Langdon Research Extension Center

NORTH DAKOTA STATE UNIVERSITY

Annual Research Report No. 97

December 2022

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
Venkat Chapara, PhD	Plant Pathologist
Anitha Chirumamilla, PhD	Extension Cropping Systems Specialist
Naeem Kalwar	Extension Soil Health Specialist
Sara Schuchard-McGregor	Administrative Assistant
Lawrence Henry	Research Specialist II/Agronomy
Amanda Arens	Research Specialist II/Plant Pathology
Travis Hakanson	Research Specialist/Foundation Seed
Carmen Ewert	Research Technician/Foundation Seed
Richard Duerr	Research Specialist/Agronomy
Darren Wilcox	Farm Business Management Instructor, LRSC
Bailey Reiser	Cavalier County Extension Agent/ANR
Katie Henry	Cavalier County Extension Agent/FCW

2022 Seasonal/Temporary Employees

Larissa Jennings	Mason Christianson	Parker Rime	Brock Freer	Iverson Peltier
Traci Murphy	Raelyn Klindt	Jacob Kram	Nancy Feil	

Langdon Research Extension Center Advisory Board

Bailey Reiser	Cavalier County Extension Agent
Reily Bata	Producer, Langdon, ND
Jon Iverson	Producer, Langdon, ND
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Pam Brekke	Producer, Edmore, ND
Tom Fagerholt	Producer, Hoople, ND
Steve McDonald	Producer, Sarles, ND

NDSU Langdon Research Extension Center
9280 107th Ave. N.E.
Langdon, ND 58249
phone: (701) 256-2582
fax: (701) 256-2580
Website: www.ag.ndsu.edu/langdonrec
Email: NDSU.Langdon.REC@ndsu.edu

NDSU NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

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The 2022 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/ (old NDSU variety trial website) and https://vt.ag.ndsu.edu/ (new NDSU variety trial website).

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. If the difference between two varieties exceeds the LSD value, it means that with 95% or 90% confidence (LSD probability 5 or 10%) the higher-yielding variety has a significant yield advantage. When the difference between two varieties is less than the LSD value, no significant difference was found between those two varieties under those growing conditions. The trial mean shown in the tables represent all named varieties and experimental lines tested in the trial. Experimental line data is not shown. Statistical analysis includes all varieties and experimental lines in the trial.

'NS' is used to indicate no significant difference for that trait among any of the varieties at the 95% or 90% level of confidence. 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 characteristics.

The NDSU Langdon Research Extension Center, in addition to its on-station research program, conducted variety research trials at several locations in 2022. 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.

2022 Weather Summary

Fall recharge at Langdon from September through October 2021 was 4.90 inches, 1.55 inches above normal. Precipitation from November 2021 through March 2022 was 4.51 inches, 1.26 inches above normal. Snowfall for 2021-2022 was 48.0 inches, 14.8 inches above normal. December-February temperatures averaged 2.3°F, 3.2°F below normal. The 2022 growing season in NE ND started with below normal subsoil moisture in the region, a result of below average precipitation during the 2021 growing season. The 2022 growing season precipitation averaged 106 percent above normal across NE North Dakota from April-September. Most of the precipitation occurred during April and May. The rainfall was needed but resulted in delayed spring planting. Disease levels were low this year with generally drier conditions in June-August. Crop yields were average to above average despite late planting dates. Above normal temperatures helped push crop development. Harvest conditions were favorable in September and October.

