	5.8	8.6	4.8		1.1	0.8	0.8	0.6	0.5		0.6	0.5	0.5	1.1	0.5		0.8	1.7	1.9	1.2	1.4	
LSD 10%	7.0	4.3	4.8	7.2	4.0		0.9	0.7	0.7	0.5	0.4		0.5	0.4	0.4	0.9	0.4		0.7	1.5	1.5	1.0	1.2	

HRWW Summary, Langdon 2015-2019*

	Yield (bu/a)					Test Weight (lbs/bu)					Winter Survival	Julian Days to Head	Height (in)	Lodging (0-9)	Protein (%)				
Variety	**15**	**16**	**17**	**19**	**3yr**	**15**	**16**	**17**	**19**	**3yr**	**19**	**19**	**19**	**17**	**15**	**16**	**17**	**19**	**3yr**
AC Emerson	85	86	90	87	88	62.0	59.3	60.2	60.4	60.0	97	172	33	0.0	11.8	10.9	11.9	11.5	11.4
Ideal	80	74	16	86	59	60.9	56.2	44.3	59.7	53.4	99	169	30	0.3	11.3	10.4	12.4	11.0	11.3
Jerry	76	65	17	84	55	59.7	56.0	46.7	59.1	53.9	98	171	34	0.0	12.0	10.7	12.9	11.2	11.6
Peregrine	78	81	80	90	84	60.7	58.8	57.0	60.3	58.7	99	171	36	0.0	11.0	10.8	10.8	10.4	10.7
SY Wolf	84	92	67	87	82	61.6	58.7	53.3	59.5	57.2	98	167	29	0.0	11.4	11.3	12.5	11.5	11.8
Northern	84	93	83	90	89	59.8	54.0	55.0	59.2	56.1	99	172	30	0.0	11.7	11.3	11.6	11.1	11.3
Loma	--	76	72	78	75	--	52.9	53.7	58.3	55.0	95	172	28	0.0	--	10.9	11.9	11.3	11.4
SY Monument	--	98	81	85	88	--	56.5	54.4	58.3	56.4	100	168	29	0.0	--	11.1	12.1	11.0	11.4
SY Sunrise	--	100	86	82	89	--	57.3	56.6	59.4	57.8	100	166	24	0.0	--	11.2	11.6	11.4	11.4
Oahe	--	--	105	83	--	--	--	60.7	59.7	--	98	167	29	0.3	--	--	11.3	11.5	--
Keldin	--	--	84	89	--	--	--	56.8	60.5	--	99	173	29	0.0	--	--	11.2	10.9	--
SY Wolverine	--	--	--	85	--	--	--	--	59.7	--	100	166	27	--	--	--	--	11.5	--
Thompson	--	--	--	90	--	--	--	--	59.9	--	99	169	32	--	--	--	--	10.9	--
TCG-Boomlock	--	--	--	79	--	--	--	--	60.3	--	97	170	30	--	--	--	--	11.6	--
WB4462	--	--	--	80	--	--	--	--	60.0	--	99	167	29	--	--	--	--	11.8	--
WB4595	--	--	--	89	--	--	--	--	61.8	--	100	170	30	--	--	--	--	10.3	--
AC Broadview	76	87	25	--	--	58.9	56.8	43.9	--	--	--	--	--	0.0	11.3	10.1	11.6	--	--
Accipiter	73	75	43	--	--	59.7	56.3	51.8	--	--	--	--	--	0.0	11.8	10.5	11.2	--	--
Decade	84	74	28	--	--	61.3	54.2	45.5	--	--	--	--	--	0.0	12.0	10.6	12.2	--	--
Flourish	75	90	75	--	--	59.1	57.4	54.9	--	--	--	--	--	0.0	11.9	11.3	11.5	--	--
Lyman	84	81	35	--	--	61.2	58.1	47.3	--	--	--	--	--	0.0	11.6	11.6	12.7	--	--
Moats	77	83	96	--	--	59.7	59.8	60.6	--	--	--	--	--	0.0	11.7	11.8	12.3	--	--
Overland	90	88	44	--	--	61.2	58.1	51.1	--	--	--	--	--	0.0	10.9	10.8	11.5	--	--
WB Matlock	70	73	20	--	--	60.6	57.1	47.3	--	--	--	--	--	0.0	12.2	10.9	12.9	--	--
AC Gateway	79	88	59	--	--	61.3	56.5	53.6	--	--	--	--	--	0.0	12.3	11.3	12.3	--	--
CDC Chase	85	90	96	--	--	61.6	59.9	60.3	--	--	--	--	--	0.0	11.2	11.6	12.1	--	--
Redfield	79	82	53	--	--	60.5	58.0	50.7	--	--	--	--	--	0.8	11.5	11.1	12.2	--	--
Ruth	--	81	85	--	--	--	56.9	56.1	--	--	--	--	--	0.0	--	10.7	11.2	--	--
WB4614	--	88	57	--	--	--	52.6	54.7	--	--	--	--	--	0.0	--	11.5	12.5	--	--
Trial Mean	80	80	63	84		59.8	56.8	53.3	59.7		98	169	30	0.0	11.7	11.2	11.9	11.3	
C.V. %	7.2	8.6	9.8	3.6		1.0	1.9	2.7	0.6		2.0	0.7	4.2	672	2.8	3.0	3.2	1.9	
LSD 5%	8.1	11.3	8.7	4.3		0.8	1.8	2.0	0.5		2.8	1.7	1.8	NS	0.5	0.5	0.5	0.3	
LSD 10%	6.7	9.5	7.2	3.6		0.7	1.5	1.7	0.4		2.3	1.4	1.5	NS	0.4	0.5	0.4	0.3	

No lodging in the 2019 trial.

Fungicides were used in 2015 but not in 2016-2019.

Severe stripe rust infections resulted in reduced yields in susceptible varieties in 2017.

*The 2018 trial was lost due to winter kill.

Barley Summary, Langdon 2015-2019

	Height (in)						Protein (%)						Days to Head					
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**
Lacey	37	32	41	28	29	33	13.5	13.9	12.7	14.3	12.7	13.2	61	54	55	50	55	53
Tradition	39	34	38	27	28	31	12.8	13.9	12.9	14.3	12.8	13.3	60	55	56	50	55	54
Pinnacle*	37	34	39	27	29	32	12.1	12.5	12.0	12.8	12.1	12.3	61	55	57	51	56	55
ND Genesis*	36	30	38	29	29	32	11.0	10.9	11.3	11.9	11.3	11.5	61	57	57	51	57	55
AAC Synergy*	--	31	37	29	28	31	--	11.9	11.9	13.1	12.4	12.5	--	58	58	52	59	56
ABI Balster*	--	31	35	28	25	29	--	12.8	12.4	13.4	12.2	12.7	--	59	59	51	59	56
Explorer*	--	--	32	24	24	27	--	--	11.5	13.4	12.4	12.4	--	--	58	50	57	55
Conlon*	37	--	--	27	25	--	12.8	--	--	13.8	13.0	--	56	--	--	47	54	--
AAC Connect*	--	--	--	--	27	--	--	--	--	--	13.1	--	--	--	--	--	58	--
Stellar-ND	37	34	40	25	--	--	12.7	13.3	12.5	13.2	--	--	61	54	56	50	--	--
Celebration	37	32	39	28	--	--	14.3	13.9	13.7	15.2	--	--	61	55	56	50	--	--
Quest	37	33	39	27	--	--	12.8	13.0	13.5	14.1	--	--	61	55	57	50	--	--
Innovation	36	32	40	25	--	--	13.6	13.5	13.5	14.7	--	--	60	55	56	51	--	--
Sirish*	--	30	33	26	--	--	--	13.0	11.9	13.4	--	--	--	60	60	53	--	--
ABI Growler*	--	32	36	26	--	--	--	12.4	13.1	13.4	--	--	--	60	59	54	--	--
LCS Genie*	--	29	32	25	--	--	--	12.4	11.0	12.9	--	--	--	62	61	54	--	--
CDC Meredith*	36	31	36	--	--	--	12.9	12.2	12.3	--	--	--	65	59	60	--	--	--
LCS Odyssey*	--	31	33	--	--	--	--	12.0	10.7	--	--	--	--	61	61	--	--	--
Rawson*	37	33	--	--	--	--	12.1	12.2	--	--	--	--	58	54	--	--	--	--
Trial Mean	37	32	37	26	27		12.3	12.5	12.3	13.4	12.1		61	56	57	51	56	
C.V. %	3.9	6.4	5.8	6.3	5.5		2.6	5.3	4.6	3.4	3.5		1.2	1.3	1.4	2.1	1.5	
LSD 5%	2.1	2.9	3.0	2.3	2.1		0.4	0.9	0.8	0.6	0.6		1.1	1.0	1.1	1.5	1.2	
LSD 10%	1.7	2.4	2.5	2.0	1.8		0.4	0.8	0.7	0.5	0.5		0.9	0.8	0.9	1.3	1.0	

*2-row

Conlon suffered damage from rodents in 2016 and 2017. Data is not presented.

Barley Summary, Langdon 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Lodging (0-9)			Plump (%)					
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**17**	**19**	**2yr**	**15**	**16**	**17**	**18**	**19**	**3yr**
Lacey	128	116	135	133	124	131	51.1	46.9	49.4	50.4	48.9	49.6	0.3	0.0	0.2	97	91	94	98	95	96
Tradition	131	108	122	131	121	125	49.8	46.8	48.8	49.8	48.3	49.0	2.3	0.0	1.2	96	89	94	96	92	94
Pinnacle*	132	106	133	130	127	130	51.9	47.9	50.8	52.0	50.6	51.1	0.0	0.0	0.0	97	96	98	99	99	99
ND Genesis*	125	105	129	139	123	131	50.5	47.3	49.1	50.4	48.7	49.4	0.0	0.3	0.2	96	96	96	97	97	97
AAC Synergy*	--	113	131	147	123	133	--	48.0	49.5	51.2	50.1	50.3	3.5	1.3	2.4	--	94	94	97	97	96
ABI Balster*	--	92	117	142	124	128	--	43.7	46.4	50.5	49.5	48.8	3.3	0.0	1.7	--	84	85	93	94	91
Explorer*	--	--	131	125	123	126	--	--	47.7	51.0	49.1	49.3	0.0	0.0	0.0	--	--	91	96	96	94
Conlon*	111	--	--	111	110	--	51.9	--	--	51.7	51.0	--	--	1.8	--	96	--	--	98	98	--
AAC Connect*	--	--	--	--	120	--	--	--	--	--	49.7	--	--	0.5	--	--	--	--	--	97	--
Stellar-ND	129	104	131	135	--	--	49.6	48.8	48.8	48.8	--	--	0.0	--	--	97	95	97	98	--	--
Celebration	130	111	128	128	--	--	49.6	47.1	47.7	49.5	--	--	4.5	--	--	97	92	91	98	--	--
Quest	124	107	115	126	--	--	49.4	45.9	47.2	49.6	--	--	5.5	--	--	92	85	82	94	--	--
Innovation	128	113	121	118	--	--	50.2	46.3	48.6	49.9	--	--	2.5	--	--	97	91	93	98	--	--
Sirish*	--	88	126	126	--	--	--	44.1	48.7	48.9	--	--	0.3	--	--	--	85	95	97	--	--
ABI Growler*	--	94	118	133	--	--	--	45.4	45.7	50.6	--	--	3.8	--	--	--	84	82	97	--	--
LCS Genie*	--	77	116	128	--	--	--	43.5	47.9	51.0	--	--	0.3	--	--	--	83	93	95	--	--
CDC Meredith*	116	90	114	--	--	--	48.6	44.7	46.9	--	--	--	4.3	--	--	92	86	89	--	--	--
LCS Odyssey*	--	71	129	--	--	--	--	39.9	47.3	--	--	--	0.8	--	--	--	82	95	--	--	--
Rawson*	124	107	--	--	--	--	49.0	46.8	--	--	--	--	--	--	--	97	97	--	--	--	--
Trial Mean	125	100	124	130	123		50.2	46.4	48.4	50.1	49.4		1.7	0.5		95	91	93	96	97	
C.V. %	5.3	6.4	6.3	6.0	3.4		1.2	2.6	1.7	2.3	0.7		122	149		1.8	4.2	3.4	1.5	1.3	
LSD 5%	9.4	9.1	11.1	11.0	5.9		0.9	1.7	1.2	1.6	0.5		2.8	1.0		2.5	5.4	4.4	2.0	1.8	
LSD 10%	7.8	7.6	9.3	9.2	4.9		0.7	1.4	1.0	1.4	0.4		2.4	0.9		2.1	4.5	3.7	1.7	1.5	

*2-row

Conlon suffered damage from rodents in 2016 and 2017. Data is not presented.

Oat Summary, Langdon 2015-2019

	Height (in)						Protein (%)						Lodging (0-9)				
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**19**	**3yr**
AC Pinnacle	48	44	51	40	42	44	8.1	7.9	8.5	11.9	11.2	10.5	1.5	5.5	6.7	1.0	4.4
Beach	51	47	53	35	38	42	10.6	9.5	10.1	13.3	13.6	12.3	0.4	4.0	3.4	0.2	2.5
CDC Dancer	48	44	52	36	40	43	8.1	7.9	7.9	9.9	9.3	9.0	1.3	5.7	5.0	0.0	3.6
HiFi	47	43	52	36	42	43	9.5	8.6	10.2	11.5	11.1	10.9	2.6	5.5	3.4	0.0	3.0
Hytest	50	45	51	37	41	43	13.2	11.4	12.8	14.2	14.1	13.7	4.7	7.2	4.3	0.8	4.1
Killdeer	44	40	46	32	35	38	9.3	8.2	9.3	11.5	10.9	10.6	2.6	5.5	5.2	0.0	3.6
Otana	50	42	51	38	42	44	9.7	8.4	9.7	12.3	11.5	11.2	4.1	6.7	6.1	1.3	4.7
Rockford	48	44	52	37	39	43	10.2	9.4	10.6	12.3	12.3	11.7	2.0	4.7	5.4	0.2	3.4
Souris	45	43	47	34	37	39	8.6	8.0	9.3	11.2	11.3	10.6	0.9	3.0	2.6	0.1	1.9
Stallion	48	43	52	38	39	43	12.6	10.1	10.9	12.8	12.9	12.2	1.7	8.0	5.1	0.1	4.4
CDC Minstrel	45	43	50	33	36	40	7.0	7.3	7.4	9.2	9.3	8.6	0.3	3.7	3.4	0.1	2.4
Newburg	50	47	55	38	42	45	9.1	7.7	9.3	11.4	10.8	10.5	3.2	7.5	6.3	1.1	5.0
Leggett	48	46	49	35	37	40	11.7	10.0	11.7	12.8	12.4	12.3	3.0	4.3	5.4	0.2	3.3
Jury	51	45	55	38	40	44	9.9	8.0	9.9	10.5	9.6	10.0	2.3	6.5	5.3	0.7	4.2
Paul*	49	43	55	38	40	44	15.1	13.4	13.8	17.1	16.7	15.9	1.0	6.0	5.0	0.1	3.7
Deon	48	42	52	36	39	42	11.8	8.7	10.0	12.7	11.9	11.5	0.6	4.3	3.6	0.0	2.6
Hayden	--	44	52	35	40	42	--	8.3	10.5	11.8	11.9	11.4	--	6.0	4.3	0.1	3.5
CS Camden	--	40	49	35	36	40	--	8.9	9.5	11.4	10.6	10.5	--	2.5	0.5	0.0	1.0
Warrior	--	--	--	--	35	--	--	--	--	--	13.3	--	--	--	--	0.0	--
GM 423	--	44	52	--	--	--	--	8.8	9.4	--	--	--	--	5.8	6.6	--	--
Furlong	47	45	--	--	--	--	9.9	9.1	--	--	--	--	0.9	3.2	--	--	--
Goliath	52	45	--	--	--	--	10.9	9.1	--	--	--	--	0.3	5.3	--	--	--
Trial Mean	48	43	52	37	40		--	--	--	--	--		1.8	5.1	4.4	0.2	
C.V. %	3.2	6.3	2.7	4.3	4.1		--	--	--	--	--		81.7	35.2	37.6	234	
LSD 5%	2.2	3.8	1.9	2.6	2.6		--	--	--	--	--		2.1	2.5	2.3	0.8	
LSD 10%	1.8	3.2	1.6	2.1	2.2		--	--	--	--	--		1.8	2.1	2.0	0.7	

*Hull-less variety

Oat Summary, Langdon 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Days to Head					
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**
AC Pinnacle	177	151	191	184	151	175	36.9	34.9	37.6	40.9	38.9	39.1	66	63	62	52	58	57
Beach	174	146	201	164	152	172	40.8	37.0	41.2	41.6	40.6	41.1	63	61	60	51	58	56
CDC Dancer	176	132	192	182	189	188	39.4	36.3	39.5	41.0	39.5	40.0	64	61	61	52	59	57
HiFi	159	139	191	179	155	175	37.2	35.8	40.9	40.8	38.5	40.1	64	62	60	52	59	57
Hytest	139	102	142	139	160	147	41.8	38.5	41.5	42.5	40.5	41.5	63	57	56	51	57	55
Killdeer	161	154	192	192	185	190	37.7	35.9	38.6	39.8	38.0	38.8	62	58	58	51	57	55
Otana	135	100	185	192	175	184	34.8	34.3	37.9	41.0	39.5	39.5	64	62	61	53	59	58
Rockford	149	125	192	178	168	179	38.4	36.8	42.5	41.7	40.4	41.5	64	63	60	52	59	57
Souris	138	136	189	165	166	174	36.6	34.8	39.9	39.9	38.5	39.4	64	61	60	51	58	56
Stallion	160	107	169	183	165	172	41.2	35.9	40.9	42.1	40.8	41.3	64	60	60	53	58	57
CDC Minstrel	160	145	219	181	177	192	34.9	33.2	37.7	40.2	37.2	38.4	64	59	59	52	58	56
Newburg	162	139	179	178	167	175	37.8	33.7	40.0	40.0	37.8	39.3	63	60	59	52	58	56
Leggett	190	157	194	195	189	193	39.3	37.1	40.7	41.2	39.5	40.5	64	61	60	52	59	57
Jury	151	128	176	208	192	192	38.7	34.9	41.0	40.3	37.6	39.6	63	60	60	52	61	58
Paul*	127	99	165	149	129	148	45.1	44.2	46.2	47.4	44.1	45.9	65	65	63	52	61	59
Deon	186	162	204	182	184	190	39.2	35.5	39.9	40.4	38.0	39.4	65	63	61	52	60	58
Hayden	--	134	195	169	177	180	--	38.3	43.2	41.2	40.3	41.6	--	59	59	52	58	56
CS Camden	--	174	229	208	188	208	--	34.1	37.5	38.7	36.3	37.5	--	61	61	52	59	57
Warrior	--	--	--	--	163	--	--	--	--	--	38.7	--	--	--	--	--	56	--
GM 423	--	123	193	--	--	--	--	33.5	38.6	--	--	--	--	65	62	--	--	--
Furlong	157	152	--	--	--	--	38.7	37.0	--	--	--	--	64	65	--	--	--	--
Goliath	171	132	--	--	--	--	40.4	36.2	--	--	--	--	65	63	--	--	--	--
Trial Mean	158	136	186	181	170		38.8	35.8	40.7	41.0	39.2		64	61	60	52	59	
C.V. %	7.6	12.4	6.6	5.8	4.1		2.0	3.1	2.4	1.1	1.1		1.1	1.5	1.1	1.2	1.0	
LSD 5%	16.9	23.8	17.2	17.2	11.5		1.1	1.5	1.3	0.7	0.7		1.0	1.3	0.9	1.0	1.0	
LSD 10%	14.2	19.9	14.4	14.3	9.6		0.9	1.3	1.1	0.6	0.6		0.9	1.1	0.8	0.8	0.8	