2022 Crop Management - Langdon					
Field Trial	**Previous Crop**	**Seeding Rate Unit/Acre**	**Planting Date**	**Harvest Date**	**Row Spacing**
Barley	soybean	1.0 million pls	May 24	Sept. 1	6
Buckwheat	wheat	50 lbs pls	May 27	Oct. 11	6
Canola – LL, CL	soybean	610,000 pls	June 3	Sept. 22	6
Canola – RR	soybean	610,000 pls	June 3	Sept. 22	6
Corn	soybean	28,000 thinned	May 24	Oct. 21	30
Durum	soybean	1.50 million pls	May 24	Sept. 13	6
Dry Bean	wheat	70,000-90,000 pls	May 27	Sept. 29	30
Faba Bean	wheat	192,000 pls	May 26	Oct. 7	6
Field Pea	wheat	325,000 pls	May 26	Sept. 7	6
Flax	wheat	2.8 million pls	May 27	Oct. 10	6
HRSW	soybean	1.50 million pls	May 24	Sept. 7	6
HRWW	fallow	1.0 million pls	Sept. 10, 2021	Aug. 17	6
Oats	soybean	1.0 million pls	May 24	Sept. 6	6
Rye	wheat	1.0 million pls	Sept. 10, 2021	Aug. 17	6
Soybean – Conv.	wheat	200,000 pls	May 26	Oct. 11	6
Soybean – RR	wheat	200,000 pls	May 26	Oct. 10	6
Sunflower – Conf.	wheat	17,000 thinned	May 27	Oct. 20	30
Sunflower – Oil	wheat	20,000 thinned	May 27	Oct. 20	30

pls=pure live seed emergence

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
Madeleine Smith – Pembina County Extension Agent
Jarvis Stein - McVille

2022 Crop Management – Off-Station					
Location (County/Field Trial)	**Previous Crop**	**Seeding Rate Unit/Acre**	**Planting Date**	**Harvest Date**	**Row Spacing**
Cavalier (Pembina)					
HRSW	soybean	1.50 million pls	June 6	Sept. 28	6
Soybean	soybean	200,000 pls	June 6	Oct. 18	6
Park River (Walsh)					
HRSW	fallow	1.50 million pls	May 25	Sept. 12	6
Soybean	wheat	200,000 pls	May 25	Oct. 13	6
Pekin (Nelson)					
HRSW	soybean	1.50 million pls	June 2	Sept. 27	6
Soybean	wheat	200,000 pls	June 2	Oct. 17	6
Cando (Towner)					
HRSW	dry bean	1.50 million pls	May 17	Sept. 12	6

Location	**Soil Type**
Cavalier	Fargo silty clay
Park River	HRSW- Glyndon silt loam, Soybean – Bearden silty clay loam
Pekin	Lankin loam
Cando	Egeland-Embden fine sandy loam

pls = pure live seeds

Record of Climatological Observation
Langdon, ND

	Precipitation		Dep. from		Temperature		Dep. from
	Normal*	2022	Normal		Normal*	2022	Normal
April	1.25	4.48	+3.23	April	37.9	29.4	-8.5
May	2.28	4.44	+2.16	May	51.5	50.3	-1.2
June	3.23	1.77	-1.46	June	61.0	63.2	+2.2
July	2.94	4.91	+1.97	July	66.3	67.2	+0.9
August	2.60	1.80	-0.80	August	64.5	65.9	+1.4
September	2.07	1.03	-1.04	September	54.6	58.1	+3.5
Total	14.37	18.43	+4.06	Total	56.0	55.7	-0.3

*120 year average

Monthly Growing Degree Days and Normals-Langdon

	Wheat Growing Degree Days			Corn Growing Degree Days			Sunflower Growing Degree Days		
	2022	Normal	Deviation	2022	Normal	Deviation	2022	Normal	Deviation
April	70	244	-174	--	--	--	--	--	--
May	572	619	-47	171	209	-38	273	308	-35
June	904	890	+14	418	360	+58	581	534	+47
July	1025	1027	-2	510	503	+7	695	689	+6
August	985	979	+6	471	472	-1	651	658	-7
September	711	704	+7	293	259	+34	422	372	+50
Total	4267	4463	-196	1863	1803	+60	2622	2561	+61

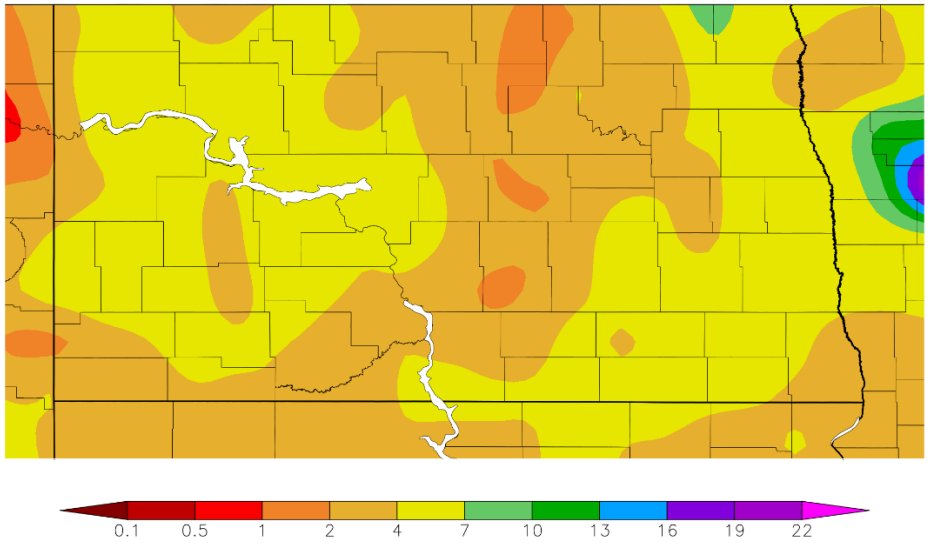
Frost Dates-Langdon and Selected Cities

	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
2022	21-May	2-May	22-Sep	6-Oct	124	157
Cavalier						
Normal	16-May	5-May	24-Sep	5-Oct	131	153
2022	3-May	26-Apr	27-Sep	6-Oct	147	163
Park River						
Normal	8-May	30-Apr	30-Sep	10-Oct	145	163
2022	2-May	26-Apr	27-Sep	28-Sep	148	155
Pekin						
Normal	18-May	3-May	22-Sep	30-Sep	127	150
2022	21-May	27-Apr	28-Sep	6-Oct	130	162

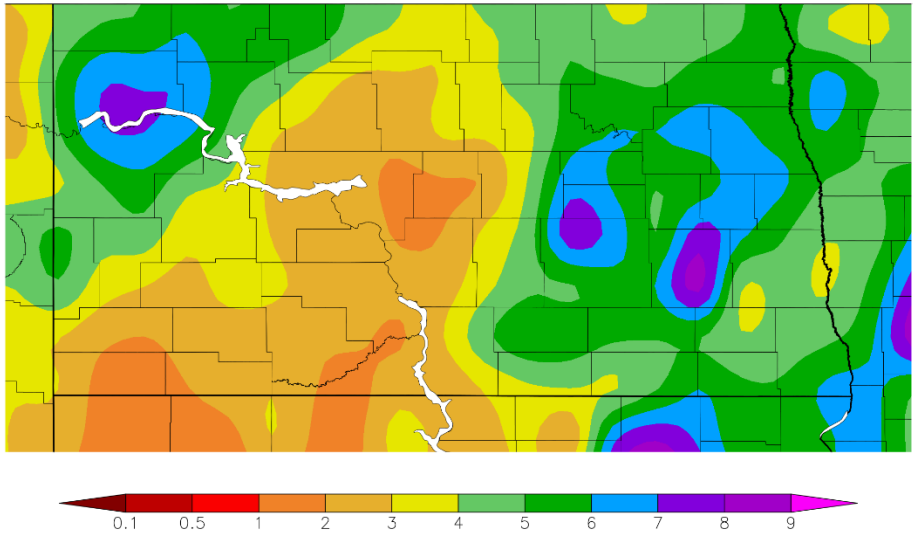
Normals are from the NWS. The 2022 frost dates are from the nearest reporting NDAWN station.