*Hull-less variety

Flax Summary, Langdon 2015-2019

	Yield (bu/a)						Test Weight (lbs/bu)						Lodging (0-9)			Height (in)						Days to Flower					
Variety	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**16**	**17**	**2yr**	**15**	**16**	**17**	**18**	**19**	**3yr**	**15**	**16**	**17**	**18**	**19**	**3yr**
Carter*	36	40	48	38	42	43	53.0	52.1	53.0	53.0	53.2	53.1	0.5	0.0	0.3	26	27	27	24	25	25	46	50	57	49	53	53
CDC Glas	41	41	54	43	42	46	50.8	50.8	51.1	51.8	50.6	51.2	0.2	0.1	0.2	29	26	25	27	22	25	50	51	58	49	53	53
Omega*	36	33	46	39	39	41	53.1	52.2	52.5	53.4	53.4	53.1	1.0	0.4	0.7	26	24	26	22	23	24	47	51	57	48	54	53
Prairie Thunder	37	39	53	43	43	46	51.5	52.2	52.2	52.4	52.1	52.2	0.4	0.1	0.3	30	28	29	27	26	27	49	51	57	53	54	55
Webster	35	40	52	44	42	46	52.2	52.6	52.0	52.9	52.5	52.5	0.8	0.6	0.7	30	28	28	27	24	26	49	50	57	50	52	53
York	35	41	50	42	43	45	52.4	51.7	52.2	52.5	51.7	52.1	0.3	0.0	0.2	30	26	27	25	28	27	49	49	56	48	52	52
Bison	37	37	49	40	40	43	52.0	52.2	52.3	52.7	52.7	52.6	0.3	0.1	0.2	29	28	28	25	27	27	46	50	57	49	52	53
Gold ND*	36	38	52	43	41	45	52.3	52.1	52.2	53.1	52.7	52.7	0.7	0.1	0.4	30	26	28	27	25	27	50	52	57	52	53	54
CDC Neela	39	37	46	38	43	42	51.9	51.4	52.4	52.4	51.4	52.1	1.6	0.0	0.8	28	26	26	23	23	24	48	50	57	49	51	52
ND Hammond	--	--	49	39	38	42	--	--	51.1	52.5	51.5	51.7	--	0.0	--	--	--	26	25	24	25	--	--	56	48	52	52
CDC Plava	--	31	46	--	40	--	--	51.4	50.7	--	51.6	--	4.0	0.0	2.0	--	25	24	--	22	--	--	49	56	--	52	--
CDC Buryu	--	--	--	--	42	--	--	--	--	--	52.9	--	--	--	--	--	--	--	--	24	--	--	--	--	--	52	--
CDC Melyn	--	--	--	--	35	--	--	--	--	--	47.4	--	--	--	--	--	--	--	--	23	--	--	--	--	--	54	--
CDC Bright	--	--	--	--	38	--	--	--	--	--	48.9	--	--	--	--	--	--	--	--	23	--	--	--	--	--	52	--
CDC Bethune	38	39	49	42	--	--	51.9	52.2	52.9	52.7	--	--	0.5	0.0	0.3	30	28	28	26	--	--	48	50	57	48	--	--
CDC Sanctuary	41	33	54	44	--	--	50.7	51.0	49.7	52.4	--	--	1.7	1.2	1.5	28	25	26	23	--	--	49	50	58	48	--	--
CDC Sorrel	40	34	49	41	--	--	52.3	51.2	51.9	52.7	--	--	2.0	1.1	1.6	31	26	29	25	--	--	48	51	58	49	--	--
Nekoma	37	38	52	42	--	--	52.6	52.1	52.9	52.7	--	--	0.6	0.2	0.4	30	27	28	23	--	--	47	49	57	50	--	--
Pembina	37	38	52	43	--	--	52.8	51.2	53.0	53.0	--	--	0.3	0.2	0.3	29	27	27	24	--	--	49	50	57	49	--	--
Prairie Blue	38	40	51	39	--	--	51.7	51.4	52.0	52.4	--	--	0.4	0.0	0.2	28	25	26	25	--	--	49	50	57	49	--	--
Prairie Sapphire	38	35	54	46	--	--	51.4	50.8	51.3	51.9	--	--	2.1	0.0	1.1	26	28	28	24	--	--	46	51	57	50	--	--
Rahab 94	38	40	51	43	--	--	50.2	51.5	49.7	52.3	--	--	0.4	0.0	0.2	27	26	27	25	--	--	48	49	56	50	--	--
Prairie Grande	37	42	50	--	--	--	51.0	51.6	52.3	--	--	--	0.8	0.0	0.4	27	25	27	--	--	--	46	49	55	--	--	--
Shape	40	44	53	--	--	--	51.4	51.4	52.3	--	--	--	0.0	0.0	0.0	27	28	27	--	--	--	45	50	56	--	--	--
CDC Arras	37	--	--	--	--	--	51.9	--	--	--	--	--	--	--	--	30	--	--	--	--	--	47	--	--	--	--	--
Hanley	37	--	--	--	--	--	52.2	--	--	--	--	--	--	--	--	30	--	--	--	--	--	48	--	--	--	--	--
Lightning	35	--	--	--	--	--	52.1	--	--	--	--	--	--	--	--	28	--	--	--	--	--	48	--	--	--	--	--
Linott	35	--	--	--	--	--	51.9	--	--	--	--	--	--	--	--	30	--	--	--	--	--	48	--	--	--	--	--
McGregor	39	--	--	--	--	--	51.8	--	--	--	--	--	--	--	--	29	--	--	--	--	--	48	--	--	--	--	--
Neche	37	--	--	--	--	--	52.5	--	--	--	--	--	--	--	--	30	--	--	--	--	--	47	--	--	--	--	--
Trial Mean	37	38	51	42	41		51.9	51.7	52.0	52.6	52.2		0.8	0.2		29	27	27	25	25		48	50	57	50	53	
C.V. %	5.7	7.3	6.6	7.9	5.8		1.0	0.8	1.8	0.5	0.8		124	340		4.8	6.3	5.0	6.2	5.0		1.1	1.7	0.8	2.2	1.3	
LSD 5%	3.0	4.0	4.7	NS	3.9		0.7	0.6	1.3	0.4	0.6		1.5	1.1		1.9	2.4	1.9	2.5	2.0		0.7	1.2	0.7	1.8	1.1	
LSD 10%	2.5	3.3	3.9	NS	3.2		0.6	0.5	1.1	0.3	0.5		1.2	0.9		1.6	2.0	1.6	2.1	1.7		0.6	1.0	0.6	1.5	0.9	

*Yellow seeded.
No lodging in 2019 trial.

Canola - Liberty Link, Clearfield and Sulfonylurea Varieties, Langdon 2018-2019

Company/Brand	Variety	Type[1]	Blackleg Rating[2]	Status[3]	Clubroot Resistant[6]	Days to First Flower			Days to End Flower			Days to Mature			% Cover[4]		
						18	19	2yr	18	19	2yr	18	19	2yr	18	19	2yr
BASF	InVigor L252	H,LL,TR	R	CA	No	41	49	45	57	63	60	85	97	91	99	90	95
BASF	InVigor L230	H,LL,TR	R	CA	No	39	45	42	55	58	57	83	93	88	100	91	96
BASF	InVigor L233P	H,LL,TR	R	CA	No	38	47	43	55	62	59	81	94	88	99	92	96
BASF	InVigor L255P	H,LL,TR	R	CA	Yes	40	49	45	58	64	61	84	97	91	100	92	96
BASF	InVigor L234P	H,LL,TR	R	CA	Yes	--	47	--	--	62	--	--	94	--	--	86	--
BASF	InVigor L345P	H,LL,TR	R	EXP	Yes	--	48	--	--	63	--	--	95	--	--	91	--
BASF	InVigor L352	H,LL,TR	R	EXP	Yes	--	50	--	--	66	--	--	99	--	--	90	--
BrettYoung	5545CL	H,CL,TR	R	CA	No	--	48	--	--	65	--	--	98	--	--	94	--
Canterra Seeds	CS2500 CL	H,CL,TR	R	CA	No	39	47	43	58	60	59	85	95	90	99	89	94
Cargill	16MH6001	H,CL,HO	R	EXP	No	--	48	--	--	64	--	--	94	--	--	90	--
Cargill	16MH6004	H,CL,HO	R	EXP	No	--	48	--	--	63	--	--	93	--	--	88	--
Dyna-Gro	DG 200CL	H,CL,TR	R	CA	No	40	49	45	59	65	62	86	96	91	99	88	94
CROPLAN[5]	CP955RR	H,RR,TR	R	CA	Yes	--	46	--	--	62	--	--	95	--	--	95	--
Brett Young[5]	4178RR	H,RR,TR	R	CA	Yes	--	50	--	--	64	--	--	96	--	--	93	--
Trial Mean						39	48		58	64		84	96		97	90	
C.V. %						1.2	1.2		1.7	1.5		1.5	1.7		2.5	4.5	
LSD 5%						0.7	0.8		1.4	1.4		1.8	2.4		3.4	5.8	
LSD 10%						0.6	0.7		1.3	1.2		1.5	2.0		2.9	4.8	

[1]H-Hybrid, LL-Liberty Link, CL-Clearfield System, SU-Sulfonylurea, TR-Traditional Oil Type, HO-High Oleic Oil Type.

[2]Blackleg Rating: MR-Moderately Resistant, R-Resistant. Rating provided by company.

[3]Status: CA-Commercially available, EXP-Experimental.

[4] % Cover-Visual rating of percent area of plot covered by plant growth. This is a measure of stand and vigor. Plants were at 5-6 leaf stage.

[5]Roundup Ready check variety.

[6]Has clubroot resistance gene.

Canola - Liberty Link, Clearfield and Sulfonylurea Varieties, Langdon 2017-2019

Company/Brand	Variety	Height (in)			Lodging (0-9)			Oil[1] (%)			Yield[1] (lbs/a)				
		18	19	2yr	18	19	2yr	18	19	2yr	2017	2018	2019	2yr	3yr
BASF	InVigor L252	49	48	49	1.8	2.8	2.3	44.8	47.1	46.0	4047	3997	3681	3839	3908
BASF	InVigor L230	44	46	45	1.8	1.8	1.8	43.6	47.4	45.5	3559	3580	3521	3550	3553
BASF	InVigor L233P	44	46	45	2.5	5.5	4.0	43.3	44.2	43.8	3770	3198	3528	3363	3499
BASF	InVigor L255P	46	48	47	2.0	2.0	2.0	44.9	47.1	46.0	3807	3749	3937	3843	3831
BASF	InVigor L234P	--	43	--	--	6.5	--	--	44.3	--	--	--	3394	--	--
BASF	InVigor L345P	--	49	--	--	4.0	--	--	44.4	--	--	--	3947	--	--
BASF	InVigor L352	--	48	--	--	3.0	--	--	47.2	--	--	--	3499	--	--
BrettYoung	5545CL	--	46	--	--	3.8	--	--	44.8	--	--	--	3536	--	--
Canterra Seeds	CS2500 CL	48	47	48	1.8	1.8	1.8	43.7	46.6	45.2	--	3563	3234	3398	--
Cargill	16MH6001	--	43	--	--	1.5	--	--	43.6	--	--	--	3291	--	--
Cargill	16MH6004	--	46	--	--	2.0	--	--	43.2	--	--	--	3109	--	--
Dyna-Gro	DG 200CL	48	50	49	3.5	4.3	3.9	43.5	43.7	43.6	4008	3448	3216	3332	3557
CROPLAN[2]	CP955RR	--	42	--	--	4.8	--	--	47.5	--	--	--	3469	--	--
Brett Young[2]	4178RR	---	50	--	--	1.3	--	--	45.7	--	--	--	3684	--	--
Trial Mean		45	47		2.5	3.1		43.5	44.8		3499	3322	3432		
C.V. %		7.2	6.3		36.2	56.4		1.6	2.8		9.7	6.3	8.2		
LSD 5%		4.6	4.2		1.3	2.5		1.0	1.8		479	294	396		
LSD 10%		3.8	3.5		1.1	2.1		0.8	1.5		400	245	331		

[1]8.5% moisture

[2]Roundup Ready check variety.

Canola - Roundup Ready, Langdon 2018-2019

Company	Variety	Type[1]	Blackleg Rating[2]	Status[3]	Clubroot Resistant	Days to First Flower			Days to End Flower			Days to Mature			% Cover[4]		
						18	19	2yr	18	19	2yr	18	19	2yr	18	19	2yr
BrettYoung	6074RR	RR	R	CA	No	39	47	43	59	63	61	85	96	91	94	96	95
BrettYoung	4187RR	RR	R	CA	Yes	42	50	46	59	65	62	85	97	91	95	92	94
BrettYoung	6090RR	RR	R	CA	Yes	42	49	46	60	64	62	85	95	90	98	95	97
Canterra Seeds	CS2100	RR	R	CA	No	39	47	43	58	63	61	85	95	90	98	97	98
Canterra Seeds	CS2300	RR	R	CA	No	41	47	44	59	65	62	86	96	91	98	97	98
Canterra Seeds	CS2600 CR-T	TF	R	CA	Yes	--	45	--	--	62	--	--	94	--	--	97	--
CROPLAN	CP930RR	RR	R	CA	No	36	45	41	54	61	58	80	94	87	98	97	98
CROPLAN	CP955RR	RR	R	CA	Yes	37	45	41	54	62	58	81	94	88	97	98	98
CROPLAN	CP9919RR	RR	R	CA	No	--	44	--	--	58	--	--	89	--	--	93	--
CROPLAN	CP9978TF	TF	R	CA	No	--	46	--	--	63	--	--	95	--	--	95	--
CROPLAN	CP9982RR	RR	R	CA	Yes	--	48	--	--	64	--	--	97	--	--	97	--
Dekalb	DKTF91SC	TF	R	CA	No	--	43	--	--	61	--	--	90	--	--	98	--
Dekalb	DKTF92SC	TF	R	CA	No	--	45	--	--	61	--	--	94	--	--	98	--
Dyna-Gro	DG 533G	RR	R	CA	No	38	48	43	58	64	61	83	94	89	93	92	93
Dyna-Gro	DG 540G	RR	R	CA	No	40	48	44	59	65	62	84	95	90	95	93	94
Integra	7389RT	TF	R	EXP	No	--	46	--	--	63	--	--	95	--	--	96	--
Pioneer	45CM39	RR	R	CA	Yes	--	46	--	--	61	--	--	95	--	--	99	--
Pioneer	45M35	RR	R	CA	No	38	48	43	56	63	60	82	95	89	100	100	100
Proseed	300 Mag	RR	R	CA	No	38	47	43	57	63	60	84	95	90	95	96	96
Proseed	PS 5000	RR	R	CA	Yes	41	47	44	58	62	60	85	93	89	96	92	94
Star	Star 402	RR	R	CA	No	38	45	42	56	62	59	83	94	89	97	98	98
Star	StarFlex	TF	R	CA	No	--	46	--	--	61	--	--	93	--	--	95	--
Trial Mean						39	46		57	63		83	94		97	96	
C.V. %						1.4	1.6		1.2	1.4		1.7	1.2		3.1	2.1	
LSD 5%						0.7	1.0		0.9	1.2		2.0	1.6		4.2	2.9	
LSD 10%						0.6	0.8		0.8	1.0		1.7	1.3		3.5	2.4	

[1]All varieties are Hybrids and Traditional Oil Types. RR-Roundup Ready, TF-Roundup Ready TruFlex.

[2]Blackleg Rating: S-Susceptible, MS-Moderately Susceptible, MR-Moderately Resistant, R-Resistant. Rating provided by company.

[3] Status: CA-Commercially available, EXP-Experimental.

[4] % Cover-Visual rating of percent area of plot covered by plant growth. This is a measure of stand and vigor. Plants were at 5-6 leaf stage.

Canola - Roundup Ready, Langdon 2017-2019

Company	Variety	Height (in)			Lodging (0-9)			Oil[1] (%)			Yield[1] (lbs/a)				
		18	19	2yr	18	19	2yr	18	19	2yr	17	18	19	2yr	3yr
BrettYoung	6074RR	41	47	44	1.3	0.2	0.8	43.9	46.6	45.3	3949	3237	4354	3796	3847
BrettYoung	4187RR	47	49	48	1.5	0.0	0.8	44.6	46.7	45.7	4257	3596	3936	3766	3930
BrettYoung	6090RR	53	47	50	1.3	1.4	1.4	42.9	45.3	44.1	--	3214	3986	3600	--
Canterra Seeds	CS2100	41	47	44	1.3	1.9	1.6	43.3	47.4	45.4	3959	3312	3971	3642	3747
Canterra Seeds	CS2300	46	48	47	1.3	1.1	1.2	43.8	47.0	45.4	4430	3382	4273	3828	4028
Canterra Seeds	CS2600 CR-T	--	47	--	--	4.1	--	--	47.2	--	--	--	4003	--	--
CROPLAN	CP930RR	37	44	41	2.3	1.6	2.0	45.8	49.0	47.4	3676	3189	3450	3320	3438
CROPLAN	CP955RR	37	47	42	2.3	1.3	1.8	45.5	48.3	46.9	3575	3161	3837	3499	3524
CROPLAN	CP9919RR	--	45	--	--	1.3	--	--	44.4	--	--	--	3477	--	--
CROPLAN	CP9978TF	--	44	--	--	1.2	--	--	47.0	--	--	--	4060	--	--
CROPLAN	CP9982RR	--	49	--	--	0.1	--	--	44.5	--	--	--	4136	--	--
Dekalb	DKTF91SC	--	44	--	--	0.7	--	--	46.4	--	--	--	3910	--	--
Dekalb	DKTF92SC	--	45	--	--	0.9	--	--	45.0	--	--	--	4020	--	--
Dyna-Gro	DG 533G	41	47	44	1.3	0.0	0.7	43.8	45.7	44.8	3951	3156	3905	3531	3671
Dyna-Gro	DG 540G	43	44	44	1.5	0.0	0.8	43.4	45.6	44.5	4165	3382	3992	3687	3846
Integra	7389RT	--	46	--	--	1.6	--	--	46.3	--	--	--	4038	--	--
Pioneer	45CM39	--	44	--	--	0.4	--	--	48.6	--	--	--	4274	--	--
Pioneer	45M35	38	46	42	1.5	0.2	0.9	45.9	48.0	47.0	4583	3338	4161	3750	4027
Proseed	300 Mag	36	44	40	2.0	4.2	3.1	44.4	46.4	45.4	4119	3125	3420	3273	3555
Proseed	PS 5000	47	47	47	1.5	4.1	2.8	43.2	44.7	44.0	3725	3275	3496	3386	3499
Star	Star 402	38	43	41	1.5	2.1	1.8	46.4	49.4	47.9	4155	3473	3865	3669	3831
Star	StarFlex	--	43	--	--	1.9	--	--	47.5	--	--	--	3874	--	--
Trial Mean		41	45		1.7	1.5		44.0	46.8		3868	3198	3931		
C.V. %		10.3	5.7		33.8	64.3		1.6	1.8		9.4	6.6	5.1		
LSD 5%		5.9	3.6		0.8	1.3		1.0	1.2		512	297	284		
LSD 10%		4.9	3.0		0.7	1.1		0.8	1.0		428	248	238		

[1] 8.5% Moisture

Dry Bean Summary, Langdon 2017-2019

Variety	Type	Days to Maturity	Plant Height	100 Seed Weight	Yield				
					2017	2018	2019	2 yr Avg.	3 yr Avg.
			(in.)	(g)	----------(lb/a)----------				
LaPaz	Pinto	109	13	36	3730	2741	2564	2653	3012
Lariat	Pinto	107	15	35	3874	2861	2516	2689	3084
Stampede	Pinto	106	15	32	3144	3202	2415	2809	2920
Windbreaker	Pinto	107	14	38	3458	2552	2291	2422	2767
ND Palomino	Pinto	109	13	34	3138	2864	2239	2552	2747
Monterrey	Pinto	107	14	35	3902	3068	2442	2755	3137
ND Falcon	Pinto	108	14	35	--	--	2280	--	--
Vibrant	Pinto	107	14	34	--	--	2693	--	--
Torreon	Pinto	107	14	34	--	--	2553	--	--
HMS Medalist	Navy	107	15	18	3118	2567	2346	2457	2677
T9905	Navy	111	13	21	3948	2781	2065	2423	2931
Blizzard	Navy	110	13	17	--	--	2327	--	--
Eclipse	Black	107	13	19	3858	2679	2181	2430	2906
Loreto	Black	109	13	18	2391	2722	2171	2447	2428
Zorro	Black	107	15	17	2738	3046	2376	2711	2720
Black Tails	Black	111	16	18	--	--	2112	--	--
Merlot	Small Red	107	15	33	2353	2284	2205	2245	2281
Viper	Small Red	109	12	26	--	--	2854	--	--
Rosetta	Pink	111	12	26	3490	2875	2389	2632	2918
Powderhorn	Great Northern	106	12	31	3327	3227	2276	2752	2943
ND Pegasus	Great Northern	109	14	32	--	--	2811	--	--
Trial Mean		108	14	28	3251	2802	2385		
C.V. %		1.8	11.8	5.2	8.2	8.2	10.8		
LSD 5%		3.2	NS	2.5	445	385	427		
LSD 10%		2.6	NS	1.9	370	319	355		

Field Pea, Langdon 2017-2019

Variety	Days to 1st Flower	Mature	Canopy Ht. at Harvest	Harvest Ease[1]	1000 KWT	Test Weight	Protein[2]	Yield			Average	
								2017	2018	2019	2 year	3 year
		(days)	(in)	(0-9)	(g)	(lbs/bu)	(%)	bu/a				
Yellow Cotyledon Type												
Agassiz	55.0	75.0	19.6	5.5	223	61.8	26.5	80.2	92.3	64.3	78.3	78.9
DS Admiral	54.0	74.8	19.5	5.0	250	62.3	25.4	78.9	84.4	61.2	72.8	74.8
Mystique	56.3	78.3	19.9	5.5	251	62.3	26.3	81.7	94.7	65.4	80.1	80.6
Nette 2010	53.0	74.8	19.8	4.0	256	63.3	25.2	79.8	90.2	64.8	77.5	78.3
CDC Amarillo	57.8	78.3	32.8	0.0	236	62.9	25.0	87.5	88.1	68.1	78.1	81.2
CDC Saffron	56.8	77.3	23.7	3.0	262	63.1	26.2	75.0	86.5	71.8	79.2	77.8
AAC Carver	55.5	75.5	24.2	2.5	254	63.1	24.2	90.8	94.5	74.0	84.3	86.4
AC Earlystar	54.5	76.3	18.6	6.0	215	62.6	23.8	74.6	92.4	67.2	79.8	78.1
Jetset	54.3	74.5	22.6	3.0	283	62.1	26.8	73.5	91.9	67.2	79.6	77.5
Spider	56.0	76.5	19.4	6.3	241	62.4	26.8	79.5	88.0	62.6	75.3	76.7
CDC Inca	56.5	77.5	28.0	0.8	243	63.3	25.5	80.8	96.6	70.6	83.6	82.7
AAC Profit	57.5	77.0	26.8	2.5	231	63.1	26.9	--	99.9	69.5	84.7	--
Durwood	54.8	77.3	27.9	1.3	254	62.7	26.3	--	91.3	60.6	76.0	--
Hyline	56.0	76.0	15.7	7.8	257	62.9	25.2	--	94.2	68.7	81.5	--
LG Amigo	55.0	78.0	24.2	3.5	238	62.4	26.5	--	79.4	61.0	70.2	--
LG Sunrise	52.3	76.3	23.4	3.5	246	62.9	25.5	--	83.9	63.7	73.8	--
Salamanca	55.3	76.0	18.7	5.3	273	62.6	27.8	--	90.2	61.2	75.7	--
CDC Spectrum	57.8	79.3	26.0	1.5	252	62.7	26.3	--	--	69.6	--	--
Hampton	56.5	77.5	9.8	9.0	222	61.7	28.2	--	--	59.3	--	--
Majestic	56.0	78.5	30.1	0.8	276	62.6	25.8	--	--	67.4	--	--
AAC Asher	56.0	78.0	18.7	6.3	280	62.3	25.3	--	--	77.1	--	--
DL Apollo	55.3	74.8	26.9	1.3	244	63.3	26.7	--	--	64.0	--	--
AAC Chrome	56.3	79.8	22.7	4.8	262	62.6	24.7	--	--	76.8	--	--
CDC Dakota	59.0	77.5	24.7	2.8	226	62.6	28.4	--	--	63.6	--	--
Astronaute	55.8	76.8	15.3	7.5	273	62.4	27.0	--	--	66.2	--	--
Korando	51.5	75.0	16.1	7.5	290	62.2	28.1	--	--	61.5	--	--
Exp01	53.5	74.3	23.8	2.8	298	62.6	27.4	--	--	66.4	--	--
Green Cotyledon Type												
CDC Striker	55.0	75.3	16.0	6.5	213	62.5	25.9	85.4	89.0	66.1	77.6	80.2
Cruiser	53.3	73.3	14.6	8.5	221	62.1	26.7	70.5	77.7	56.0	66.9	68.1
Arcadia	55.5	75.5	16.8	6.0	210	62.5	25.7	81.0	84.0	65.4	74.7	76.8
AAC Comfort	61.8	80.5	25.6	2.8	281	62.6	26.5	74.8	93.4	66.7	80.1	78.3
CDC Greenwater	58.8	79.5	31.3	0.0	256	63.4	24.8	89.1	88.1	67.9	78.0	81.7
Trial Mean	55.7	76.7	21.9	4.2	250	62.6	26.1	80.2	89.0	66.1		
C.V. %	1.0	1.9	15.3	43.2	2.3	0.6	1.5	6.9	6.3	5.8		
LSD 5%	0.8	2.0	4.7	2.5	11.5	0.5	0.6	7.9	7.9	5.4		
LSD 10%	0.7	1.7	3.9	2.1	9.6	0.4	0.5	6.6	6.6	4.5		

[1] Harvest Ease: 1=plants standing erect, 9=plants laying horizontal.