North Dakota 2022 Precipitation (inches) Maps

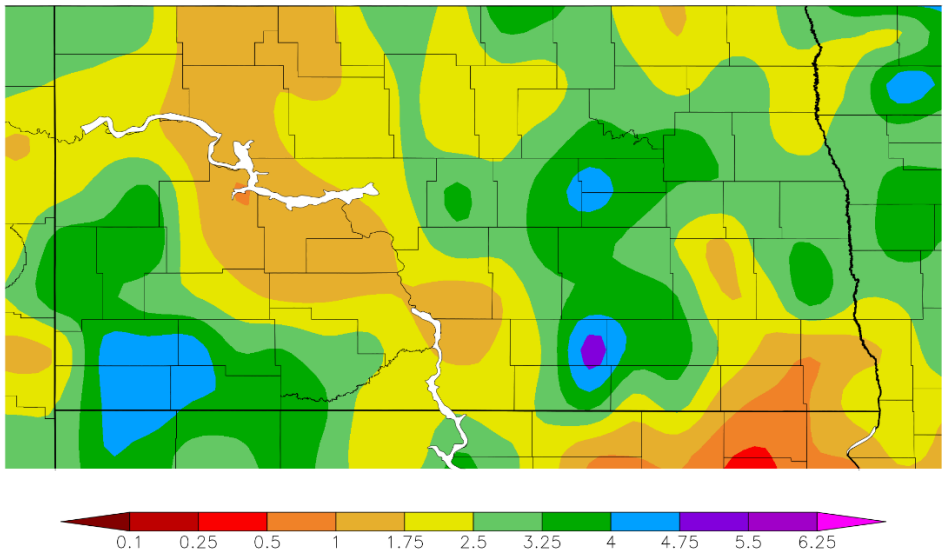
4/1/22 – 4/30/22



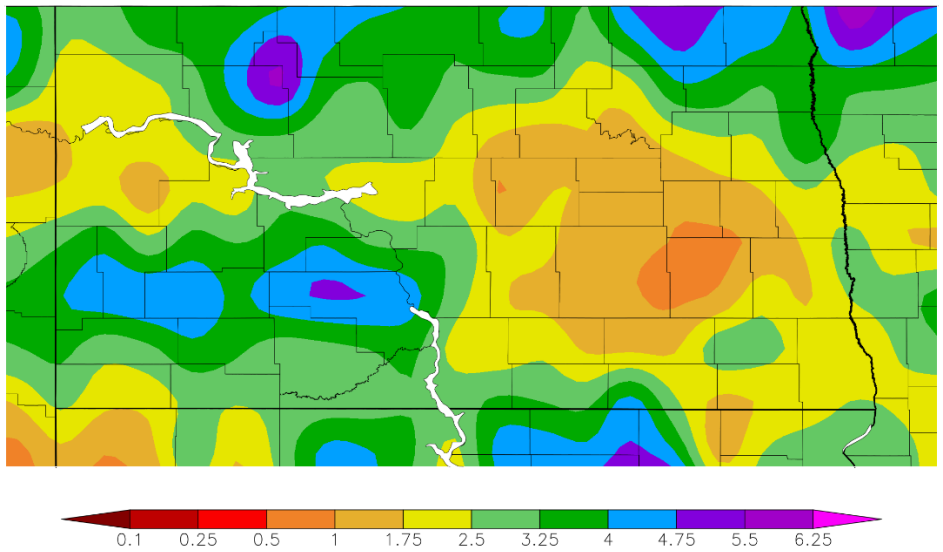
5/1/22 – 5/31/22



6/1/22 – 6/30/22

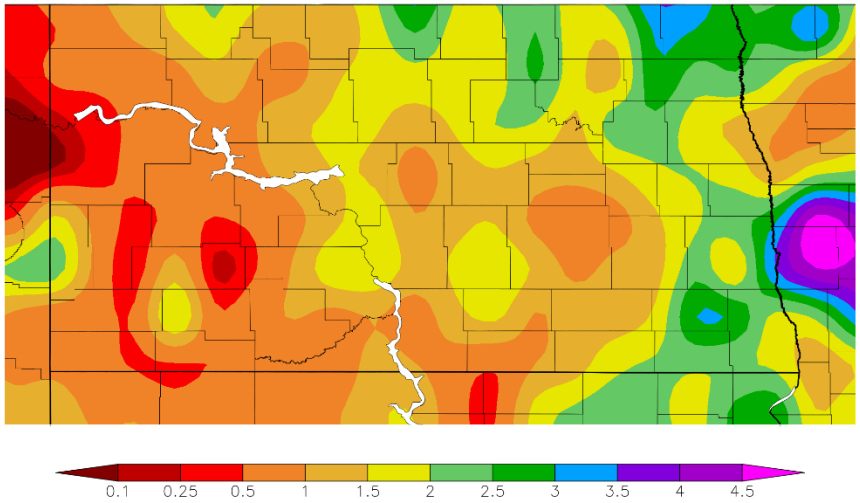


7/1/22 – 7/31/22

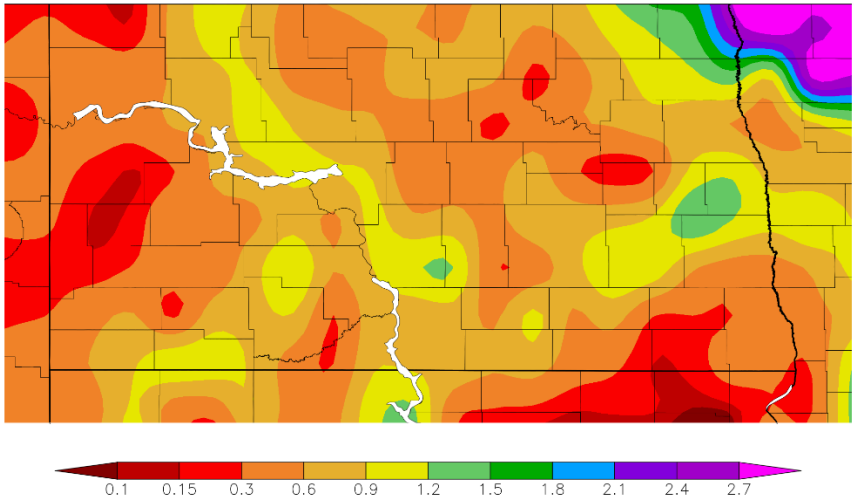


North Dakota 2022 Precipitation (inches) Maps Continued

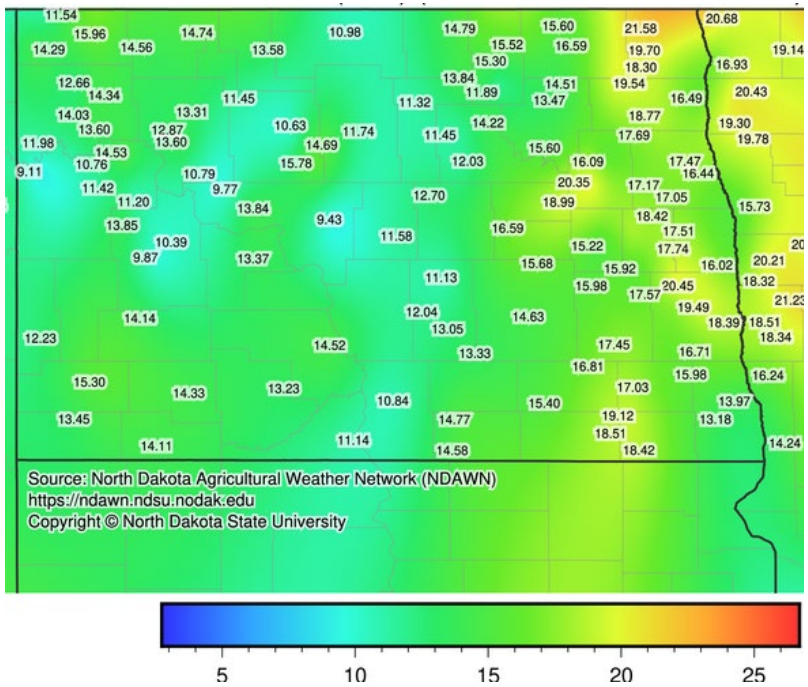
8/1/22 – 8/31/22



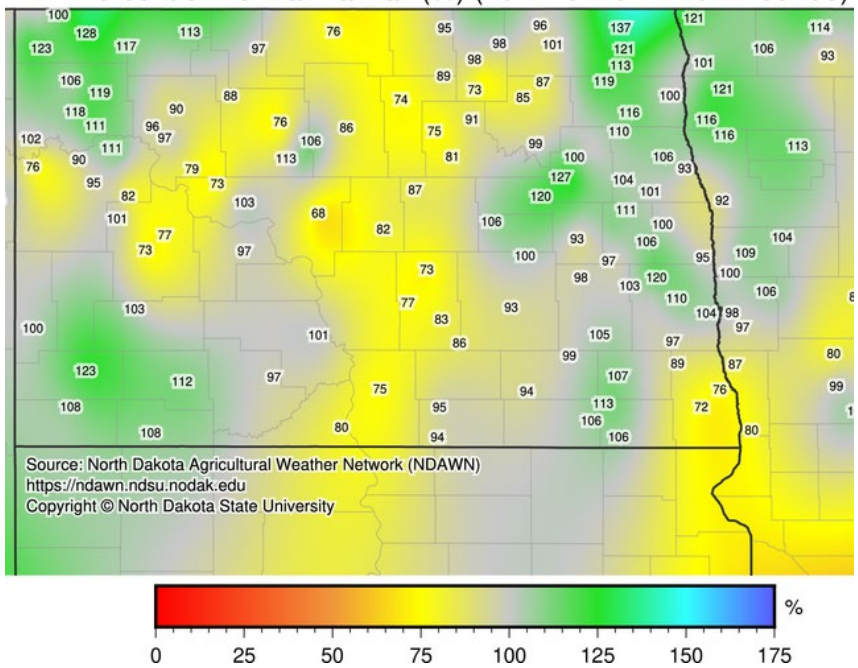