[2] 0% moisture basis

Faba Bean, Langdon 2019

Variety	Plant Stand Seedling	Days to 1st Flower	Days to Mature	Plant Height	Pod Height 1st Pod	1000 KWT	Protein[2]	Test Weight	Chocolate Brown Spot Inc.	Chocolate Brown Spot Severity	Yield[2]	Seed Yield 2-yr Avg.	Seed Yield 3-yr Avg.
	(ft^2)	(DAP[1])	(DAP[1])	(in)	(in)	(g)	(%)	(lbs/bu)	--------(%)--------		(bu/a)	(bu/a)	(bu/a)
Boxer	5.6	52	97	30	13	462	24.7	63.4	23	2.8	51.3	60.6	78.3
Fanfare	4.5	54	98	31	13	458	25.0	64.7	22	1.7	54.5	62.4	82.9
Laura	5.1	52	98	30	12	459	25.0	64.6	29	2.2	51.9	63.1	83.7
Fabelle	4.7	53	97	30	11	441	26.6	63.9	13	1.3	53.6	66.8	--
CDC Snowdrop	3.3	55	98	29	12	274	22.6	63.6	20	1.7	41.8	--	--
PUSA 1820	5.2	53	96	24	12	414	19.5	61.7	19	1.9	50.4	--	--
PUSA 1920	4.7	51	97	31	12	491	26.9	64.5	24	2.7	53.9	--	--
Tiffany	5.9	54	97	31	13	446	25.8	63.4	23	2.5	55.0	--	--
Trumpet	5.9	55	98	30	12	392	24.8	64.8	17	1.7	58.3	--	--
Trial Mean	5.0	53	97	30	12	426	24.5	63.8	21	2.0	52.3		
C.V. %	16.8	1.3	0.9	8.3	9.4	3.9	1.3	1.3	25.7	26.6	5.9		
LSD 5%	1.2	1.0	1.2	3.6	NS	24.2	0.5	1.2	NS	0.9	4.5		
LSD 10%	1.0	0.8	1.0	3.0	NS	20.0	0.4	1.0	NS	0.8	3.7		

[1] DAP - Days after planting

[2] Yield and protein at 16% moisture.

Targeted plant stand was 4 plants/ft^2.

Roundup Ready Soybean, Langdon 2019 *(page 1 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Protein (%)	Oil (%)	Yield 2019	Yield 2 yr Avg.	Yield 2-site Avg.[4]
								bu/a		
Allegiant	01E23	E3	0.1	9/22	28	31.4	14.7	52.9	--	45.8
Allegiant	009E71	E3	00.9	9/21	29	30.7	14.6	51.4	--	--
Allegiant	07X30N	RR2XT	0.7	9/29	32	31.7	14.4	60.2	--	--
Allegiant	007X32N	RR2XT	00.7	9/13	30	32.1	14.5	49.8	49.0	44.5
Allegiant	008X30N	RR2XT	00.8	9/16	32	32.1	15.6	45.4	47.2	42.2
Allegiant	009X08	RR2XT	00.9	9/16	32	32.9	14.5	54.1	52.2	48.2
Allegiant	009X41	RR2XT	00.9	9/22	28	32.3	15.2	49.7	--	43.8
BioGene	BG8000RR2X	RR2XT	00.9	9/16	32	32.4	15.3	53.4	--	--
BioGene	BG8007RR2X	RR2XT	00.7	9/15	30	31.4	15.2	45.2	--	--
BioGene	BG8008RR2X	RR2XT	00.8	9/15	29	32.4	14.7	46.5	--	--
Dahlman	1001E3	E3	0.1	9/20	26	32.1	14.7	48.2	--	41.7
Dahlman	60009X	RR2XT	00.9	9/21	27	33.3	15.1	50.3	--	45.0
Dyna-Gro	S005XT38	RR2XT	00.5	9/10	30	29.9	15.4	49.6	49.2	44.1
Dyna-Gro	S007XT27	RR2XT	00.7	9/15	31	31.5	15.0	52.0	50.7	44.0
Dyna-Gro	S009XT49	RR2XT	00.9	9/15	31	31.7	15.0	52.5	50.9	46.4
Dyna-Gro	S009XT68	RR2XT	00.9	9/17	32	32.8	13.8	54.1	51.6	47.9
Golden H.	GH00866	RR2Y	00.8	9/13	32	31.7	15.9	52.2	50.3	46.4
Golden H.	GH0145X	RR2XT	0.1	9/15	32	31.2	14.9	50.1	49.3	44.6
Hefty Seed	H008X8	RR2XT	00.8	9/16	31	31.8	15.4	49.7	49.6	44.0
Hefty Seed	H02X9	RR2XT	0.2	9/19	32	31.3	15.0	53.1	50.9	49.9
Integra	20097	RR2Y	00.9	9/20	33	32.2	15.3	54.6	52.7	46.7
Integra	40089N	E3	00.8	9/21	32	31.1	15.2	56.4	--	48.3
Integra	40129	E3	0.1	9/22	27	29.6	16.0	41.3	--	37.8
Integra	50001	RR2XT	0.0	9/23	28	32.3	14.8	52.8	--	43.7
Legacy	LS-00639N RR2X	RR2XT	00.6	9/13	30	31.7	15.2	50.1	--	44.8
Legacy	LS-00829 E3	E3	00.8	9/22	28	31.2	15.4	44.4	--	39.5
Legacy	LS-00930 RR2X	RR2XT	00.9	9/22	27	32.1	15.1	55.4	--	46.6
Legacy	LS-0239N RR2X	RR2XT	0.2	9/22	30	32.2	14.4	56.8	53.4	51.2
Legend	LS 005E953N	E3	00.5	9/23	30	31.8	15.3	47.4	--	--
Legend	LS 007X956N	RR2XT	00.7	9/19	31	32.8	14.4	48.3	48.6	--
Legend	LS 009E955N	E3	00.9	9/21	30	31.1	15.4	44.9	--	--
Legend	LS 009X852N	RR2XT	00.9	9/18	31	31.6	15.5	51.7	49.8	--
Legend	LS 02E963	E3	0.2	9/22	26	31.8	14.8	51.2	--	--
LG Seeds	LGS00663RX	RR2XT	00.6	9/16	28	31.9	14.8	50.6	46.4	43.5
LG Seeds	LGS00899RX	RR2XT	00.8	9/17	32	31.5	15.1	51.8	48.9	45.4
LG Seeds	LGS0111RX	RR2XT	0.1	9/22	33	33.3	14.8	56.4	52.5	50.6
NDSU	ND17009GT	GT	00.9	9/15	31	34.2	15.5	46.0	44.7	41.6
NDSU	ND18008GT	GT	00.8	9/12	29	32.4	15.7	42.3	40.5	37.0

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our northern region. Langdon REC and Pembina County (Cavalier).

No lodging observed in trial.

Yield, oil and protein reported at 13% moisture.

Roundup Ready Soybean, Langdon 2019 *(page 2 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Protein (%)	Oil (%)	Yield 2019 (bu/a)	Yield 2 yr Avg. (bu/a)	Yield 2-site Avg.[4] (bu/a)
Syng NK	S006-R7X	RR2XT	00.6	9/11	28	31.3	15.5	47.3	--	41.9
Syng NK	S007-Y4	RR2Y	00.7	9/10	28	29.7	15.6	48.4	49.4	--
Syng NK	S008-N2	RR2Y	00.8	9/10	30	32.0	15.8	52.0	--	--
NorthStar	NS 60065NXR2	RR2XT	00.6	9/17	31	33.5	14.1	47.6	--	41.5
NorthStar	NS 90084NE3	E3	00.7	9/23	29	31.3	15.2	50.5	--	44.0
NorthStar	NS 90094E3	E3	00.9	9/21	30	31.9	15.5	46.7	--	39.7
NorthStar	NS 90214E3	E3	0.1	9/21	27	32.5	14.4	51.1	--	44.6
Peterson	18X008	RR2XT	00.8	9/14	29	31.4	15.2	51.5	50.5	46.0
Peterson	19EN008	E3	00.8	9/21	31	32.3	15.2	53.9	--	44.8
Peterson	20X01	RR2XT	0.1	9/24	27	32.4	15.1	53.3	--	45.0
Pioneer	P006A37X	RR2XT	00.6	9/11	27	30.0	16.0	47.9	45.9	--
Pioneer	P00A49X	RR2XT	0.0	9/23	34	31.3	15.2	53.4	49.8	45.1
Pioneer	P01A84X	RR2XT	0.1	9/23	30	30.1	15.8	52.8	--	45.7
Pioneer	P03A17X	RR2XT	0.3	9/25	28	32.0	15.2	46.2	--	42.7
Proseed	50-10	RR2Y	0.1	9/17	32	32.2	15.6	53.2	--	47.7
Proseed	XT 60-09	RR2XT	00.9	9/16	34	33.6	14.3	54.7	51.2	47.1
Proseed	XT 80-20N	RR2XT	0.2	9/21	30	30.5	15.7	55.9	52.3	48.6
Proseed	XT 90-06	RR2XT	00.6	9/12	30	30.2	15.4	49.2	--	42.7
REA	RX00749	RR2XT	00.7	9/15	30	31.8	14.7	45.2	45.7	39.8
REA	RX00810	RR2XT	00.8	9/15	25	31.6	15.2	52.4	--	42.7
REA	RX0228	RR2XT	0.2	9/21	35	32.1	15.5	53.5	50.3	47.8
Stine	01EA63	E3	00.9	9/22	28	32.3	14.7	50.7	--	43.4
Thunder	36008 R2YN	RR2Y	00.8	9/17	32	33.6	14.4	56.3	--	--
Thunder	ASTRO	RR2Y	00.8	9/19	33	33.5	14.4	49.9	50.4	45.1
Thunder	SB8001	RR2XT	0.1	9/22	26	33.1	15.2	54.2	--	44.9
Thunder	SB88007N	RR2XT	00.7	9/14	31	31.7	15.5	50.6	50.2	44.7
Thunder	3601 R2Y	RR2Y	0.1	9/17	31	32.8	15.6	47.3	--	43.9
Thunder	TE7902	E3	0.2	9/23	27	31.4	14.4	49.9	--	43.2
Trial Mean				9/17	30	31.8	15.1	50.6		
C.V. %				1.3	6.5	--	--	8.1		
LSD 5%				2.2	2.7	--	--	5.7		
LSD 10%				1.9	2.3	--	--	4.8		

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our northern region. Langdon REC and Pembina County (Cavalier).

No lodging observed in trial.

Yield, oil and protein reported at 13% moisture.

Roundup Ready Soybean, Pembina County 2019 *(page 1 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Yield 2019	Yield 2 yr Avg.	Yield 2-site Avg.[4]
						bu/a		
Allegiant	007X32N	RR2XT	00.7	9/6	26	39.1	32.5	44.5
Allegiant	008X30N	RR2XT	00.8	9/8	29	38.9	33.8	42.2
Allegiant	009X08	RR2XT	00.9	9/9	29	42.2	35.5	48.2
Allegiant	01E23	E3	0.1	9/12	23	38.7	--	45.8
Allegiant	009x41	RR2Y	0.1	9/13	23	37.9	--	43.8
Dahlman	1001E3	E3	0.1	9/13	23	35.1	--	41.7
Dahlman	60009X	RR2XT	00.9	9/11	23	39.7	--	45.0
Dyna-Gro	S005XT38	RR2XT	00.5	9/6	26	38.5	32.5	44.1
Dyna-Gro	S007XT27	RR2XT	00.7	9/7	28	36.0	31.9	44.0
Dyna-Gro	S009XT49	RR2XT	00.9	9/8	28	40.2	33.9	46.4
Dyna-Gro	S009XT68	RR2XT	00.9	9/9	30	41.6	35.6	47.9
Golden H.	GH00866	RR2Y	00.8	9/6	27	40.5	34.0	46.4
Golden H.	GH0145X	RR2XT	0.1	9/10	28	39.1	33.3	44.6
Hefty Seed	H008X8	RR2XT	00.8	9/7	28	38.3	33.2	44.0
Hefty Seed	H02X9	RR2XT	0.2	9/14	29	46.6	37.6	49.9
Integra	20097	RR2Y	00.9	9/7	27	38.7	33.1	46.7
Integra	40089N	E3	00.8	9/11	29	40.2	--	48.3
Integra	40129	E3	0.1	9/12	24	34.3	--	37.8
Integra	50001	RR2XT	0.0	9/14	22	34.6	--	43.7
Legacy	LS-00639N RR2X	RR2XT	00.6	9/5	27	39.4	--	44.8
Legacy	LS-00829 E3	E3	00.8	9/12	24	34.6	--	39.5
Legacy	LS-00930 RR2X	RR2XT	00.9	9/13	21	37.8	--	46.6
Legacy	LS-0239N RR2X	RR2XT	0.2	9/12	27	45.6	36.3	51.2
LG Seeds	LGS00663RX	RR2XT	00.6	9/8	26	36.3	30.9	43.5
LG Seeds	LGS00899RX	RR2XT	00.8	9/7	27	38.9	--	45.4
LG Seeds	LGS0111RX	RR2XT	0.1	9/13	31	44.7	37.7	50.6
NDSU	ND17009GT	GT	00.9	9/10	28	37.1	32.5	41.6
NDSU	ND18008GT	GT	00.8	9/5	25	31.7	28.4	37.0
Syng NK	S006-R7X	RR2XT	00.6	9/5	25	36.4	--	41.9
Syng NK	S01-C4X	RR2XT	0.1	9/10	29	42.4	35.5	--
Syng NK	S02-E3	E3	0.2	9/14	23	39.7	--	--
Syng NK	S02-F9X	RR2XT	0.2	9/11	25	43.0	--	--
NorthStar	NS 60065NXR2	RR2XT	00.6	9/5	27	35.3	--	41.5
NorthStar	NS 90084NE3	E3	00.7	9/11	29	37.4	--	44.0
NorthStar	NS 90094E3	E3	00.9	9/11	25	32.7	--	39.7

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our northern region. Langdon REC and Pembina County (Cavalier).

Yield, oil and protein reported at 13% moisture.

Roundup Ready Soybean, Pembina County 2019 *(page 2 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Yield 2019 (bu/a)	Yield 2 yr Avg. (bu/a)	Yield 2-site Avg.[4] (bu/a)
NorthStar	NS 90214E3	E3	0.1	9/14	23	38.1	--	44.6
Peterson	18X008	RR2XT	00.8	9/7	28	40.5	34.4	46.0
Peterson	19EN008	E3	00.8	9/10	28	35.7	--	44.8
Peterson	20X01	RR2XT	0.2	9/15	23	36.6	--	45.0
Pioneer	P00A49X	RR2XT	0.0	9/13	29	36.7	--	45.1
Pioneer	P01A84X	RR2XT	0.1	9/14	25	38.6	--	45.7
Pioneer	P03A17X	RR2XT	0.3	9/12	26	39.2	--	42.7
Proseed	50-10	RR2Y	0.1	9/7	28	42.2	--	47.7
Proseed	XT 60-09	RR2XT	00.9	9/8	28	39.5	33.9	47.1
Proseed	XT 80-20N	RR2XT	0.2	9/13	26	41.2	33.5	48.6
Proseed	XT 90-06	RR2XT	00.6	9/4	27	36.2	--	42.7
REA	RX00749	RR2XT	00.7	9/5	27	34.4	30.5	39.8
REA	RX00810	RR2XT	00.8	9/6	22	32.9	--	42.7
REA	RX0228	RR2XT	0.2	9/10	29	42.1	35.6	47.8
Stine	01EA63	E3	00.9	9/14	22	36.1	--	43.4
Thunder	ASTRO	RR2Y	00.8	9/8	29	40.2	34.8	45.1
Thunder	SB8001	RR2XT	0.1	9/13	22	35.6	--	44.9
Thunder	SB87009	RR2XT	00.9	9/10	29	41.5	35.3	--
Thunder	SB88007N	RR2XT	00.7	9/6	28	38.8	33.2	44.7
Thunder	3601 R2Y	RR2Y	0.1	9/7	29	40.4	34.5	43.9
Thunder	TE7902	E3	0.2	9/16	22	36.4	--	43.2
Trial Mean				9/9	26	38.4		
C.V. %				1.3	7.4	7.9		
LSD 5%				1.9	2.7	4.2		
LSD 10%				1.6	2.3	3.5		

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our northern region. Langdon REC and Pembina County (Cavalier).

Yield, oil and protein reported at 13% moisture.

Roundup Ready Soybean, Nelson County 2019 *(page 1 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Lodging (0-9)	Protein (%)	Oil (%)	Yield 2019 bu/a	Yield 2 yr Avg. bu/a	Yield 2-site Avg.[4] bu/a
Allegiant	01E23	E3	0.1	9/16	33	2.7	33.3	14.9	38.4	--	--
Allegiant	02X21N	RR2XT	0.1	9/16	34	2.4	33.1	14.2	51.2	--	--
Allegiant	04X08N	RR2XT	0.2	9/22	35	0.8	34.2	15.1	57.0	--	--
Dahlman	1003E3	E3	0.3	9/22	28	0.0	33.4	14.5	44.4	--	34.8
Dahlman	6903XN	RR2XT	0.3	9/16	34	1.0	32.1	15.3	51.7	--	44.9
Dairyland	DSR-0200/R2Y	RR2Y	0.2	9/12	37	1.8	33.8	14.9	49.6	47.7	40.5
Dairyland	DSR-C999/R2Y	RR2Y	00.9	9/17	33	0.0	32.2	14.9	47.7	50.4	41.1
Dyna-Gro	S009XT68	RR2XT	00.9	9/12	37	1.3	33.5	13.9	53.3	52.9	41.4
Dyna-Gro	S03XT29	RR2XT	0.3	9/16	36	1.2	33.2	13.8	53.3	52.3	45.1
Dyna-Gro	S04XT77	RR2XT	0.4	9/19	31	0.2	33.5	15.1	53.5	53.4	41.8
Golden H.	GH0145X	RR2XT	0.1	9/14	35	1.1	32.6	14.5	52.4	--	42.1
Golden H.	GH0308X	RR2XT	0.3	9/16	31	0.3	33.2	14.1	51.4	--	42.8
Hefty	H008X8	RR2XT	00.8	9/10	34	1.4	32.2	15.5	44.1	--	37.5
Hefty	H02X9	RR2XT	0.2	9/17	35	1.2	32.6	14.2	56.7	--	45.3
Hefty	H03X8	RR2XT	0.3	9/20	36	0.0	32.5	14.2	52.9	49.8	41.5
Hefty	H03E9	E3	0.3	9/23	31	0.0	33.7	14.2	49.6	--	36.5
Integra	40209	E3	0.2	9/16	29	2.5	33.3	15.0	40.3	--	35.7
Integra	50001	RR2XT	0.0	9/19	31	0.0	33.7	14.7	45.4	--	37.9
Integra	50309N	RR2XT	0.3	9/17	34	1.3	32.9	14.7	49.1	52.2	42.1
Legacy	LS-0239N RR2X	RR2XT	0.2	9/15	34	1.2	32.1	14.6	58.0	55.3	48.0
Legacy	LS-0337N RR2X	RR2XT	0.3	9/19	33	0.0	33.9	15.1	55.4	55.7	44.4
Legacy	LS-0429 E3	E3	0.4	9/20	35	0.6	34.1	14.8	50.7	--	42.7
Legacy	LS-0438 RR2X	RR2XT	0.4	9/22	33	0.1	34.3	15.1	56.3	55.0	45.1
LG Seeds	LGS00663RX	RR2XT	00.6	9/10	29	1.2	31.2	15.8	44.7	43.6	35.0
LG Seeds	LGS00899RX	RR2XT	00.8	9/9	32	0.6	32.2	16.1	50.8	49.7	39.8
LG Seeds	LGS0111RX	RR2XT	0.1	9/16	34	0.6	34.4	15.2	51.8	51.0	43.7
LG Seeds	LGS0355RX	RR2XT	0.3	9/17	35	0.6	33.2	14.1	55.4	52.9	46.2
LG Seeds	LGS0400RX	RR2XT	0.4	9/21	35	0.1	32.8	14.7	52.5	53.8	45.9
NDSU	ND17009GT	GT	00.9	9/10	34	0.1	35.9	15.4	45.0	45.1	35.6
NDSU	ND18008GT	GT	00.8	9/9	31	0.6	33.0	15.9	35.6	35.7	27.8

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our southern region, Walsh County (Park River) and Nelson County (Pekin).

No lodging observed in trial.

Yield, oil and protein reported at 13% moisture.

Roundup Ready Soybean, Nelson County 2019 *(page 2 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity	Plant Height	Lodging	Protein	Oil	Yield 2019	Yield 2 yr Avg.	Yield 2-site Avg.[4]
				date[3]	(in)	(0-9)	(%)	(%)	bu/a		
Syng NK	S01-C4X	RR2XT	0.1	9/14	34	0.1	32.0	14.6	51.9	--	42.1
Syng NK	S02-F9X	RR2XT	0.2	9/16	31	0.0	31.3	15.7	51.4	--	41.7
Syng NK	S03-E3	E3	0.2	9/16	31	1.7	32.3	14.7	49.3	--	--
Syng NK	S03-S6X	RR2XT	0.3	9/16	33	0.9	32.4	14.7	51.8	--	40.0
Syng NK	S05-N5X	RR2XT	0.5	9/22	31	0.0	32.7	14.6	60.1	--	--
Peterson	20EN02	E3	0.2	9/17	30	2.0	34.0	14.6	42.5	--	37.2
Peterson	20EN03	E3	0.3	9/19	32	1.2	31.4	14.8	44.5	--	36.7
Proseed	50-10	RR2Y	0.1	9/10	39	2.1	32.8	16.1	53.5	--	44.0
Proseed	BX 80-35	LLGT27	0.3	9/22	31	0.1	36.3	14.0	58.9	--	48.4
Proseed	XT 60-40	RR2XT	0.4	9/20	33	0.0	33.8	15.3	54.3	--	42.8
Proseed	XT 60-09	RR2XT	00.9	9/11	36	0.6	33.1	14.6	54.2	52.6	44.4
Proseed	XT 80-20N	RR2XT	0.2	9/16	31	2.1	33.0	14.1	48.9	49.8	42.4
REA	RX00810	RR2XT	00.8	9/7	29	0.1	32.2	15.3	39.4	--	32.5
REA	RX0228	RR2XT	0.2	9/16	39	0.2	33.6	14.7	47.6	45.3	37.8
REA	RX0330	RR2XT	0.3	9/22	33	0.2	32.8	14.6	46.8	--	39.0
Thunder	SB8001	RR2XT	0.1	9/17	30	0.5	33.3	15.3	45.5	--	37.9
Thunder	SB8903N	RR2XT	0.3	9/16	36	1.8	32.2	14.1	54.4	54.8	45.1
Thunder	3601 R2Y	RR2Y	0.1	9/13	36	1.7	32.1	16.0	52.6	51.9	42.5
Thunder	TE7003	E3	0.3	9/18	33	2.4	32.8	14.7	48.0	--	39.5
Thunder	TE7902	E3	0.2	9/18	32	1.3	33.4	14.2	42.2	--	35.7
Trial Mean				9/16	33	0.8	--	--	50.1		
C.V. %				1.3	8.7	112	--	--	6.2		
LSD 5%				2.1	4.0	1.2	--	--	4.3		
LSD 10%				1.8	3.3	1.0	--	--	3.7		

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our southern region, Walsh County (Park River) and Nelson County (Pekin).

No lodging observed in trial.

Yield, oil and protein reported at 13% moisture.

Roundup Ready Soybean, Walsh County 2019 *(page 1 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Yield 2018	Yield 2019	Yield 2 yr Avg.	Yield 2-site Avg.[4]
						bu/a	bu/a	bu/a	bu/a
Dahlman	1003E3	E3	0.3	9/19	16	--	25.2	--	34.8
Dahlman	6903XN	RR2XT	0.3	9/14	20	--	38.0	--	44.9
Dairyland	DSR-0200/R2Y	RR2Y	0.2	9/6	21	51.5	31.3	41.4	40.5
Dairyland	DSR-C999/R2Y	RR2Y	00.9	9/11	20	60.6	34.5	47.6	41.1
Dyna-Gro	S009XT68	RR2XT	00.9	9/7	20	51.8	29.4	40.6	41.4
Dyna-Gro	S03XT29	RR2XT	0.3	9/13	21	51.9	36.9	44.4	45.1
Dyna-Gro	S04XT77	RR2XT	0.4	9/15	17	58.3	30.0	44.2	41.8
Golden H.	GH0145X	RR2XT	0.1	9/9	19	--	31.7	--	42.1
Golden H.	GH0308X	RR2XT	0.3	9/14	18	--	34.2	--	42.8
Hefty	H008X8	RR2XT	00.8	9/4	22	--	30.9	--	37.5
Hefty	H02X9	RR2XT	0.2	9/12	20	--	33.8	--	45.3
Hefty	H03X8	RR2XT	0.3	9/16	21	58.5	30.0	44.3	41.5
Hefty	H03E9	E3	0.3	9/18	17	--	23.3	--	36.5
Integra	40209	E3	0.2	9/14	17	--	31.0	--	35.7
Integra	50001	RR2XT	0.0	9/12	18	--	30.4	--	37.9
Integra	50309N	RR2XT	0.3	9/13	20	57.2	35.0	46.1	42.1
Legacy	LS-0239N RR2X	RR2XT	0.2	9/13	21	56.0	38.0	47.0	48.0
Legacy	LS-0337N RR2X	RR2XT	0.3	9/15	20	54.9	33.3	44.1	44.4
Legacy	LS-0429 E3	E3	0.4	9/14	20	55.0	34.7	44.9	42.7
Legacy	LS-0438 RR2X	RR2XT	0.4	9/15	20	--	33.8	--	45.1
LG Seeds	LGS00663RX	RR2XT	00.6	9/5	18	61.3	25.3	43.3	35.0
LG Seeds	LGS00899RX	RR2XT	00.8	9/6	20	60.2	28.7	44.5	39.8
LG Seeds	LGS0111RX	RR2XT	0.1	9/14	22	54.7	35.5	45.1	43.7
LG Seeds	LGS0355RX	RR2XT	0.3	9/13	21	47.0	36.9	42.0	46.2
LG Seeds	LGS0400RX	RR2XT	0.4	9/16	23	53.2	39.3	46.3	45.9
NDSU	ND17009GT	GT	00.9	9/10	20	55.0	26.2	40.6	35.6
NDSU	ND18008GT	GT	00.8	9/4	16	49.4	20.0	34.7	27.8
Syng NK	S01-C4X	RR2XT	0.1	9/9	21	61.7	32.2	47.0	42.1
Syng NK	S02-E3	E3	0.2	9/14	17	--	28.5	--	--
Syng NK	S02-F9X	RR2XT	0.2	9/7	18	--	32.0	--	41.7
Syng NK	S03-G9	RR2Y	0.3	9/14	19	57.8	35.5	46.7	--
Syng NK	S03-S6X	RR2XT	0.3	9/10	21	--	28.2	--	40.0
NorthStar	NS 60264NXR2	RR2XT	0.2	9/12	20	58.3	36.9	47.6	--

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist, LLGT27=Liberty Link GT27

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our southern region, Walsh County (Park River) and Nelson County (Pekin).

Yield reported at 13% moisture.

Roundup Ready Soybean, Walsh County 2019 *(page 2 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Yield 2018	Yield 2019	Yield 2 yr Avg.	Yield 2-site Avg.[4]
						----------bu/a----------			
NorthStar	NS 90094E3	E3	00.9	9/15	19	--	28.5	--	--
NorthStar	NS 90214E3	E3	0.1	9/14	18	--	28.4	--	--
NorthStar	NS 90334E3	E3	0.3	9/16	19	--	30.4	--	--
Peterson	18X008	RR2XT	00.8	9/6	22	51.4	29.5	40.5	--
Peterson	19EN008	E3	00.8	9/11	21	--	30.3	--	--
Peterson	20EN02	E3	0.2	9/16	17	--	31.8	--	37.2
Peterson	20EN03	E3	0.3	9/16	20	--	28.8	--	36.7
Pioneer	P00A49X	RR2XT	0.0	9/9	19	--	31.1	--	--
Pioneer	P01A84X	RR2XT	0.1	9/11	22	--	32.1	--	--
Pioneer	P03A17X	RR2XT	0.2	9/15	20	--	35.6	--	--
Proseed	50-10	RR2Y	0.1	9/6	22	--	34.5	--	44.0
Proseed	BX 80-35	LLGT27	0.3	9/16	19	--	37.9	--	48.4
Proseed	XT 60-40	RR2XT	0.4	9/15	20	--	31.3	--	42.8
Proseed	XT 60-09	RR2XT	00.9	9/6	24	54.3	34.6	44.5	44.4
Proseed	XT 80-20N	RR2XT	0.2	9/13	20	54.1	35.8	45.0	42.4
REA	RX00810	RR2XT	00.8	9/4	17	--	25.6	--	32.5
REA	RX0228	RR2XT	0.2	9/7	21	56.9	28.0	42.5	37.8
REA	RX0330	RR2XT	0.3	9/16	19	--	31.2	--	39.0
Thunder	SB8001	RR2XT	0.1	9/9	18	--	30.2	--	37.9
Thunder	SB87009	RR2XT	00.9	9/7	20	50.2	31.0	40.6	--
Thunder	SB8903N	RR2XT	0.3	9/12	20	55.8	35.7	45.8	45.1
Thunder	3601 R2Y	RR2Y	0.1	9/7	23	54.7	32.4	43.6	42.5
Thunder	TE7003	E3	0.3	9/15	18	--	30.9	--	39.5
Thunder	TE7902	E3	0.2	9/15	19	--	29.1	--	35.7
Trial Mean				9/11	19	55.5	31.6		
C.V. %				1.3	10.7	13.1	9.4		
LSD 5%				2.0	2.9	10.2	4.2		
LSD 10%				1.7	2.4	8.5	3.5		

[1]Herbicide Trait - RR2XT= RR2Xtend, GT= Glyphosate Tolerant, E3=Enlist, LLGT27=Liberty Link GT27

[2]Maturity Group provided by company.

[3]Date of physiological maturity at 95% brown pod.

[4]A 2-site average of our southern region, Walsh County (Park River) and Nelson County (Pekin).

Yield reported at 13% moisture.

Conventional - Liberty Link Soybean, Langdon 2019

Brand	Variety	Maturity Group[1]	Maturity date[2]	Plant Height (in)	Protein (%)	Oil (%)	Yield 2019	Yield 2 yr Avg.	Yield 2 -site Avg.[3]
Conventional:							---------bu/a--------		
Caldbeck Consulting	ATSOY062234	00.6	9/3	28	31.4	15.7	38.4	--	--
Caldbeck Consulting	ATSOY121302	00.4	8/29	28	30.5	16.4	34.0	--	--
Caldbeck Consulting	ATSOY102408	00.6	9/5	27	32.3	15.4	36.8	--	--
Caldbeck Consulting	ATSOY0825X2	00.7	9/13	24	33.6	13.3	39.3	--	--
Caldbeck Consulting	ATSOY082500	00.4	9/5	26	31.4	16.1	31.7	--	--
Caldbeck Consulting	ATSOY080668	00.6	9/1	22	31.8	16.8	37.5	--	--
Caldbeck Consulting	ATSOY110978	00.6	9/4	28	31.1	16.4	37.7	--	--
NDSU	ND Benson	0.4	9/23	25	32.9	16.0	41.1	--	32.9
NDSU	ND Henson	0.0	9/15	23	31.4	16.4	44.2	47.2	32.7
NDSU	ND Rolette	00.9	9/16	25	30.4	16.5	43.6	47.0	32.3
Richland IFC	MK0249	0.2	9/22	24	31.8	15.0	34.4	38.2	--
Sevita International	Meteor	00.8	9/13	25	34.2	15.0	36.8	--	26.9
Sevita International	Astor	0.2	9/16	24	33.5	15.9	40.6	--	36.8
Roundup Ready Check Varieties:									
	RR2Y Check #1	00.6	9/10	26	30.2	15.6	40.5	45.1	32.2
	RR2Y Check #2	00.8	9/11	26	30.9	15.2	47.1	49.1	40.2
	RR2Y Check #3	00.9	9/12	28	32.0	14.9	42.0	47.4	37.6
	RR2Y Check #4	0.2	9/13	25	31.8	15.3	45.9	--	41.7
Trial Mean			9/14	25	31.6	15.8	42.1		
C.V. %			1.4	7.5	2.2	1.8	6.3		
LSD 5%			2.3	2.6	1.4	0.6	3.7		
LSD 10%			1.9	2.2	1.2	0.5	3.1		

[1]Maturity Group provided by company.

[2]Date of physiological maturity at 95% brown pod.

[3]A 2-site average of conventional trials at Langdon REC and Walsh County (Park River).

Yield, oil and protein reported at 13% moisture.

No lodging in trial.

Conventional - Liberty Link Soybean, Walsh County 2019

Brand	Variety	Maturity Group[1]	Maturity	Plant Height	Yield 2019	Yield 2 yr Avg.	Yield 2-site Avg.[3]
Conventional:			date[2]	(in)	---------bu/a--------		
Sevita International	Meteor	00.8	9/14	13	17.0	--	26.9
Sevita International	Astor	0.2	9/19	17	32.9	--	36.8
NDSU	ND Benson	0.4	9/24	18	24.7	--	32.9
NDSU	ND Henson	0.0	9/16	16	21.1	36.6	32.7
NDSU	ND Rolette	00.9	9/17	15	21.0	--	32.3
Roundup Ready Check Varieties:							
	RR2Y Check #1	00.6	9/9	16	23.8	37.0	32.2
	RR2Y Check #2	00.8	9/9	16	33.2	--	40.2
	RR2Y Check #3	00.9	9/10	18	33.2	41.2	37.6
	RR2Y Check #4	0.2	9/12	19	37.5	--	41.7
Trial Mean			9/17	16	25.7		
C.V. %			1.4	11.9	17.1		
LSD 5%			2.3	2.7	6.2		
LSD 10%			1.9	2.3	5.2		

[1]Maturity Group provided by company.

[2]Days to physiological maturity at R7 stage (one brown pod on the main stem obtains mature brown or tan color).

[3]A 2-site average of conventional trials at Langdon REC and Walsh County (Park River).

Yield, oil and protein reported at 13% moisture.

No lodging in trial.

Rye, Langdon 2019

Variety	Winter Survival	Julian Days to Head	Plant Height (in)	Test Weight (lbs/bu)	Yield (bu/a)	2 yr Avg. Yield (bu/a)	3 yr Avg. Yield (bu/a)
Aroostok	86	162	47	53.8	53.2	51.5	53.8
Dacold	60	167	42	54.7	58.8	61.9	66.4
ND Gardner	91	161	43	54.4	55.8	55.9	64.0
Hancock	45	166	44	53.5	44.3	50.3	59.7
ND Dylan	85	165	44	54.8	71.7	71.2	79.1
Rymin	79	165	42	55.2	65.9	69.4	76.2
Spooner	80	164	45	54.5	61.2	57.8	61.9
Brasetto	70	165	34	53.6	82.6	85.7	103.2
Hazlet	93	164	43	55.7	71.8	68.7	78.0
Wheeler	53	167	48	50.2	22.2	31.0	37.9
Bono	83	165	36	54.8	89.7	--	--
Trial Mean	75	165	43	54.1	61.5		
C.V. %	21.7	0.5	5.8	1.2	11.7		
LSD 5%	23.5	1.3	3.6	1.0	10.4		
LSD 10%	19.5	1.1	3.0	0.8	8.6		

No lodging in 2019.

Air temperatures were 7° F lower than average from planting to October 24.

Hemp, Langdon 2019

Variety	Plant Stand	PLSE[1]	Seedling Mortality	Plant Height	Test Weight	Oil[4]	Grain Yield				
							2017	2018	2019	2 yr. Avg.	3 yr. Avg.
	(/ft^2)	(%)	(%)	(in)	(lbs/bu)	(%)	lbs/a				
CRS-1	9.6	60	40	59	40.7	32.7	1891	1135	1400	1267	1475
CFX-1	8.6	54	46	48	41.2	33.0	2052	1236	1282	1259	1523
CFX-2	9.7	61	40	53	40.8	32.5	1949	1031	1361	1196	1447
Grandi	13.0	82	19	45	40.7	32.1	1729	1157	1256	1206	1381
Katani	9.7	61	39	41	41.2	32.6	1820	1164	1151	1158	1378
Picolo	10.5	66	34	40	41.0	32.3	1686	1085	1138	1112	1303
Canda	9.8	61	39	62	40.0	30.5	2005	802	1361	1081	1389
Joey	10.5	66	34	56	40.7	30.5	1991	905	1190	1048	1362
X-59	9.9	62	39	52	40.6	30.0	2022	979	1544	1261	1515
Cyclone V-1 TRT[2,3]	5.7	36	64	74	--	--	--	--	--	--	--
Cyclone V-1, CK[3]	7.2	45	55	72	--	--	--	--	--	--	--
Altair TRT[2]	11.6	67	33	65	38.5	31.1	--	--	1400	--	--
Altair CK	12.5	73	28	68	38.1	30.4	--	--	1177	--	--
Rigel TRT[2]	9.4	71	29	69	39.0	31.1	--	--	1295	--	--
Rigel CK	9.0	69	32	68	38.9	30.5	--	--	1256	--	--
Trial Mean	10.0	63	37	59	40.1	31.5	1907	1031	1293		
C.V. %	16.2	16.2	28.0	6.8	1.5	1.7	8.7	10.6	11.8		
LSD 5%	2.3	14.7	14.6	5.8	0.9	0.8	240	158	218		
LSD 10%	1.9	12.2	12.2	4.8	0.7	0.6	199	131	182		

[1]Pure live seed emergence

[2]TRT= Metalaxyl + Ipconazole 3 fl oz/100 lb seed, varieties with a 'CK' received none.

[3]Cyclone V-1 did not reach maturity before a killing frost.

[4]Oil content reported as is basis (uniformly dried to approximately 3% moisture).

Target seeding rate was 16 PLS/ft^2 which includes 25% extra for expected mortality loss. Altair and Rigel seeding rate was 17 and 13 PLS/ft^2 inclulding 25% for mortality loss, respectively. This was due to late seed arrival with seed weight and germinations completed after seeding the trial.

Previous crop: Barley

Cultivar Evaluation to Manage Clubroot on Canola

Venkat Chapara

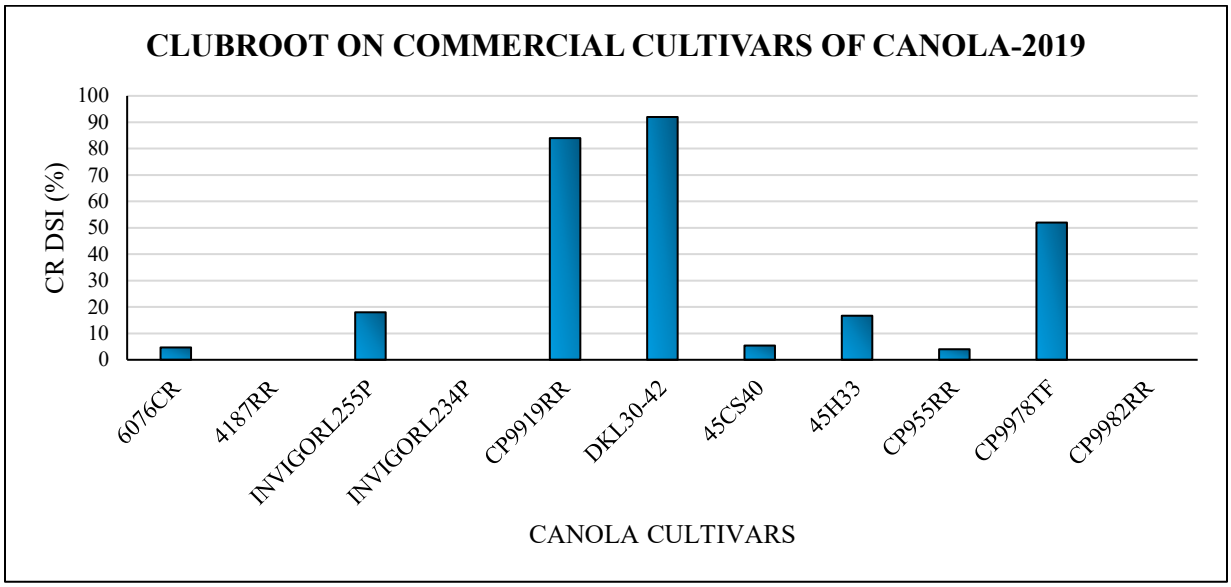
Objective: To evaluate the resistance potential of commercial canola cultivars against clubroot pathogen in field conditions.
Canola cultivars/varieties: Eleven commonly cultivated canola varieties were planted to determine the level of resistance against clubroot (Table 1).
Planted: First week of June (Hand planted after thorough tillage with a rototiller.)
Field design: Randomized complete block design (RCBD) with four replications.
Plot size: 3 ft. x 5ft.

Table 1: Commonly cultivated canola cultivars/varieties in Cavalier County.

Cultivar	Description
6076CR	BrettYoung Seeds
4187RR	BrettYoung Seeds
INVIGOR L255PC	BASF
INVIGOR L234P	BASF
CP9919RR	Croplan Genetics
DKL30-42	Cargill
45CS40	Pioneer (Corteva)
45H33	Pioneer (Corteva)
CP955RR	Croplan Genetics
CP9978TF	Croplan Genetics
CP9982RR	Croplan Genetics

Clubroot Evaluated: Early August (59 days after planting).
Clubroot Disease Index (CRDI):
CRDI: <30% of Susceptible Check = Resistant (R)
CRDI: 30-69% = Intermediate (I)
CRDI: ≥70% = Susceptible (S)
Note: To validate a clubroot research trial, the susceptible check should have > 60% of Disease Index.

Figure 1: Mean clubroot incidence (%) on various commercial cultivars of canola tested in 2019.



Results: Canola cultivars 6076CR, 4187RR, InVigor L234P, InVigor L255PC, 45H33, 45CS40 CP955RR and CP9982RR showed resistance to clubroot and were significantly different from other varieties tested.

Future research: Testing more commercial cultivars of canola will be helpful to growers and to monitor clubroot in available resistant varieties of canola.

Monitoring clubroot in resistant varieties: (By Canola Council of Canada)

"*Growers using clubroot-resistant varieties in clubroot-infested fields may experience some infected plants, which can be attributed to susceptible volunteers and off-types. Volunteer canola seed can germinate many years after it was last grown, and if this comes from a susceptible canola crop, then the volunteers will be susceptible. Off-types are a normal part of hybrid canola production – no canola hybrid is 100% pure, so there may be a small proportion (1 to 4%) of the seed that is susceptible.*

***When scouting, if more than 10% of seeded plants (do not count volunteers) are infected, that may indicate that the clubroot resistance is no longer functional against the pathogen population in the field. These infected plants may be restricted to a small patch which indicates a recent pathogen change*.**"

End Note: Practice crop rotation (one canola crop in three years).

Management of Clubroot (*Plasmodiophora brassicae*) using Chemicals, Surfactants, and Various types of Lime

Venkat Chapara

Objective: Effect of surfactant (ORO-RZ) alone, fungicides along with a surfactant, and various types of lime alone and along with surfactant to manage clubroot on canola in patches.