9/1/22 – 9/30/22



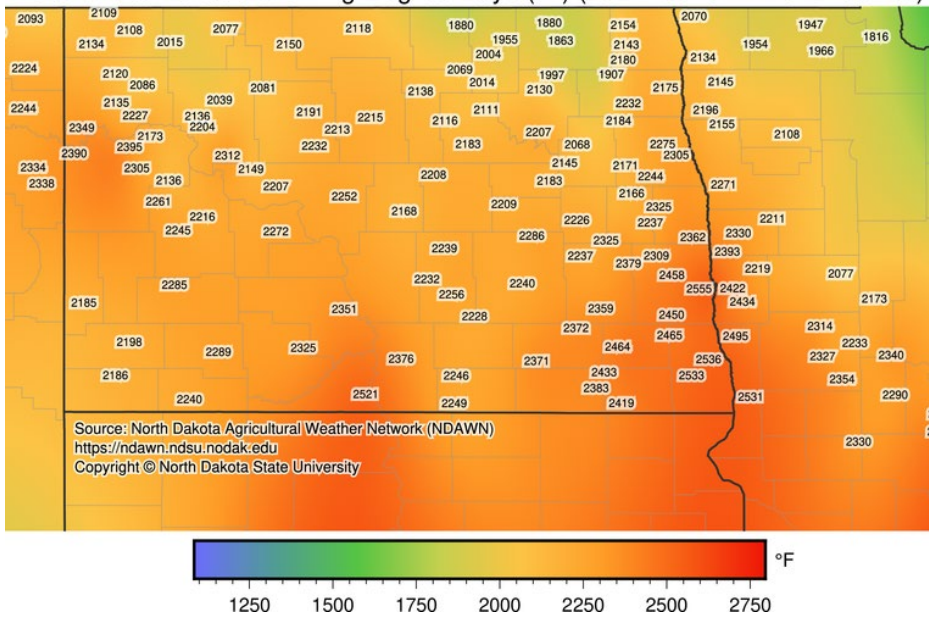
Growing Season 4/1/22 – 9/30/22



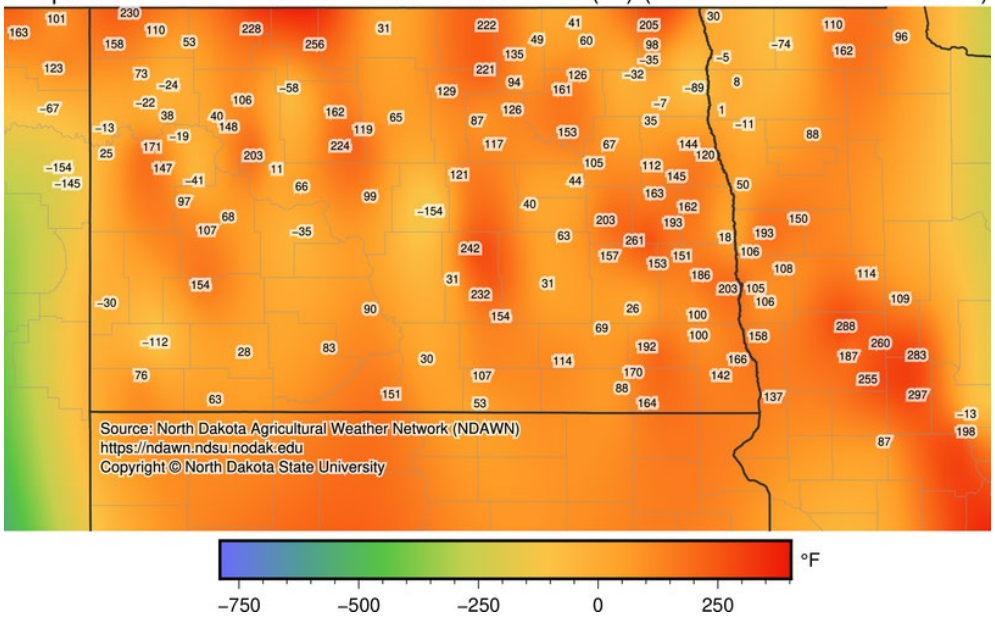
Percent of Normal Rainfall (%) (2022–04–01 – 2022–09–30)