Methods: The following treatments (Table 1) were tested alone and along with a surfactant (ORO-RZ®) in a Randomized Complete Block Design, replicated four times under field conditions. The field has natural soil population of *P. brassicae* of 5.5 million resting spores/g of soil. Treatments of ORO-RZ, Aquagro, Ranman, allegro, nanocal, and *Trichoderma* were applied in-furrow just before planting at the rate mentioned in Table 1. Whereas, lime and beet lime were incorporated at a depth of 4-6 inches a week before planting. The canola seed of "DKL 30-42" (susceptible cultivar to clubroot) was planted at a depth of one half inch. Beet lime was acquired from American Crystal Sugar Factory, Drayton, ND. Whereas, lime was acquired from the Langdon land fill (a by-product of lime sludge and remains from the Langdon water plant). The trial was planted in the first week of June and evaluated the first week of August (exactly 60 days after planting) at growth stage BBCH-65.

Rating scale: Clubroot rating scale: 0 = no galling, 1 = a few small galls (small galls on less than 1/3 of roots), 2 = moderate galling (small to medium-sized galls on 1/3 to 2/3 of roots), 3 = severe galling (medium to large-sized galls on more than 2/3 of roots) (S.E. Strelkov). The rating scale was used for disease rating of incidence and severity. A Clubroot Disease Severity Index (CRDSI) was calculated using the incidence and severity data of clubroot obtained.

Soil sampling to determine pH: Soil samples were collected from all the plots before application of soil treatments and on the day of clubroot evaluations to know the effect of unit change in pH and their impact on clubroot control.

Table 1: Effect of treatments applied in-furrow before planting on clubroot disease severity index (DSI %), and the change in soil pH before and after the application.

Name	Rate	Clubroot DSI (%)	pH before	pH after
ORO-RZ	2 pt/a	**28**	**5.95**	**6.38**
TRICHODERMA	10.5 oz/a	**46.3**	**5.8**	**6.2**
AQUAGRO + ORO-RZ	10 g/meter of row	**37**	**5.58**	**5.98**
RANMAN + ORO-RZ	7.5 l/ha	**26**	**5.95**	**6.28**
ALLEGRO + ORO-RZ	1.75 l/ha	**49.3**	**5.83**	**6.18**
BEET LIME + ORO-RZ	7.5 tons/ha	**42**	**5.45**	**6.13**
NANOCAL	4 pt/a	**63.3**	**5.68**	**6.18**
LIME + ORO-RZ	7.5 tons/ha	**75**	**5.15**	**6.03**
BEET LIME	7.5 tons/ha	**13.3**	**5.4**	**6.4**
LIME	7.5 tons/ha	**21**	**5.55**	**6.35**
CHECK	CHK	**87**	**5.65**	**5.88**
	MEAN	44	5.6	6.2
	CV%	69	6.93	6.86
	LSD	44	NS	NS
	p-Value (0.05)	0.0417*	NS	NS

Results: Beet lime when used alone has lower clubroot disease severity index (13%) followed by solo treatment of lime (21%), combination treatment of fungicide Ranman + ORO-RZ (26%) and solo treatment of the surfactant ORO-RZ (28%) (Table 1, Figure 1). Statistically, there were no significant differences observed in pH among the treatments tested before and after application, however, beet lime had a one unit increase in soil pH and lime had a 0.8-unit increase after application. As the results look promising, we will continue the research onto the second year.

Figure 1: Graphical representation of clubroot management of various soil treatments.

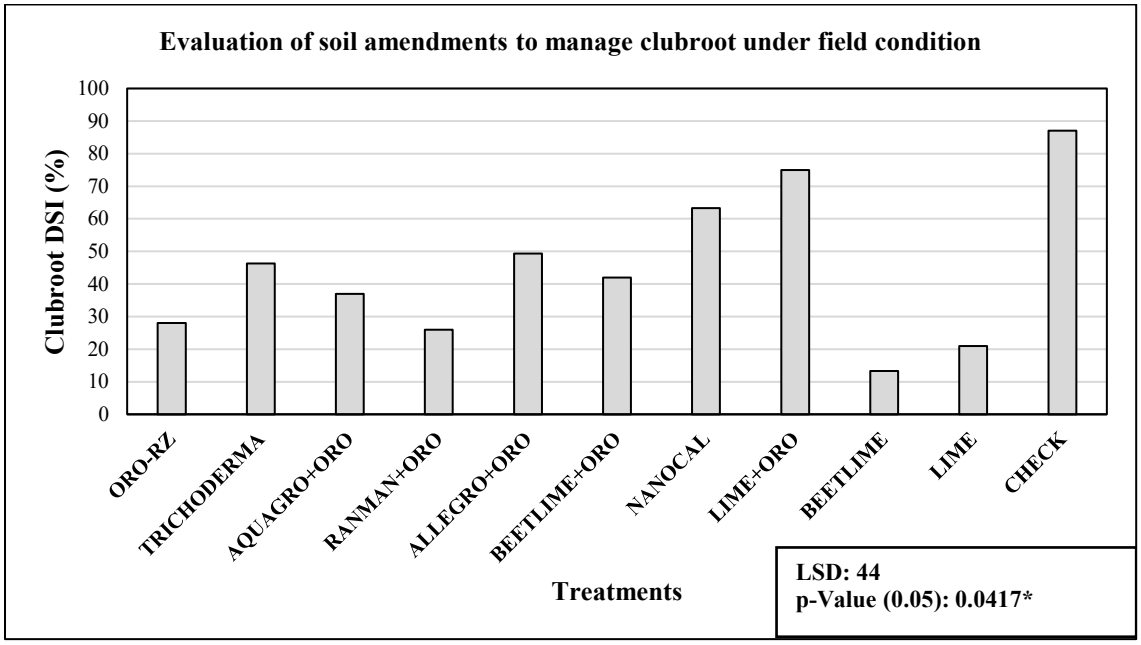
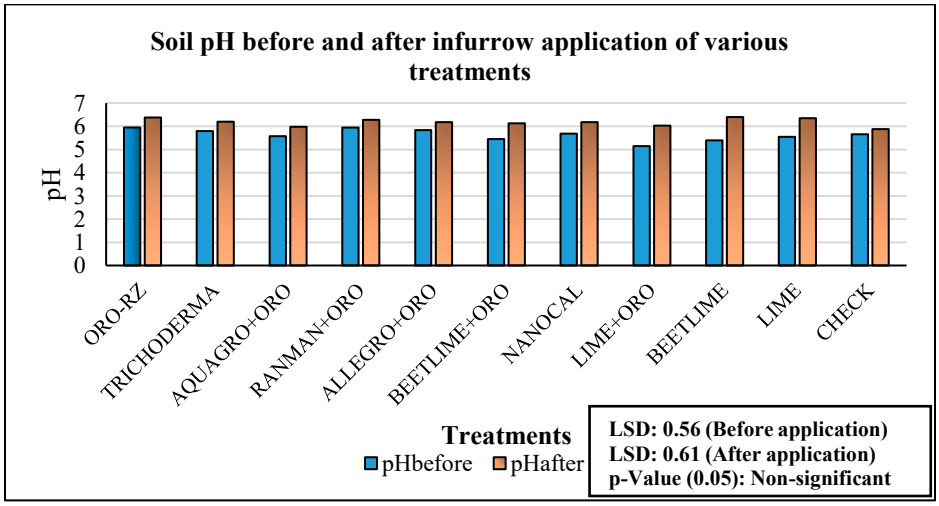


Figure 2: Graphical representation of the change in soil pH due to application of various soil treatments.



Acknowledgments: Funding from the Northern Canola Growers Association and North Dakota Crop Protection Product Harmonization Board, and thanks to all the product suppliers. Special thanks to Intern Mr. Jacob Kram (NDSU).

Clubroot of Canola Survey in North Dakota

Venkat Chapara (Principal Investigator)

Collaborators: Dr. Travis J. Prochaska, Dr. Audrey Kalil, Dr. Anitha Chirumamilla, Dr. Kishore Chittem and Dr. Luis del Rio

Project Title: Survey and Creating Awareness on Identification and Management Plan of Clubroot of Canola in Northeastern North Dakota

Survey Procedure:
The survey involved two components: 1. Visual Survey and soil sampling and 2. Molecular assays for clubroot identification and resting spore quantification of clubroot pathogen.
Note: The ongoing clubroot survey program has been conducted for over four years in various counties of North Dakota. Survey results indicate a threat to the canola crop if proper attention is not given towards longer crop rotations **(canola only once in 3 years)** and equipment sanitation.
Component 1. Visual Survey: Clubroot scouting was done visually by inspecting canola crop roots. The disease survey was conducted in northeastern counties (Pembina, Walsh, Ramsey, Towner, Rolette and Cavalier) along with North Central and Western counties of North Dakota that are bordering Canada. County selection was based on canola acreage, bordering Canada and on the assumption of clubroot propagules movement in all directions through equipment, soil or water to neighboring counties from Cavalier County. In each county, one field in every 5,000 acres was targeted for scouting. Soil samples were collected from the positive and likely positive clubroot fields with an intent to determine how high the pH of the soil in which clubroot is present. In all, a minimum of 5-10 fields per county were targeted for scouting.

The survey was done in two phases.

1st phase: at flowering (10% of flowering onwards)

In the growing season, plants were sampled from distinct stunted patches or prematurely senescing plants in the field. Patches visible from the edge of the field were checked by digging plants and observing the roots for symptoms of clubroot and soil samples were collected.

2nd phase:
After swathing:
The scouting at swathing was based on the methodology followed in Canada by the Alberta Agricultural and Rural Development (AARD) for clubroot disease survey. Reports by AARD indicate that the incidence of clubroot is greater in the field entrances. The survey was done from the main entrances/approaches in a field. The survey group walked in a "W" pattern, stopping at 10 spots and uprooting 10 consecutive stems from the ground at each spot. Each sampling point was separated by 100 meters or 328 feet. In all, roots of 100 stems were evaluated for the presence of clubroot and incidence was noted. Excess soil was shook off. Roots were visually examined for the presence of galls. At sample sites where infection was observed or suspected, root specimens with galls and soil were double bagged and labeled with the field location. The soil samples were collected at a depth of three inches at five sites by walking in a "W" pattern.

Infected roots were air-dried then stored long-term at -20º C. The soil samples from all the fields surveyed were submitted to Dr. Luis del Rio's laboratory for molecular assays to quantify resting spores of the clubroot pathogen and to the NDSU Soil Testing Laboratory for pH determination.

Figure 1: Fields surveyed in 2019 for prevalence of clubroot in various counties of North Dakota.

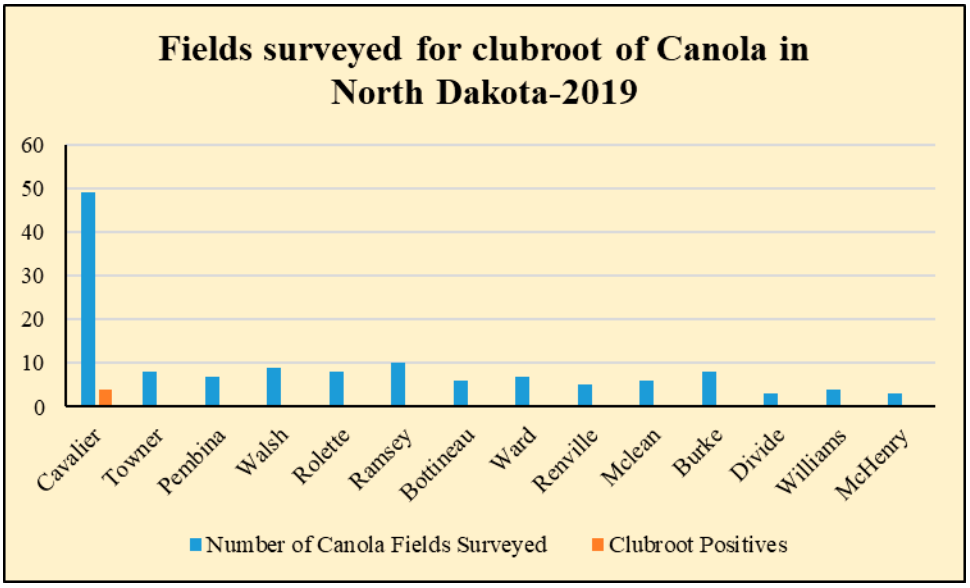
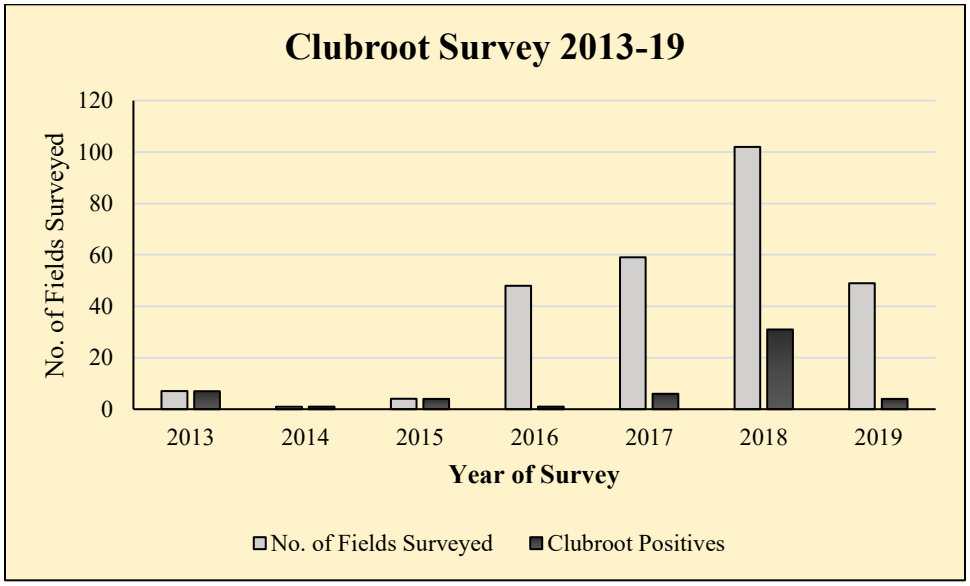


Figure 2: Fields surveyed from 2013 to 2019 for prevalence of clubroot in North Dakota



Component 2. Molecular assays for clubroot identification and resting spore quantification of clubroot pathogen.

Annual surveys of clubroot indicate that the disease is spreading faster than expected. **The objective of this procedure is to quantify resting spores of clubroot pathogen in soil and to inform growers before occurrence of field visible gall symptoms in canola**. The NDSU canola pathology program led by Dr. del Río has the capability to perform laboratory tests to verify clubroot presence in soil samples. This has been possible by molecular assays that have been conducted by Dr. Chittem (Research Scientist) working at Dr. Luis del Rio's lab in Fargo, ND. We encourage growers to submit soil samples for quick confirmation of clubroot.

Results of 2019 soil samples: Identifying clubroot infested fields with molecular assays indicate that the disease on canola has been spreading to neighboring counties (Table 1). However, no visible symptoms have been observed on the roots. Positive identification of clubroot in the molecular assays of soil samples with no visible galls in the surveyed fields could be due to the resting spore population has not reached the required spores per gram of soil to express infection. In general, clubroot infections express on canola plants when spore populations are about 80,000 per gram of soil. Until then there will be no expression of clubroot symptoms on canola roots (Canadian Research).

Table 1: Clubroot positive fields observed in neighboring counties of Cavalier County.

Sample ID	Depth (Inches)	pH	Buffer pH	Spore population/gm of soil
Cavalier County				
CCtc-38	0-3	5.3	6.73	**13280**
CCtc-11	0-3	7.6	7.64	**184**
Rollette County				
RLTC-3	0-3	7.6	7.42	**27**
Towner County				
TWC-3	0-3	7.3	7.32	**17.15**
TWC-5	0-3	7.0	7.22	**16.56**
Pembina County				
PBC-1	0-3	6.5	6.95	**25.32**
PBC-3	0-3	6.3	6.87	**13.98**
PBC-5	0-3	7.0	7.10	**29.42**
PBC-6	0-3	7.5	7.50	**29**

Notice: Growers who suspect clubroot in a field(s) are encouraged to contact Dr. Venkat Chapara at the Langdon REC (701-256-2582), Dr. Anitha Chirumamilla at the Cavalier County Extension Office (701-256-2560), Dr. Luis del Río in the Department of Plant Pathology (701-231-8362) or NDSU Extension (701-231-8363).

In addition, growers should consider practicing longer crop rotations in clubroot-identified fields and planting once in three years with an available clubroot resistant canola variety. Clean equipment thoroughly after working in a clubroot-infected field since the primary mechanism of spreading between fields is the movement of infested soil on farm equipment. Yield losses were recorded up to 25% in severely infected canola fields in Cavalier County in 2018. The fields where clubroot occurred had acidic soils but were approaching basic pH, 7.0 or greater.

In all 133 canola fields have been scouted in 2019 in various counties of northern North Dakota, of which four fields in Cavalier County are positive to clubroot for visual symptoms survey. Nine fields were found positive for clubroot through molecular assays in four counties. Three counties (Pembina, Towner and Rolette) have been identified for the first time with clubroot resting spores in the soils. Clubroot resting spores that were quantified from those samples ranged from 16 to 13,280 per gram of soil. The pH of clubroot positive fields with visual symptoms ranged from 4.5 - 6.7. Molecular assays detected spores in soil pH of 7.64. However, there were no visible symptoms of clubroot. These results indicate an immediate need to test soil samples from fields of all canola growing counties in North Dakota to predict clubroot infections earlier and to follow management options.

Acknowledgements: Many thanks to the growers and collaborators from North Dakota and Minnesota. Special thanks to the support given by all the funding agencies: Northern Canola Growers Association, State Board of Agriculture Research and Education, ND Crop Protection Product Harmonization Board, and the Northern Canola Research Program (NIFA/USDA).

Pathotypes of *Plasmodiophora brassicae,* the causal agent of Clubroot on Canola in North Dakota

Stephen Strelkov, Edmonton, AB, Canada and Venkat Chapara, Langdon REC, Langdon, ND

In 2018, clubroot galls on canola roots were collected from 32 infected fields in North Dakota. Representative samples from these fields were selected and tested in a greenhouse by Dr. Strelkov's group in Edmonton, AB, Canada to determine clubroot pathotypes that are prevalent in North Dakota on cruciferous hosts determined by researchers; Some, Williams, and Strelkov (Canadian Clubroot Differentials).

Results: The clubroot galls tested indicated that fields in North Dakota were infected with minor pathotypes, which can be controlled by first generation clubroot resistant varieties that are currently commercially available. Likewise, these canola clubroot resistant varieties have to be planted once in a three-year rotation.

Acknowledgements: Ron Beneda, CHS, Milton, ND.

Efficacy of Various Doses of Soil Amendments to Manage Clubroot on Canola in Field Conditions

Venkat Chapara

Objective: Determination of optimum rate of soil amendments to manage clubroot in patches on canola.

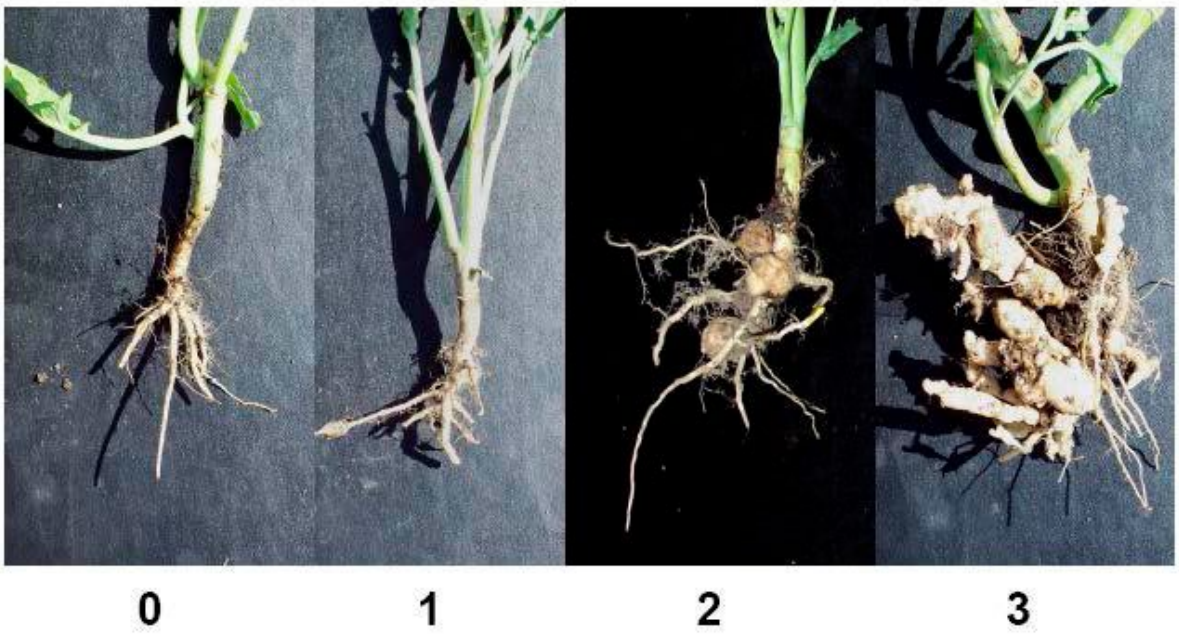
Two years of on farm research with soil amendments of beet lime, pellet lime and wood ash has given promising results to manage clubroot (2017 and 2018 Langdon Research Extension Center Annual Reports). The rates at which the amendments were applied were 15, 7.5 and 7.5 tons/ha, respectively. However, application at such huge rates under field conditions can be a practical feasibility question. Taking these results into consideration, the current objective was formulated.

Method: Soil amendments of beet lime, pellet lime, and wood ash were evaluated. Three doses of 15, 10, and 7.5 tons/ha for beet lime. Pellet lime and wood ash were tested at 7.5, 5 and 2.5 tons/ha. Soil amendments were arranged as whole plot treatments, and doses/rates were sub-plots arranged in factorial randomized complete block design and replicated 4 times. Whereas, the non-treated check did not receive any treatment and was fine tilled as the other treatments.

All three doses of each treatment of wood ash, pellet lime, and beet lime were applied seven days before planting into a soil depth of four inches and were thoroughly mixed in the soil with a rototiller.