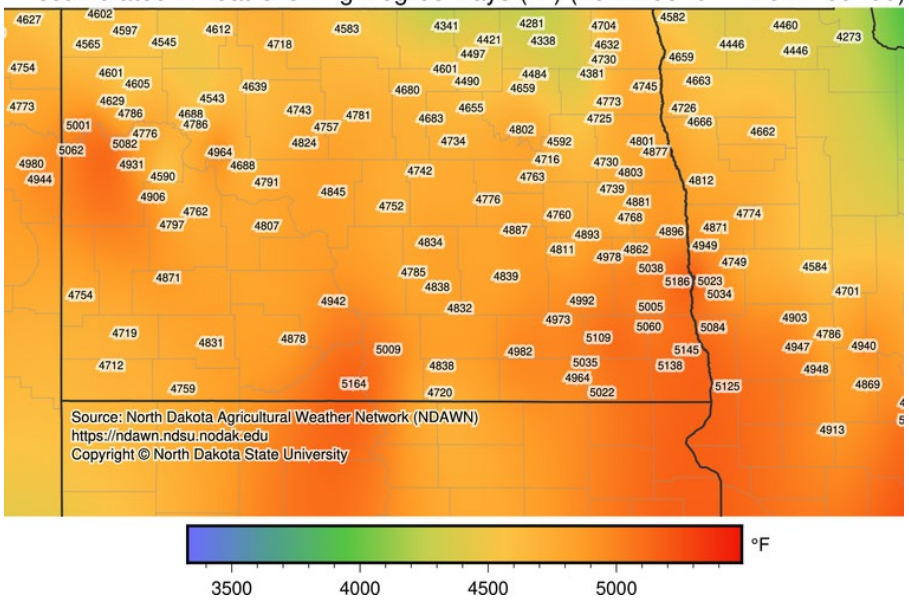
Corn Accumulated Growing Degree Days (°F) (2022–05–01 – 2022–09–30)



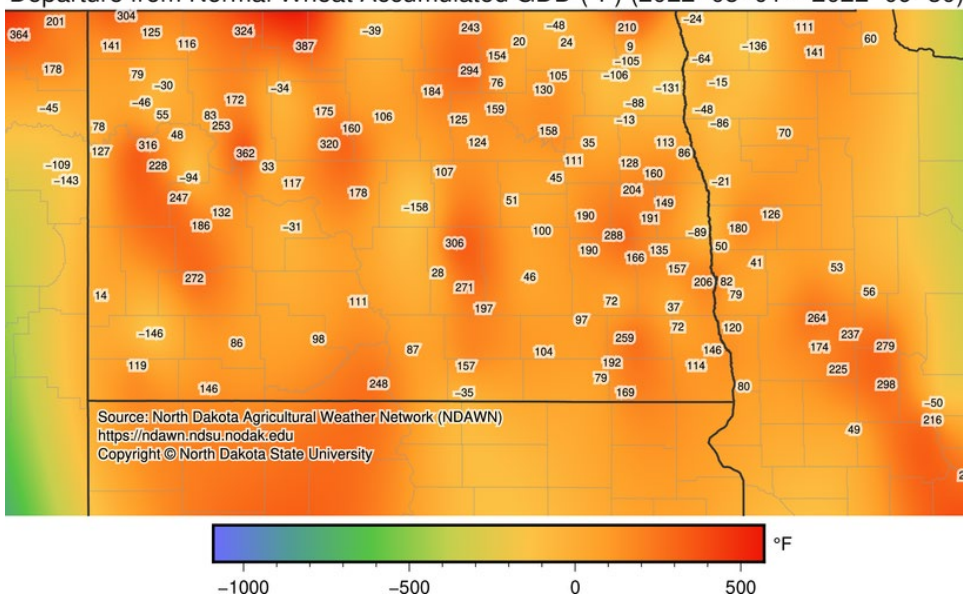
Departure from Normal Corn Accumulated GDD (°F) (2022–05–01 – 2022–09–30)