Initial clubroot resting spore counts were calculated by taking soil samples before application of soil amendments from a four inch soil depth. Variety "DKL 30-42" was planted as it proved very susceptible to clubroot (Chapara, 2018 Langdon Research Extension Center Annual Report). Canola roots were evaluated after 60 days of planting and were rated as shown in Figure 1 below.

Figure 1: Clubroot rating scale.



Clubroot rating scale: 0 = no galling; 1 = a few small galls (small galls on less than 1/3 of roots), 2 = moderate galling (small to medium-sized galls on 1/3 to 2/3 of roots), 3 = severe galling (medium to large-sized galls on more than 2/3 of roots) (S.E. Strelkov).

Data was analyzed using GLM in Agrobase.

Results: Beet lime at 15 tons/ha was the most effective treatment among the different treatments tested at different rates ($p < .05$) (Figure 2). A 1.6 unit pH change (Figure 3) was observed on the application of beet lime at 15 tons/ha and could be attributed in lowering the disease severity index (DSI) of clubroot. The high rate of beet lime can be used in patch management of clubroot on canola.

Figure 2: Effect of different rates of beet lime, pellet lime, and wood ash on clubroot management on canola.

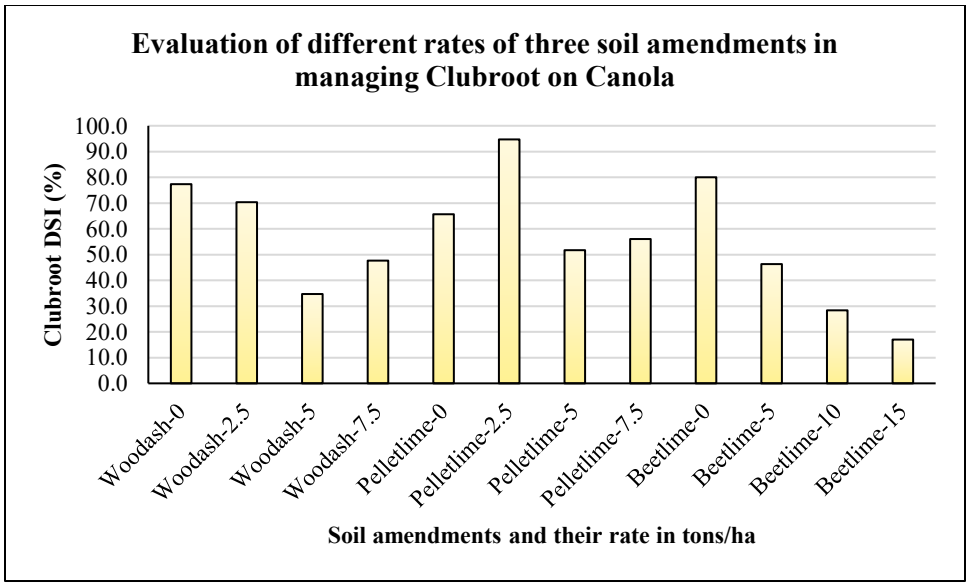
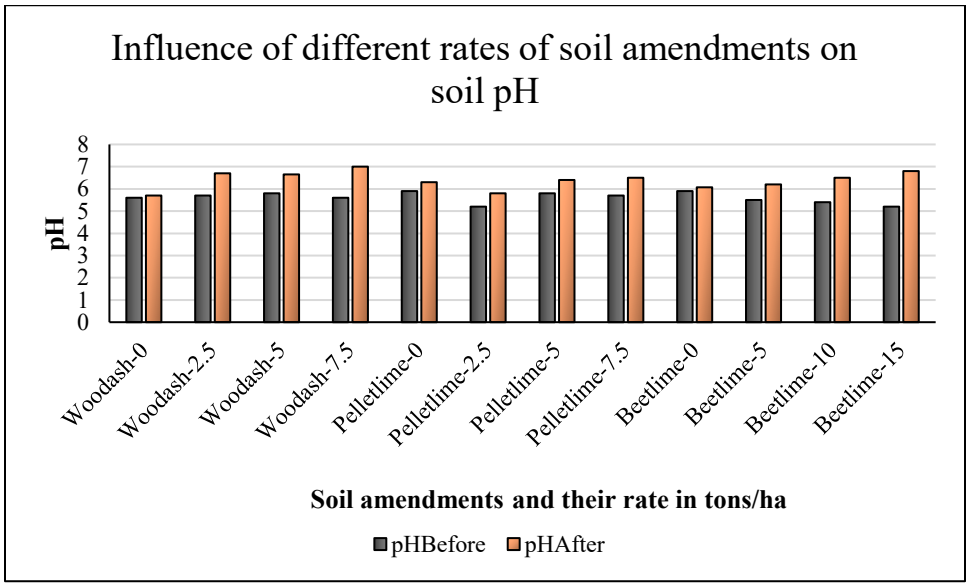


Figure 3: Effect of different rates of beet lime, pellet lime, and wood ash on soil pH to manage clubroot on canola.



Acknowledgements: Funding from Northern Canola Growers Association and North Dakota Crop Protection Product Harmonization Board, and thanks to all the product suppliers. Special thanks to Intern Mr. Jacob Kram (NDSU) and Ben Girodat (LREC Seasonal Employee).

Evaluate Miravis Ace Efficacy at Different Timing Applications to Manage Fusarium Head Blight in Hard Red Spring Wheat

Venkat Chapara, Amanda Arens and Andrew Friskop

Objectives:

1. Evaluate Miravis Ace vs Prosaro on Fusarium head blight (FHB) in hard red spring wheat (HRSW).

2. Evaluate Miravis Ace efficacy at different timings.

Methods:

Location: NDSU Langdon Research Extension Center

Experimental design: Randomized complete block, replicated four times.

Previous crop: Canola

Cultivars of HRSW tested: WB Mayville

Planting: 1.5 million pure live seeds/A planted on May 9, 2019. A border plot was planted between treated plots to minimize interference from spray drift.

Plot size: Seven rows at six inch spacing, 5 ft. x 20 ft., mowed back to 5 ft. x 16 ft.

Herbicides applied: Axial XL (16.4 Fl. oz/A) + Huskie (15 Fl. oz/A) + Prowl H_2O (36 Fl. oz/A)

Inoculation: Plots were inoculated by spreading corn spawn inoculum at around boot stage (Feekes 9-10) at the rate of 300 g/plot.

Disease development: Supplemental moisture was provided by running overhead irrigation from Feekes 9 to 11.2.5 at the rate of one hour per day to create a conducive environment for FHB development.

Fungicide treatments: Fungicides were applied with a CO_2-pressurized backpack sprayer with a three nozzle boom (XR-8002) and the water volume used was 20 GPA. Fungicide (Miravis Ace) application was made at full head emergence on July 3rd. Miravis Ace, Prosaro and Caramba were applied at Feekes 10.5.1(anthesis) on July 5th and repeated 5 days after the first spray (July 10th) based on protocol recommendations. Refer to Table 1 for the treatments, dosages and application timings.

Disease assessment: Data on FHB incidence was obtained by counting the number of heads showing FHB symptoms out of 50 heads. FHB head severity was rated using 0-100% scale on arbitrary 50 heads, excluding two outer rows. FHB index (Index) was calculated using formula: Index = (SEV*INC)/100.

Harvest: Plots were harvested on September 4th with a small plot combine and the yield was determined at 13.5% moisture.

Data analysis: Statistical analysis was done using Agrobase. Fisher's least significant difference (LSD) was used to compare means at p ($\alpha = 0.05$). Actual means were presented in the table for simplicity of understanding.

Table 1: Efficacy of Miravis Ace at various application timings in comparison to commercial fungicides to manage Fusarium Head Blight on Hard Red Spring Wheat.

		Rate	Fusarium Head Blight				
Treatments	Application Timing	Oz/A	Incidence (%)	Severity (%)	Index	DON (ppm)	Yield (bu/A)
NON-TREATED CONTROL	CHK	CHK	99.5	31.2	31	5.7	49.5
PROSARO	FKS 10.51 (EARLY-ANTHESIS)	6.5	57	10.9	6.94	3.42	57.2
MIRAVIS ACE + PROSARO	FKS 10.51 + 3-7 DAYS	13.7 + 6.5	9.5	4.05	0.43	0.86	74.8
MIRAVIS ACE + CARAMBA	FKS 10.51 + 3-7 DAYS	13.7 + 13.5	7	3.5	0.36	0.83	73.5
MIRAVIS ACE	FKS 10.3 (FULL HEAD EMERGENCE)	13.7	42	16.45	6.77	4.53	62.9
MIRAVIS ACE	FKS 10.51 (EARLY-ANTHESIS)	13.7	29.5	8.4	2.91	1.94	70.4
CARAMBA	FKS 10.51 (EARLY-ANTHESIS)	13.5	53	10.85	6	2.83	64.18
MIRAVIS ACE	3-7 DAYS AFTER ANTHESIS	13.7	21.5	7	1.55	0.6	77.22
		Mean	39.8	11.54	6.99	2.58	66.2
		CV (%)	37.9	45.2	54.8	56.5	6.37
		LSD	22.3	7.7	5.6	2.13	6.2
		p-Value (0.05)	0.00001*	0.00001*	0.00001*	0.0003*	0.00001*

***** Indicates treatments are statistically significant.

Note: All treatments were applied with NIS @ 0.125 v/v.

Results: Treatments of Miravis Ace applied at full head emergence and at anthesis resulted in equal performance on managing Fusarium head blight. However, Miravis Ace applied at 3-7 days after anthesis was the best performer of the parameters tested such as FHB Index, DON content and yield in this research trial (Table 1).

Funded by: US Barley and Wheat Scab Initiative Project and Syngenta.

Evaluation of Commercially Available Fungicides at various Application Timings to Manage Fusarium Head Blight on Hard Red Spring Wheat

Venkat Chapara, Amanda Arens, and Andrew Friskop

Objective: To evaluate the efficacy of fungicides in single and sequential applications to manage Fusarium head blight (FHB) in hard red spring wheat (HRSW).

Methods:

Location: NDSU Langdon Research Extension Center

Experimental design: Randomized complete block with split plot arrangement, four replications.

Previous crop: Canola

Cultivars of HRSW tested: WB Mayville and SY Ingmar

Planting: 1.5 million pure live seeds/A planted on May 9, 2019. A border plot was planted between treated plots to minimize interference from spray drift.

Plot size: Seven rows at six inch spacing, 5 ft. x 20 ft., mowed back to 5 ft. x 16 ft.

Herbicides applied: Axial XL (16.4 Fl. oz/A) + Huskie (15 Fl. oz/A) + Prowl H_2O (36 Fl. oz/A)

Inoculation: Plots were inoculated by spreading corn spawn inoculum around boot stage (Feekes 9-10) at the rate of 300 g/plot.

Disease development: Supplemental moisture was provided by running overhead irrigation from Feekes 9 to 11.2.5 at the rate of one hour per day to create a conducive environment for FHB development.

Fungicide treatments: Fungicides were applied with a CO_2-pressurized backpack sprayer with a three-nozzle boom (XR-8002) and the water volume used was 20 GPA. Fungicide (Miravis Ace) application was made at full head emergence on July 3rd. Miravis Ace, Prosaro and Caramba were applied at Feekes 10.5.1(anthesis) on July 5th and repeated 5 days after the first spray (July 10th) based on protocol recommendations. Refer to Table 1 for the treatments, dosages and application timings.

Disease assessment: Data on FHB incidence was obtained by counting the number of heads showing FHB symptoms out of 50 heads. FHB head severity was rated using 0-100% scale on arbitrary 50 heads, excluding two outer rows. FHB index (Index) was calculated using formula: Index = (SEV*INC)/100.

Harvest: Plots were harvested on September 4th with a small plot combine and the yield was determined at 13.5% moisture.

Data analysis: Statistical analysis was done using Agrobase. Fisher's least significant difference (LSD) was used to compare means at p ($\alpha = 0.05$). Actual means were presented in the table for simplicity of understanding.

Table 1: Evaluation of commercially available fungicides at various application timings to manage Fusarium Head Blight on Hard Red Spring Wheat.

HRSW			Fusarium Head Blight			DON	Yield	Test Weight
Cultivar	Treatment and Application Timings	Rate (fl.oz)	% Incidence	% Severity	Index	(ppm)	bu/A	lbs/bu
WB Mayville	MIRAVIS ACE AFTER ANTHESIS	13.7	28.5	8.75	3.1	1.1	61.3	59.4
WB Mayville	PROSARO AFTER ANTHESIS	6.5	52	12.6	6.7	1.75	66.0	58.4
WB Mayville	PROSARO TWICE @ 10.5.1 and 3-7 days after	6.5	5.5	2.8	0.3	0.55	69.0	58.8
WB Mayville	MIRAVIS ACE TWICE @ 10.5.1 and 3-7 days after	13.7	7.5	3.85	0.4	0.82	70.4	60.2
WB Mayville	PROSARO @ 10.5.1	6.5	49	12.6	6.3	2.33	58.8	57.6
WB Mayville	MIRAVIS ACE @ 10.5.1	13.7	22	8.05	1.9	0.91	66.3	59.6
WB Mayville	MIRAVIS ACE @ Full Head Emergence	13.7	38.5	9.45	4.5	1.8	65.0	59
WB Mayville	INOCULATED, NON-TREATED	CHK	80.5	27	19.5	2.4	54.0	57.1
WB Mayville	CARAMBA @ 10.5.1	13.5	31.5	9.45	3.1	1.68	64.6	57.5
SY Ingmar	PROSARO TWICE @ 10.5.1 and 3-7 days after	6.5	3.5	2.8	0.1	0.09	66.6	60.0
SY Ingmar	PROSARO @ 10.5.1	6.5	41.5	8.05	3.5	0.5	61.0	59.4
SY Ingmar	MIRAVIS ACE AFTER ANTHESIS	13.7	24.5	8.05	2.4	0.31	71.5	60.4
SY Ingmar	INOCULATED, NON-TREATED	CHK	55	11.9	6.8	0.64	59.9	59.5
SY Ingmar	MIRAVIS ACE TWICE @ 10.5.1 and 3-7 days after	13.7	6.5	5.25	0.4	0.18	75.4	61.0
SY Ingmar	MIRAVIS ACE @ Full Head Emergence	13.7	30	8.75	4.1	0.66	69.2	60.0
SY Ingmar	MIRAVIS ACE @ 10.5.1	13.7	7.5	3.5	0.4	0.36	67.9	60.5
SY Ingmar	PROSARO AFTER ANTHESIS	6.5	12	5.25	0.7	0.58	69.9	60.1
SY Ingmar	CARAMBA @ 10.5.1	13.5	34.5	9.45	4.0	0.88	65.0	59.6
	*All treatments were applied with NIS @ 0.125 v/v							

Results: Fusarium head blight (FHB) incidence, severity, index, and Deoxynivalenol (DON) content were significantly different (p-Value = 0.007) among the cultivars, likewise, with fungicide applied at different timings (p-Value = 0.00001). Yield in various tested treatments was significantly different between the cultivars and among the non-treated check and the fungicide treatments.

Table 2: Fusarium Head Blight (FHB) Incidence, Severity, Index, Deoxynivalenol (DON) and Yield from Miravis Ace treated plots on two Hard Red Spring Wheat (HRSW) cultivars at various application timings.

Cultivar SY INGMAR	FHB INCIDENCE (%)	FHB SEVERITY(%)	FHB INDEX	DON (ppm)	YIELD (bu/A)
MIRAVIS ACE Early	30	8.75	4.1	0.66	69.2
MIRAVIS ACE @ 10% Flowering	7.5	3.5	0.4	0.36	67.9
MIRAVIS ACE TWICE @ 10.51 and 3-7 days after	6.5	5.25	0.4	0.18	75.4
MIRAVIS ACE 3-7 days after 10% Flowering Stage	24.5	8.05	2.4	0.31	71.5
INOCULATED, NON-TREATED	80.5	27	19.5	2.4	54.0
Cultivar WB MAYVILLE					
MIRAVIS ACE Early	38.5	9.45	4.5	1.8	65.0
MIRAVIS ACE @ 10% Flowering	22	8.05	1.9	0.91	66.3
MIRAVIS ACE TWICE @ 10.51 and 3-7 days after	7.5	3.85	0.4	0.82	70.4
MIRAVIS ACE 3-7 days after 10% Flowering stage	28.5	8.75	3.1	1.1	61.3
INOCULATED, NON-TREATED	55	11.9	6.8	0.64	59.9

Results: Fungicide Miravis Ace when applied early (Full Head Emergence) and at 3-7 days after 10% flowering stage of HRSW was similar in managing FHB and in yield. However, there were significant differences in DON contents (LSD = 0.2) in cultivar SY Ingmar, but not in the cultivar WB Mayville. Solo treatment of Miravis Ace applied at 10% flowering was best among the three application timings in cultivar SY Ingmar, no such difference was observed in the cultivar WB Mayville.

Funded By: US Barley and Wheat Scab Initiative Project and Syngenta.

Evaluation of various Fungicides to Manage Fusarium Head Blight in Barley

Venkat Chapara and Amanda Arens

Objective: Evaluate various fungicides for their efficacy on barley to manage Fusarium head blight (FHB).

Methods:

Location: NDSU Langdon Research Extension Center

Experimental design: Randomized complete block, replicated four times.

Previous crop: Canola

Cultivar of barley on which the treatments were tested: Tradition

Planting: 1.25 million pure live seeds/A planted on May 8, 2019. A border plot was planted between treated plots to minimize interference from spray drift.

Plot size: Seven rows at six inch spacing, 5 ft. x 20 ft. mowed back to 5 ft. x 16 ft.

Herbicides applied: Axial XL (16.4 fl. oz/A) + Huskie (15 fl. oz/A) + Prowl H_2O (36 fl. oz/A)

Inoculation: Plots were inoculated by spreading corn spawn inoculum at around boot stage (Feekes 9-10) at the rate of 300 g/plot.

Disease development: Supplemental moisture was provided by running overhead irrigation from Feekes 9 to 11.2.5 at the rate of one hour per day to create a conducive environment for FHB development.

Fungicide treatments: Fungicides were applied with a CO_2-pressurized backpack sprayer with a three-nozzle boom (XR-8002), and the water volume used was 20 GPA. Application timings: Sprayed at Feekes 10.5.1 stage repeated in treatment of Prosaro after 4-5 days of first spray. Likewise, Proline was sprayed after 4-5 days of first spray. Refer to Table 1 for the treatments, dosages and application timings.

Disease assessment: Data on FHB incidence was obtained by counting the number of heads showing FHB symptoms out of 50 heads. FHB head severity was rated using 0-100% scale on arbitrary 50 heads, excluding two outer rows. FHB index (Index) was calculated using formula: Index = (SEV*INC)/100.

Harvest: Plots were harvested on August 19th with a small plot combine and the yield was determined at 13.5% moisture.

Data analysis: Statistical analysis was done using Agrobase. Fisher's least significant difference (LSD) was used to compare means at p ($\alpha = 0.05$). Actual means were presented in the table for simplicity of understanding.

Table 1: Efficacy of Prosaro at various application timings to manage Fusarium head blight on barley.

		Fusarium Head Blight				
Treatment	**Rate (Oz/A)**	**% Incidence**	**% Severity**	**Index**	**DON (ppm)**	**Yield (bu/A)**
NON-TREATED	CHK	79.5	8.4	21.4	14.5	76.18
PROSARO + NIS	8.2	10.5	1.4	0.76	2.6	91.11
Coded Product	10.3	13.5	11.2	1.4	3.7	92.43
PROSARO + NIS (TWICE)	4.1	12	5.6	0.8	2.0	77.65
PROSARO + NIS; PROLINE + NIS	6.5+4.3	6.5	2.8	0.42	1.9	58.10
PROSARO + BAYTHROID + NIS	8.2+1.6	18	14	1.9	2.9	75.25
Mean		23.33	9.6	4.4	4.6	76.00
CV%		50.37	89.5	205	40.6	8.50
LSD		17.71	12.95	13.8	2.8	9.80
p-Value(0.05)		0.00001*	NS	0.03*	0.00001*	0.0042*
* Indicates treatments are statistically significant						

Note: All treatments were applied with Non-Ionic Surfactant @ 0.125 v/v.

Results: Treatments of fungicides applied at different timings resulted in equal performance on managing Fusarium head blight (FHB); Prosaro applied at "Full head emergence" stage was the best treatment of the parameters tested in this research trial (Table 1).

Funded By: Bayer CropScience

Evaluation of Bio-Fungicide to Manage White Mold on Dry Beans

Amanda Arens and Venkat Chapara

With an objective to evaluate the performance of fungicides to manage white mold in dry beans, a research trial was conducted at the Langdon Research Extension Center. The trial was planted on May 16, 2019 with dry bean variety "Palomino" in a randomized complete block design with 4 replications. The trial location followed state recommended practices for land preparation, fertilization, seeding rate and weed control. The plot size was 5 ft. x 16 ft. with a dry bean border on both sides of each plot. The trial was irrigated with an overhead sprinkler system set at one hour each day beginning one week before the start of bloom to four weeks after bloom to help increase disease infection levels. A bio-fungicide was tested at different rates, applied at 100% bloom using a CO2-pressurized backpack style sprayer with a three-nozzle boom (XR-8002) at 15 GPA, and repeated 15 days after first spray. The amount of white mold infection obtained in the research plots was natural. Fifty plants were rated within each plot and the levels of incidence and severity were recorded for each plant prior to swathing (August 12) on a 0-5 scale, where 1 = superficial lesions or small branch infected; 2 = large branch(es) dead; 3 = main stem at least 50% girdled; 4 = stem girdled but plant produced good seed; 5 = main stem girdled, much reduced yield. A white mold disease severity index (DSI) was calculated with weighted mean of incidence and number of plants in each severity rating.

Table 1: Efficacy of commercially available fungicides in managing white mold and their influence on yield and test weight.

	Rate	White Mold		Yield	Test Weight
Treatments	(oz/A)	% Incidence	DSI (1-5)	(bu/A)	(lbs/bu)
T-77 LOW RATE	3.5	10.6	2.3	46.18	58.89
T-77 STANDARD RATE	7	19.38	3.44	49.27	59.28
T-77 HIGH RATE	10.5	10	2.55	56.91	59.16
PROLINE + T-77 STANDARD RATE	4.3 + 7	5	2.96	69.18	59.2
PROLINE	4.3	6.25	2.06	61.52	59.09
NON-TREATED CONTROL	CHECK	26.25	4.1	55.08	59.79
	Mean	12.92	2.9	56.36	59.23
	CV%	100	60.3	11.97	1.17
	LSD	NS	NS	8.36	NS
	p-Value (0.05)	NS	NS	0.0028*	NS
* indicates treatments are statistically significant					

Results: The results indicate that there were no significant differences in white mold incidence or in disease severity index (DSI) obtained among the fungicides tested and the non-treated check (p-Value non-significant). However, there were significant differences observed among the treatments when yields were compared ($p < 0.05$).

Acknowledgements: Bryan Hanson, Travis Hakanson and Lawrence Henry for their technical support.

EXTENT OF SOIL SALINITY AND SODICITY IN NORTHEAST NORTH DAKOTA IN 2018

Soil salinity and sodicity are two critical soil health issues producers face in northeast North Dakota. Both result in poor stands or barren spots, especially along the headlands. As per the 2019 NDSU projected crop budgets for NE North Dakota, producer's spend an average of $82 to $187 per acre to plant soybean, spring wheat, canola and corn, resulting in a net loss on these areas. It is estimated that at least 15% of the crop land acres in North Dakota is affected by salinity. This amounts to approximately six million acres.

Excessive levels of water soluble salts result in salinity and deprive plants of water as salts compete with plant roots for water. Soil sodicity is caused by excessive levels of sodium (Na^+) that is attracted to the negative charges of soil clay and humus particles and is not present as a salt. Sodicity makes the soil layers tight by causing "dispersion and swelling". Sodicity will happen if calcium (Ca^{2+}) levels are lower than sodium. In addition, higher magnesium (Mg^{2+}) levels than calcium in the soil exchange complex can also lead to excessive swelling resulting in dense soil layers, especially in case of shrinking and expanding type of clayey soils. Occurrence of high magnesium levels compared to calcium resulting in dense soil layers in the Red River Valley had been reported by Ellis and Caldwell in 1935 and Clayton in 1936.

Remediation of salinity and sodicity starts by sampling the problem areas three to four-feet deep and analyzing all samples and depths for Electrical Conductivity or EC to assess salinity, Sodium Adsorption Ratio or SAR to assess sodicity and pH by using "Saturated Paste Extract Method". SAR analysis will also provide individual levels of Ca^{2+}, Mg^{2+} and Na^+, which could be used to determine if Mg^{2+} levels are higher than Ca^{2+}. If sodicity is established, in order to calculate the rates of soil amendments like gypsum that add Ca^{2+} to the soils, 0-12-inch depths will also need to be analyzed for Cation Exchange Capacity or CEC by using the "Sodium Saturation and Ammonium Extraction Method."

Analyzing the problem areas for salinity, sodicity and in some cases high magnesium levels provides producers a basis to establish a remediation plan. Sensing the need, the NDSU Langdon Research Extension Center, NDSU Extension and in some cases crop consultants have been helping producers with sampling and analyzing the unproductive areas three to four-feet deep since 2012. In 2018, however, this activity reached its peak as the Langdon Research Extension Center acquired a new pickup mounted soil probe. A total of 40 producers were helped in nine counties in northeast North Dakota with sampling of 136 unproductive sites. Sampling was followed by a detailed explanation of soil results along with suggestions for remediation.

The 2018 results of 133 producer soil samples confirmed the high levels of salinity, sodicity and excessive Mg^{2+} versus Ca^{2+} contrary to the common belief that there are not serious soil health issues in the northeast (Table 1). Though some individual EC levels were higher than 20.0 dS/m, the average EC of the 133 samples for the 0-12-inch depth was 8.96 (dS/m), which is not even suitable for the most salt-tolerant annual crops like barley, oat and sugarbeet. EC levels decreased with depths with an average of 7.13 dS/m (12-24-inch), 6.43 dS/m (24-36-inch) and 6.32 dS/m (36-48-inch). At these salt levels, producers will be better off planting a mix of perennial salt-tolerant grasses like Tall Wheatgrass, Slender Wheatgrass, Western Wheatgrass, Green Wheatgrass (AC Saltlander) and Russian Wildrye. These grasses will establish in about a year, reduce evaporation, use excess water, add biomass, induce increased microbial activity and could be hayed, grazed or mowed.

The soil SAR levels were found to be the highest in the 0-12-inch depths with an average of 10.74 for the 133 samples. These SAR results confirmed the sodicity issues in the northeast and will require application of soil amendments like gypsum, which will add Ca^{2+} to the soils. The average SAR levels for the 12-24-inch, 24-36-inch and 36-48-inch depths were 9.17, 8.25 and 8.33 respectively for the 133 samples. High SAR results are also reflected by the high average Na^+ (Meq/L) levels compared to average Ca^{2+} (Meq/L). Higher Ca^{2+} levels versus Na^+ will prevent sodicity from happening.

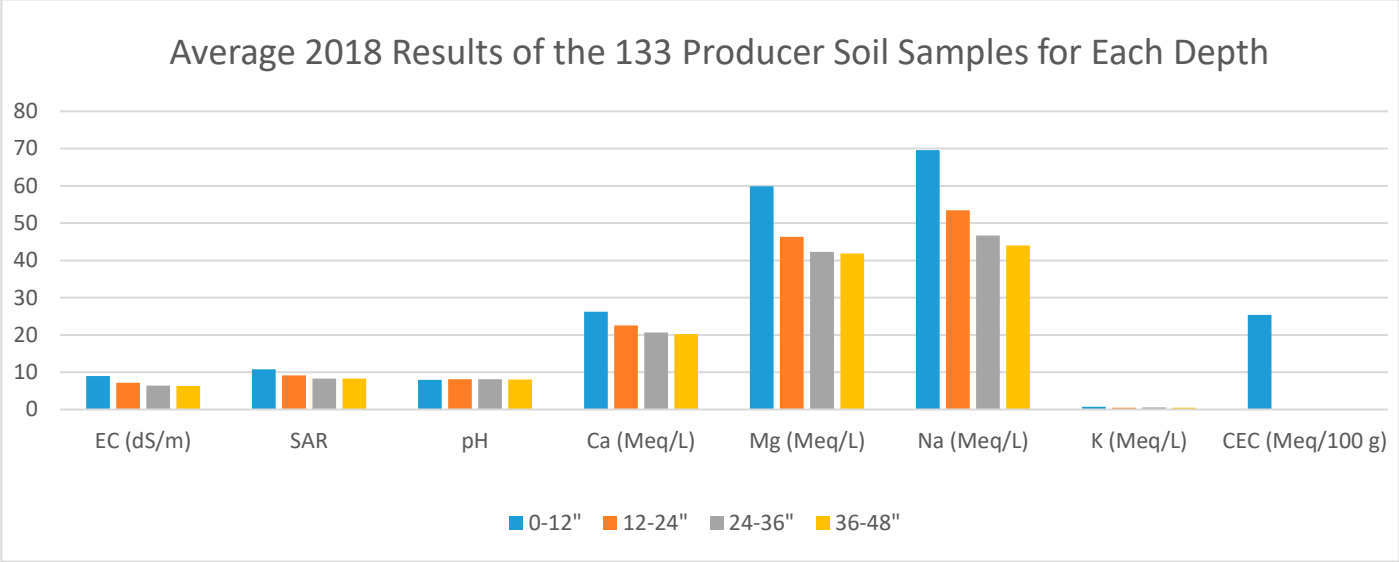


Table 1. Average EC, SAR, pH, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+} results of 0-12-inch, 12-24-inch, 24-36-inch and 36-48-inch depths by using Saturated Paste Extract Method and average CEC levels of 0-12-inch depth by using Sodium Saturation and Ammonium Extraction Method for the 133 producer soil samples (excluding the results of three samples) that were taken in 2018.

Though not as widespread as sodicity, higher Mg^{2+} versus Ca^{2+} levels were also found to be an issue, which may need application of amendments that add Ca^{2+}. The higher levels of Na^{+} and Mg^{2+} versus Ca^{2+} and the need for the amendment application to correct these issues also highlights the importance of analyzing the true soil CEC by using "Sodium Saturation and Ammonium Extraction Method". The common Addition or Summation Method generally results in artificially high CEC values, especially if salt levels are high, which is the case for almost all of the unproductive areas in the northeast. Higher CEC values will calculate higher rates of soil amendments that are not needed, however, will cost more. The average soil CEC of 133 samples was 25.40 Meq/L.

The average soil pH levels were alkaline and were 7.93 for 0-12-inch, 8.11 for 12-24-inch, 8.09 for 24-36-inch and 8.05 for 36-48-inch depths.

The 2018 results highlight the importance of sampling the areas, that either do not produce anything or produce way below the yield potential, three to four-feet deep in 12-inch increments and analyzing the samples for EC, SAR and pH by using the Saturated Paste Extract Method and CEC by using Sodium Saturation and Ammonium Extraction Method. This is especially important as often there are no clear visual symptoms of sodicity and high Mg^{2+} issues at the soil surface. For salinity, salts may form a visible crust at the soil surface when excess water evaporates, however, analyzing the samples for EC will help determine which crop/grass type will have a chance to establish.

For detailed information please refer to the following publications and websites:

1. Soil Testing Unproductive Areas, SF1809.
2. Managing Saline Soils in North Dakota, SF1087 (revised September 2019).
3. The NDSU Langdon Research Extension Center Soil Health webpage: https://www.ag.ndsu.edu/langdonrec/soil-health
4. The NDSU Soil Health website: https://www.ndsu.edu/soilhealth/
5. The North Central Research Extension Center Soil Health webpage: https://www.ag.ndsu.edu/NorthCentralREC/soil-health

DETERMINING THE ECONOMIC RESPONSE OF SODIC SOILS TO REMEDIATION BY GYPSUM, ELEMENTAL SULFUR AND VERSALIME IN NORTHEAST NORTH DAKOTA ON TILED FIELDS

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This research report is an extension of an ongoing research trial. If you would like to know more about the trial background, objectives, location, site description, design and methodology, please refer to the previous Langdon Research Extension Center's Annual Reports.

RESULTS AND DISCUSSION

The findings below are based on the statistical analysis of the effects of soil amendments (treatments) and average annual growing-season groundwater depths on the 2014, 2016, 2017, 2018 and 2019 soil EC (salinity), SAR (sodicity) and pH levels measured at zero to four-foot depths by using SAS package 9.4 at 95% confidence interval. The 2014 results represent soil samples collected at the time when the field was tiled, 2016 results represent samples collected two years after tiling and one year after the application of soil amendments, 2017 results are for samples collected three years after tiling and two years after applying the amendments, 2018 results are for the samples collected four years after tiling and three years after applying the amendments and 2019 results are for the samples collected five years after tiling and four years after applying the amendments.

Soil EC, SAR and pH Levels at the Time of Tiling (2014)

At the time of tiling, all plots had moderately high EC levels with control plots having the lowest levels (mean = 7.39 dS/m) and gypsum plots having the highest levels (mean = 9.58 dS/m). The soil SAR levels in all of the plots were high to very high with control plots having the lowest levels (mean = 12.58) and gypsum plots having the highest levels (mean = 18.36). Soil pH of all plots were close to neutral. Details are in Table 2.

Table 2. The Treatment means of the Soil EC, SAR and pH Levels at the time of Tiling (2014).

Soil Property	2014 Treatment Means			
	Control	Gypsum	VersaLime	E-Sulfur
EC (dS/m)	7.39	9.58	9.19	8.91
SAR	12.58	18.36	16.33	16.58
pH	7.05	7.04	7.14	6.94

Effect of Soil Amendments on EC, SAR and pH Levels

Differences in Soil EC Levels

Statistically, there were significant differences in the annual soil EC levels among treatments and between replications (Table 3) compared to the EC levels at the time of tiling (2014).

Table 3. Statistical Differences in Soil EC (dS/m) Levels.

Source	Mean Square	P > F
Year	152.53	<.0001
Treatment	44.67	<.0001
Replication	65.19	<.0001
Soil Depths	11.30	0.0647

Year vs Treatment	1.50	0.9642
Treatment vs Soil Depths	1.93	0.9227
Year vs Treatment vs Soil Depths	1.08	1.0000

The 2016, 2017, 2018 and 2019 soil EC levels were significantly lower than 2014. However, EC levels increased in 2017, 2018 and 2019 significantly compared to 2016 due to drier weather and resulting capillary rise (wicking up) of soil water. In addition, soil EC levels of gypsum, E-Sulfur (elemental sulfur) and VersaLime treatments were significantly higher than the control treatments. There were no significant differences among gypsum, E-Sulfur and VersaLime treatments. The EC levels in the 12-24 inch depths also remained significantly higher than the EC levels in the 0-12 inch and 36-48 inch depths. Overall, highest EC levels were measured in 12-24 inch depths, followed by 24-36 inch, 0-12 inch and 36-48 inch depths. Details are in Table 4.

Table 4. Soil EC (dS/m) Level Differences between Years, Treatments and Soil Depths.

Annual Means	
2014	8.77
2016	3.75
2017	6.59
2018	6.24
2019	6.14
Treatment Means	
Control	5.01
E-Sulfur	6.67
Gypsum	6.76
VersaLime	6.76
Means for Soil Depths	
0-12 inch	6.03
12-24 inch	6.82
24-36 inch	6.47
36-48 inch	5.87

Based on the differences in the annual means of soil EC levels (Table 5), in 2016, EC levels dropped significantly compared to 2014 despite higher rainfall and shallower average annual growing-season groundwater depths. In 2017, 2018 and 2019, EC levels remained lower than 2014, however, compared to 2016, EC levels increased despite lower average annual growing-season groundwater depths due to drier weather. That could be attributed to the increased capillary rise of soil water due to increased evapotranspiration. The differences in EC levels of 2017, 2018 and 2019 were not significant.

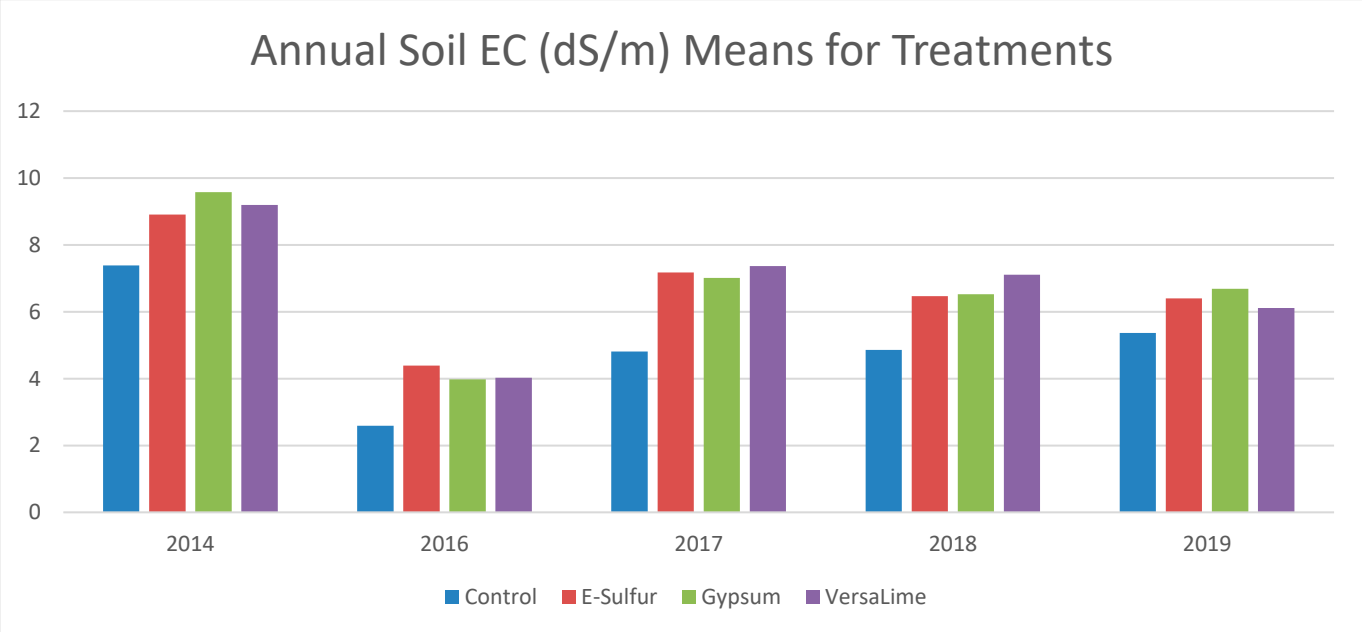
Table 5. Annual Differences in the Means of Soil EC (dS/m) Levels among Treatments.

	Least Square Means			
Year	**Control**	**E-Sulfur**	**Gypsum**	**VersaLime**
2016	2.59	4.39	3.98	4.03
2014	7.39	8.91	9.58	9.19
Difference	-4.80	-4.52	-5.60	-5.16
2017	4.81	7.17	7.01	7.37
2014	7.39	8.91	9.58	9.19
Difference	-2.58	-1.74	-2.57	-1.82
2018	4.86	6.47	6.52	7.11

2014	7.39	8.91	9.58	9.19
Difference	-2.53	-2.44	-3.06	-2.08
2019	5.37	6.40	6.69	6.11
2014	7.39	8.91	9.58	9.19
Difference	-2.02	-2.51	-2.89	-3.08
2017	4.81	7.17	7.01	7.37
2016	2.59	4.39	3.98	4.03
Difference	2.22	2.78	3.03	3.34
2018	4.86	6.47	6.52	7.11
2016	2.59	4.39	3.98	4.03
Difference	2.27	2.08	2.54	3.08
2019	5.37	6.40	6.69	6.11
2016	2.59	4.39	3.98	4.03
Difference	2.78	2.01	2.71	2.08
2018	4.86	6.47	6.52	7.11
2017	4.81	7.17	7.01	7.37
Difference	0.05	-0.70	-0.49	-0.26
2019	5.37	6.40	6.69	6.11
2017	4.81	7.17	7.01	7.37
Difference	0.56	-0.77	-0.32	-1.26
2019	5.37	6.40	6.69	6.11
2018	4.86	6.47	6.52	7.11
Difference	0.51	-0.07	0.17	-1.00

The chart below (Figure 1) has the annual soil EC means for the four treatments.

Figure 1. Annual Means of Soil EC (dS/m) Levels for all Four Treatments.



Differences in Soil SAR Levels

Statistically, there were significant differences in the annual soil SAR (sodicity) levels among treatments and soil depths (Table 6) compared to the levels at the time of tiling (2014).

Table 6. Statistical Differences in Soil SAR Levels.

Source	Mean Square	P > F
Year	92.14	0.0292
Treatment	349.73	<.0001
Replication	0.27	0.9919
Soil Depths	664.71	<.0001
Year vs Treatment	38.01	0.3339
Treatment vs Soil Depths	24.21	0.5211
Year vs Treatment vs Soil Depths	18.29	0.9359

The 2018 soil SAR levels remained significantly higher versus 2014, 2016 and 2017. The soil SAR levels of control treatments remained significantly lower than the rest of the treatments. In addition, SAR levels in the gypsum treatments remained significantly higher than E-sulfur and VersaLime treatments. There was a significant increase in SAR levels with soil depth, with 0-12 inch depths having the lowest SAR levels and 36-48 inch depths having the highest SAR levels. Details are in Table 7.

Table 7. Soil SAR Level Differences between Years, Treatments and Soil Depths.

Annual Means	
2014	15.96
2016	16.45
2017	15.15
2018	18.82
2019	17.12
Treatment Means	
Control	13.53
E-Sulfur	17.00
Gypsum	19.40
VersaLime	16.87
Means for Soil Depths	
0-12 inch	13.26
12-24 inch	15.08
24-36 inch	17.50
36-48 inch	20.96

Based on the differences in the annual means of soil SAR levels (Table 8), 2018 SAR levels remained significantly higher than the SAR levels in 2014, 2016 and 2017. Whereas, there were no significant differences in 2014, 2016 2017 and 2019 SAR levels.

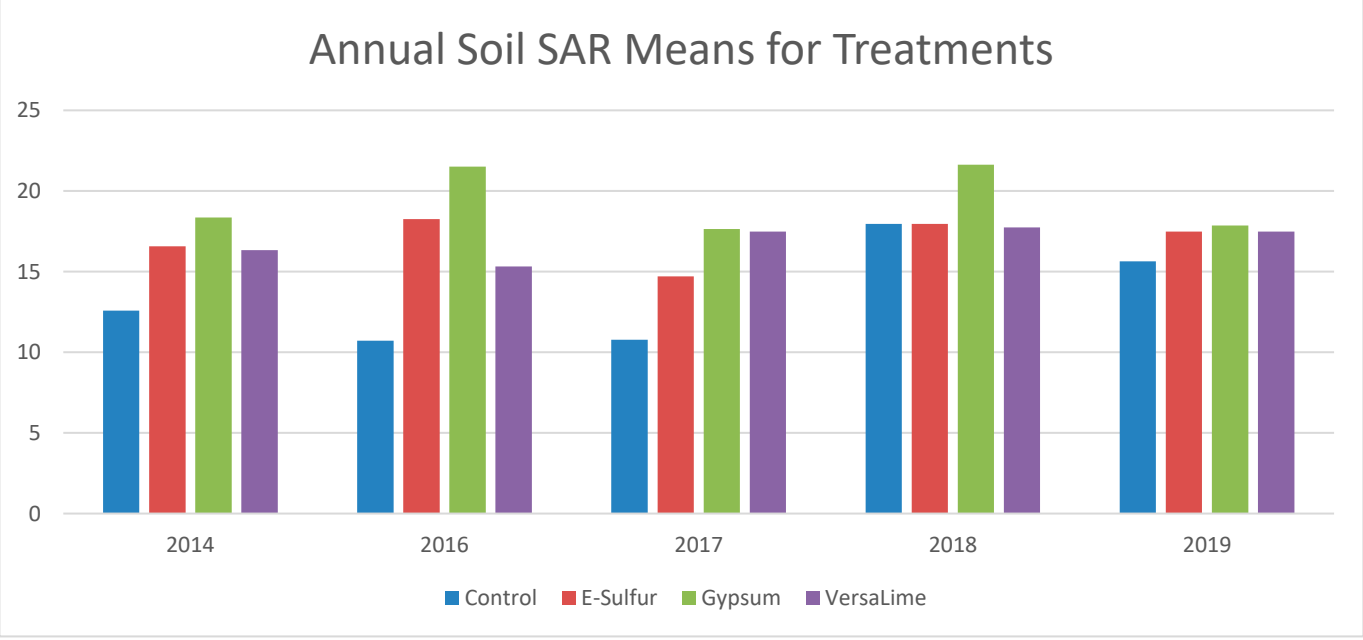
Table 8. Annual Differences in the Means of Soil SAR (sodicity) Levels among Treatments.

	Means			
Year	**Control**	**E-Sulfur**	**Gypsum**	**VersaLime**
2016	10.72	18.26	21.51	15.32
2014	12.58	16.58	18.36	16.33
Difference	-1.86	1.68	3.15	-1.01
2017	10.77	14.71	17.64	17.48
2014	12.58	16.58	18.36	16.33

Difference	-1.81	-1.87	-0.72	1.15
2018	17.95	17.95	21.64	17.75
2014	12.58	16.58	18.36	16.33
Difference	5.37	1.37	3.28	1.42
2019	15.63	17.49	17.87	17.49
2014	12.58	16.58	18.36	16.33
Difference	3.05	0.91	-0.49	1.16
2017	10.77	14.71	17.64	17.48
2016	10.72	18.26	21.51	15.32
Difference	0.05	-3.55	-3.87	2.16
2018	17.95	17.95	21.64	17.75
2016	10.72	18.26	21.51	15.32
Difference	7.23	-0.31	0.13	2.43
2019	15.63	17.49	17.87	17.49
2016	10.72	18.26	21.51	15.32
Difference	4.91	-0.77	-3.64	2.17
2018	17.95	17.95	21.64	17.75
2017	10.77	14.71	17.64	17.48
Difference	7.18	3.24	4.00	0.27
2019	15.63	17.49	17.87	17.49
2017	10.77	14.71	17.64	17.48
Difference	4.86	2.78	0.23	0.01
2019	15.63	17.49	17.87	17.49
2018	17.95	17.95	21.64	17.75
Difference	-2.32	-0.46	-3.77	-0.26

The chart below (Figure 2) has the annual soil SAR means for the four treatments.

Figure 2. Annual Means of Soil SAR Levels for all Four Treatments.



Differences in Soil pH Levels

Statistically, there were significant differences in the annual soil pH levels (Table 9). In addition, pH levels differed significantly for soil depths.

Table 9. Statistical Differences in Soil pH Levels.

Source	Mean Square	P > F
Year	7.90	<.0001
Treatment	0.03	0.7602
Replication	0.25	0.0716
Soil Depths	2.59	<.0001
Year vs Treatment	0.04	0.9333
Treatment vs Soil Depths	0.04	0.6939
Year vs Treatment vs Soil Depths	0.04	0.9761

The 2016, 2017, 2018 and 2019 soil pH levels were significantly higher than the pH levels in 2014. However, there were no significant differences in pH between 2016, 2017, 2018 and 2019. The lower soil pH levels in 2014 can be attributed to the lower soil moisture levels at the time of sampling (September 2014) compared to rest of the years. Like SAR, soil pH significantly increased with soil depth, with 0-12 inch depths having the lowest pH levels and 36-48 inch depths having the highest pH levels. Increase in pH with soil depth was due to the increase in soil moisture levels. There were no significant differences in soil pH among the four treatments. Details are in Table 10.

Table 10. Annual Differences in Soil pH Levels.

Annual Means	
2014	7.04
2016	7.90
2017	7.92
2018	8.01
2019	7.96
Treatment Means	
Control	7.77
E-Sulfur	7.73
Gypsum	7.77
VersaLime	7.79
Means for Soil Depths	
0-12 inch	7.49
12-24 inch	7.73
24-36 inch	7.87
36-48 inch	7.97

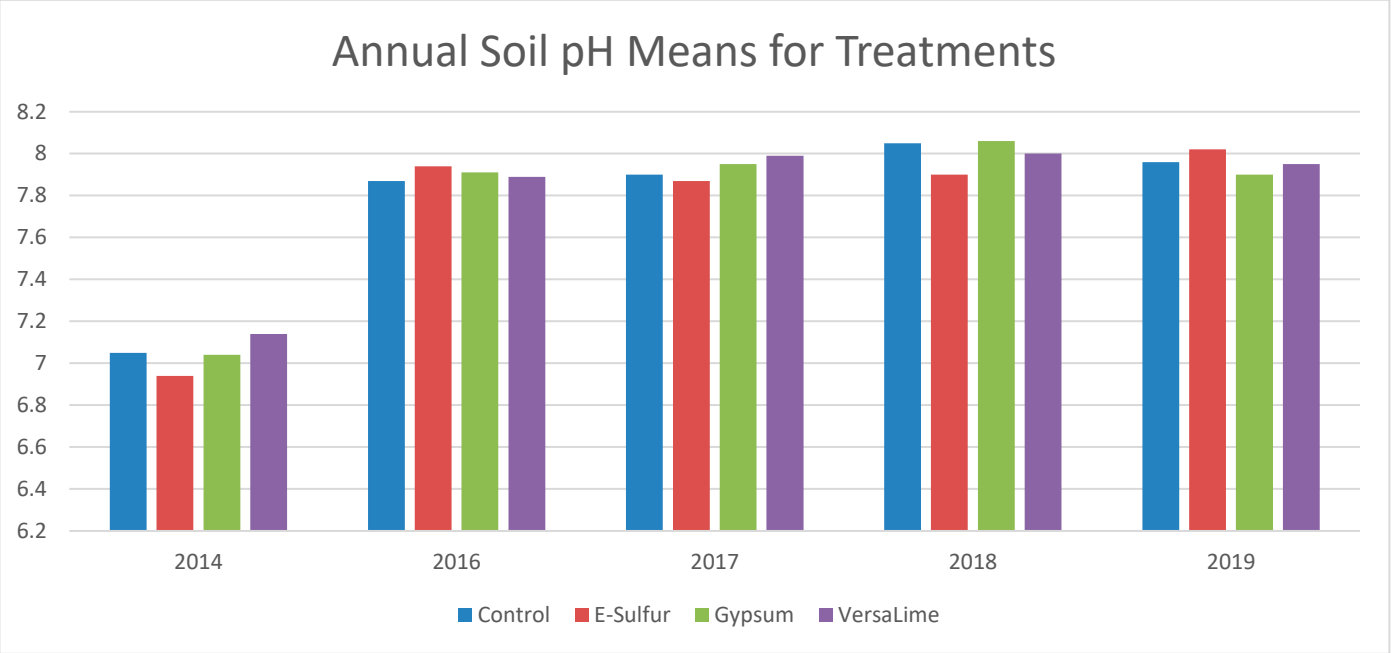
Based on the differences in the annual means of soil pH (Table 11), 2014 pH levels were lower than the rest of the years due to the lower soil moisture conditions at the time of sampling (September 2014). In 2016, 2017, 2018 and 2019, soil samples were collected in June of each year when moisture levels were higher than September 2014.

Table 11. Annual Differences in the Means of Soil pH Levels among Treatments.

	Means			
Year	Control	E-Sulfur	Gypsum	VersaLime
2016	7.87	7.94	7.91	7.89
2014	7.05	6.94	7.04	7.14
Difference	0.82	1.00	0.87	0.75
2017	7.90	7.87	7.95	7.99
2014	7.05	6.94	7.04	7.14
Difference	0.85	0.93	0.91	0.85
2018	8.05	7.90	8.06	8.00
2014	7.05	6.94	7.04	7.14
Difference	1.00	0.96	1.02	0.86
2019	7.96	8.02	7.90	7.95
2014	7.05	6.94	7.04	7.14
Difference	0.91	1.08	0.86	0.81
2017	7.90	7.87	7.95	7.99
2016	7.87	7.94	7.91	7.89
Difference	0.03	-0.07	0.04	0.10
2018	8.05	7.90	8.06	8.00
2016	7.87	7.94	7.91	7.89
Difference	0.18	-0.04	0.15	0.11
2019	7.96	8.02	7.90	7.95
2016	7.87	7.94	7.91	7.89
Difference	0.09	0.08	-0.01	0.06
2018	8.05	7.90	8.06	8.00
2017	7.90	7.87	7.95	7.99
Difference	0.15	0.03	0.11	0.01
2019	7.96	8.02	7.90	7.95
2017	7.90	7.87	7.95	7.99
Difference	0.06	0.15	-0.05	-0.04
2019	7.96	8.02	7.90	7.95
2018	8.05	7.90	8.06	8.00
Difference	-0.09	0.12	-0.16	-0.05

The chart below has the annual soil pH means for the four treatments (Figure 3).

Figure 3. Annual Means of Soil pH Levels for all Four Treatments.



Effect of Average Annual Growing-Season Groundwater Depths on EC, SAR and pH Levels

For statistical analysis, 2016, 2017, 2018 and 2019 average annual growing-season groundwater depths measured at zero to seven foot depths were used. However, since observation wells were installed in 2015, Table 12 contains differences between 2015, 2016, 2017, 2018 and 2019 average annual growing-season groundwater depths. Also, 2015 average annual growing-season groundwater depths were not measured for the entire growing-season (April to October). Based on the data in Table 12, 2016 groundwater depths were shallower than the 2015, 2017, 2018 and 2019 depths. The lowest average annual growing-season groundwater depths were recorded in 2018 groundwater.

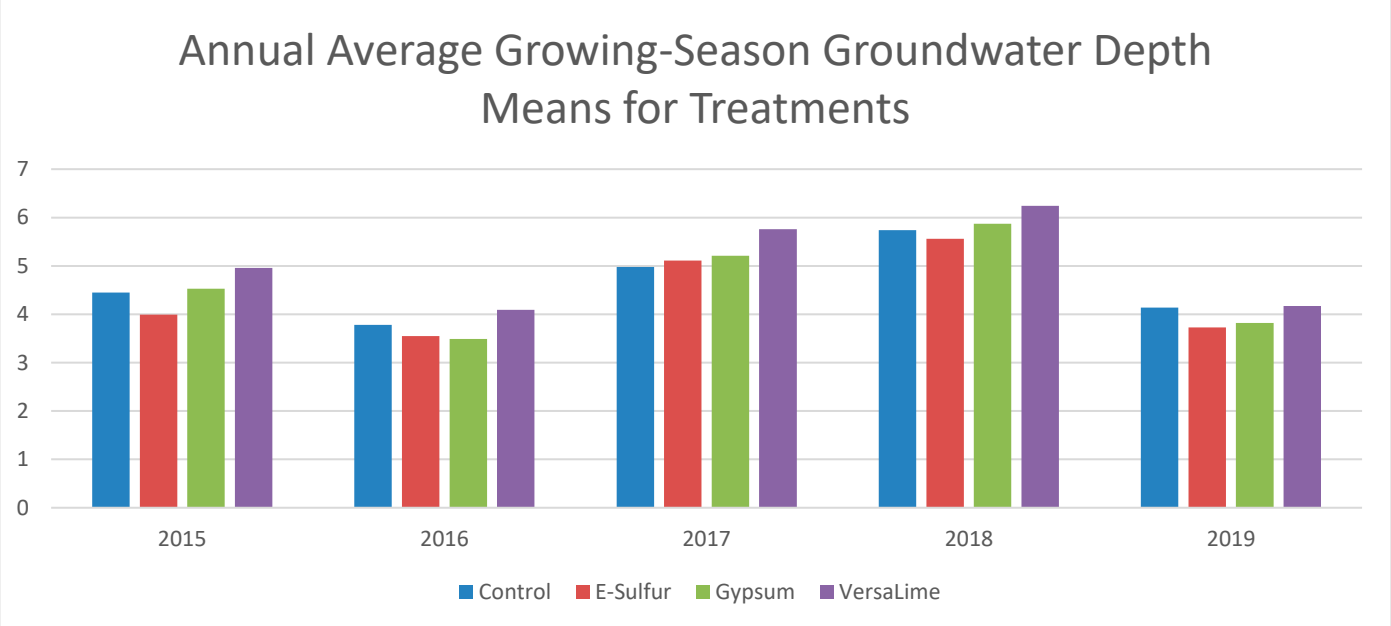
Table 12. Average Annual Growing-Season Groundwater Depth Differences among Treatments in feet.

	Average Annual Growing-Season Groundwater Depths in feet			
Year	**Control**	**E-Sulfur**	**Gypsum**	**VersaLime**
2015	4.45	3.99	4.53	4.96
2016	3.78	3.55	3.49	4.09
Difference	0.67	0.44	1.04	0.87
2015	4.45	3.99	4.53	4.96
2017	4.98	5.11	5.21	5.76
Difference	-0.53	-1.12	-0.68	-0.80
2015	4.45	3.99	4.53	4.96
2018	5.74	5.56	5.87	6.24
Difference	-1.29	-1.57	-1.34	-1.28
2015	4.45	3.99	4.53	4.96
2019	4.14	3.73	3.82	4.17
Difference	0.31	0.26	0.71	0.79

2016	3.78	3.55	3.49	4.09
2017	4.98	5.11	5.21	5.76
Difference	-1.20	-1.56	-1.72	-1.67
2016	3.78	3.55	3.49	4.09
2018	5.74	5.56	5.87	6.24
Difference	-1.96	-2.01	-2.38	-2.15
2016	3.78	3.55	3.49	4.09
2019	4.14	3.73	3.82	4.17
Difference	-0.36	-0.18	-0.33	-0.08
2017	4.98	5.11	5.21	5.76
2018	5.74	5.56	5.87	6.24
Difference	-0.76	-0.45	-0.66	-0.48
2017	4.98	5.11	5.21	5.76
2019	4.14	3.73	3.82	4.17
Difference	0.84	1.38	1.39	1.59
2018	5.74	5.56	5.87	6.24
2019	4.14	3.73	3.82	4.17
Difference	1.60	1.83	2.05	2.07

Figure 4 has the average annual growing-season groundwater depths for the four treatments in feet.

Figure 4. Annual Means of Average Growing-Season Groundwater Depths for all Four Treatments in feet.



Fluctuations in groundwater depths is also reflective of a very wet 2016 versus drier weather in 2017 and 2018 (Table 13). In 2019, weather was dry until July 30th and started getting wet from July 31st. The NDSU Langdon Research Extension Center, North Dakota Agricultural Weather Network (NDAWN) Station recorded 6.28 inches of rainfall versus a normal of 10.73 inches from April 1st to July 30th of 2019. The Total Potential Evapotranspiration (Penman) for the same period was 25.17 inches. Same station recorded 9.74 inches of rain versus a normal of 4.76 inches for July 31st to October 5th 2019 time period. The Total Potential Evapotranspiration (Penman) for the same period was 9.04 inches. On July 31st 0.77 inches were recorded and in August of 2019, 2.48 inches of rain was recorded versus a normal of 2.57 inches. September 2019 was wettest and 5.87 inches of rain was

recorded versus a normal of 1.81 inches. Overall, growing-season was dry, whereas, fall was very wet which created a lot of harvest issues.

Table 13. Four-year Rainfall versus Evapotranspiration Data of the NDSU Langdon Research Extension Center, North Dakota Agricultural Weather Network (NDAWN) Station.

Time Period	Total Potential Evapotranspiration (Penman)	Total Rainfall (inches)	Total Normal Rainfall (inches)
April 1 – Oct. 31, 2015	41.37"	18.46"	16.68"
April 1 – Oct. 31, 2016	35.29"	24.91"	
April 1 – Oct. 31, 2017	38.72"	10.24"	
April 1 – Oct. 31, 2018	38.28"	11.41"	
April 1 – Oct. 31, 2019	35.62"	16.39"	

Differences in Soil EC Levels

Statistically, there were significant differences in the annual soil EC levels among treatments and between replications due to the changes in the average annual growing-season groundwater depths (Table 14).

Table 14. Statistical Differences in Soil EC (dS/m) Levels.

Source	Mean Square	P > F
Year	152.53	0.0003
Treatment	44.67	0.0106
Replication	65.19	0.0056
Soil Depths	11.30	0.1652
Year vs Groundwater Depths	6.93	0.3307
Groundwater Depths vs Soil Depths	2.53	0.9074
Year vs Groundwater Depths vs Soil Depths	3.41	0.6452

The 2016 soil EC levels were significantly lower than the 2017, 2018 and 2019 EC levels despite the shallowest average annual growing-season groundwater depths. The average annual growing-season groundwater depths lowered in 2017, 2018 due to drier weather (Table 13) resulting in increased capillary rise and EC levels. That trend continued in 2019 during most of the growing-season except late fall when 5.87 inches of rain was recorded during September versus a normal of 1.81 inches. Overall, 9.74 inches of rain was recorded versus a normal of 4.76 inches during July 31st to October 5th. Among treatments, EC levels in the control treatments were significantly lower than the EC levels in E-sulfur, gypsum and VersaLime treatments. In addition, replication 2 had significantly higher EC levels than replications 1 and 3, whereas, replication 1 had significantly higher EC levels than replication 3.

Differences in Soil SAR Levels

Statistically there were significant differences in the annual soil SAR levels between treatments and soil depths due to the changes in the average annual growing-season groundwater depths (Table 15). The SAR levels in 2018 were significantly higher than the SAR levels in 2016, 2017 and 2019. In addition, SAR levels in 2019 were significantly higher than the SAR levels in 2017. The control treatment had significantly lower SAR levels compared to gypsum, E-sulfur and VersaLime treatments, whereas, gypsum treatments had the highest SAR levels versus the rest of the treatments. The SAR levels also increased significantly with an increase in soil depths with 0-12 inch depths having the lowest SAR levels and 36-48 inch depths being the highest.

Table 15. Statistical Differences in Soil SAR Levels.

Source	Mean Square	P > F
Year	92.14	0.0111
Treatment	349.73	0.0004
Replication	0.27	0.9744
Soil Depths	664.71	<.0001
Year vs Groundwater Depths	61.31	0.0166
Groundwater Depths vs Soil Depths	14.81	0.3567
Year vs Groundwater Depths vs Soil Depths	32.83	0.0955

Differences in Soil pH Levels

Statistically there were significant effects of the average annual growing-season groundwater depths on soil pH levels between replication and soil depths (Table 16). Soil pH levels in 2014 were significantly lower than 2016, 2017, 2018 and 2019. Since groundwater depths could not be measured in 2014, it cannot be concluded that these differences were due to the differences in average annual growing-season groundwater depths.

Table 16. Statistical Differences in Soil pH Levels.

Source	Mean Square	P > F
Year	7.90	<.0001
Treatment	0.03	0.5462
Replication	0.25	0.0465
Soil Depths	2.59	<.0001
Year vs Groundwater Depths	0.11	0.1211
Groundwater Depths vs Soil Depths	0.04	0.6585
Year vs Groundwater Depths vs Soil Depths	0.03	0.6247

Replication 3 had significantly higher pH levels than replication 1 and 2. That could be a result of shallower average annual groundwater depths in replication 3 resulting in higher soil moisture levels. The effect of soil moisture levels on pH was also evident due to the difference in pH levels between different soil depths. The pH levels also increased significantly with an increase in soil depths with 0-12 inch depths having the lowest pH levels and 36-48 inch depths being the highest.

CONCLUSION

Based on the data collected five years after tiling and four years after applying soil amendments, changes in soil EC (salinity) levels were consistent with the fluctuations in the annual rainfall and evapotranspiration data. Tiling the saline-sodic site alone did not seem to make a big difference as the highest annual decrease in EC levels was recorded in 2016 with shallower groundwater levels and higher seasonal rainfall (24.91”). Drier weather in 2017, 2018 and early part of 2019, resulted in an increase in EC levels despite lower annual average growing-season groundwater depths. That could be due to the absence of a decent amount of rain to push the salts deeper and increased evapotranspiration resulting in capillary rise of soil water. Consistently higher SAR (sodicity) levels could also be contributing to the slower leaching of excessive salts from the top four feet of soil due to the poor permeability.

Tiling seemed to help when there was excess water to drain in 2016 and help maintain slightly lower groundwater depths. However, under drier weather, groundwater depths lowered naturally and salt levels increased due to capillary rise (wicking up) despite tiling.

Soil sodicity levels remained inconsistent four years after applying the amendments and the site being tiled for five years. This could be due to the absence of a decent amount of rain to dissolve the amendments and create the desired chemical reaction for the conversion of sodicity into salinity.

The changes in soil pH were found to be consistent with soil moisture availability at the time of sampling. No effects of soil amendments were observed on pH four years after the application.

Producers and landowners, who are thinking about tiling entire fields, may want to consider looking at the following points before making a final decision:

- Under drier weather, **"tiling may not be necessary as average annual growing-season groundwater depths may lower naturally."**
- If the potential fields have unproductive or marginal areas, **"they should be sampled three to four feet deep and analyzed for EC (salinity) and SAR (sodicity) levels."**
- Tiling saline fields alone under drier weather **"will not lower salinity as moving the excess salts into deeper depths will also require a decent amount of rain."**
- Under drier weather, **"salinity levels can increase despite tiling due to the increased evaporation and resulting capillary rise of soil water."**
- Tiling sodic or saline-sodic fields alone **"will not remediate sodicity and will require application of amendments."**
- If sodicity problems are established, **"amendments application should be considered before tiling in order for the amendments to convert sodicity into salinity."**
- The conversion of sodicity into salinity **"will also result in improved soil water infiltration resulting in timely leaching of salts"**.
- Conversion of sodicity into salinity by amendments **"may take years, especially under drier weather."**

Langdon REC Foundation Seed Stocks Program

The Langdon REC supports a Foundation Seed Stocks Program to help increase and distribute the newest NDSU varieties of HRSW, Durum, Barley, Soybeans and Flax. We also periodically increase seed for the University of Minnesota and South Dakota Ag Experiment Station. Each year approximately 500 acres are planted for the FSS program. The harvested acreage is available for sale to producers and seedsmen in the region. The varieties of crops that are available for the 2020 growing season are listed below:

HRSW – Faller, Prosper, Linkert, Bolles, ND VitPro, MN-Washburn
Barley – ND Genesis
Soybeans - ND Henson, ND17009GT, ND18008GT

Growers who have grown seed for certification in one of the last four years who request seed prior to December 1st will be guaranteed an allocation. Any seed inventories available after December 1st will be sold on a first come, first serve basis. Seed availability and prices may be obtained by calling the Langdon Research Extension Center at 701-256-2582.

Visit our website at www.ag.ndsu.edu/langdonrec/

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