Accumulated Wheat Growing Degree Days (°F) (2022–05–01 – 2022–09–30)



Departure from Normal Wheat Accumulated GDD (°F) (2022–05–01 – 2022–09–30)



Durum Summary, Langdon 2018-2022

	Yield (bu/a)						Test Weight (lbs/bu)						Lodging (0-9)					Height (in)					Days to Head				
Variety	**18**	**19**	**20**	**21**	**22**	**5yr**	**18**	**19**	**20**	**21**	**22**	**5yr**	**15**	**16**	**17**	**20**	**4yr**	**19**	**20**	**21**	**22**	**4yr**	**19**	**20**	**21**	**22**	**4yr**
Alkabo	81	67	80	49	78	71	61.4	60.2	59.8	59.5	60.6	60.3	0.5	5.8	1.3	0.1	1.9	34	37	29	37	34	57	49	62	53	55
Maier	80	69	62	40	68	64	61.5	60.9	56.0	59.4	59.8	59.5	0.5	5.0	4.8	2.6	3.2	34	38	27	37	34	57	49	61	54	55
Mountrail	87	68	70	49	86	72	62.3	58.5	57.4	59.3	60.5	59.6	2.0	7.2	5.0	3.8	4.5	34	36	29	37	34	58	49	61	54	56
Strongfield	77	64	62	46	71	64	61.5	60.1	56.2	58.8	58.7	59.1	3.8	6.4	4.5	5.5	5.1	34	35	30	34	33	58	50	62	53	56
Tioga	89	69	77	48	81	73	62.2	60.5	58.4	59.3	62.1	60.5	0.3	6.4	6.0	4.0	4.2	36	39	33	40	37	57	50	61	55	56
Carpio	93	70	77	50	81	74	62.6	61.1	59.5	59.8	62.7	61.1	1.0	7.6	6.5	2.7	4.5	34	38	31	37	35	59	52	63	55	57
Joppa	90	75	76	44	86	74	62.3	60.9	58.3	60.2	61.1	60.6	0.5	6.9	6.8	3.5	4.4	34	39	32	38	36	58	49	63	53	56
Divide	89	68	78	51	75	72	61.6	59.9	58.6	59.7	61.1	60.2	1.8	6.9	6.3	2.9	4.5	34	38	32	40	36	58	51	62	56	57
Rugby	76	63	63	41	69	62	61.8	60.3	57.1	59.8	61.1	60.0	4.0	7.0	8.0	7.0	6.5	36	38	31	40	36	57	49	61	53	55
ND Grano	84	70	75	50	84	72	62.1	60.7	58.2	61.0	61.9	60.8	0.8	6.4	5.0	1.9	3.5	35	39	29	37	35	59	50	64	53	57
ND Riveland	89	71	79	45	81	73	62.0	60.3	58.7	59.5	61.6	60.4	1.8	5.9	3.3	3.1	3.5	35	40	32	39	37	58	50	63	55	57
ND Stanley	86	66	82	50	86	74	62.7	60.7	60.0	60.4	62.7	61.3	--	--	4.0	2.6	--	33	38	30	36	34	58	50	63	54	56
TCG Webster	69	71	55	40	71	61	62.0	59.8	57.7	59.6	59.9	59.8	--	--	--	0.2	--	28	31	24	29	28	54	47	59	50	53
CDC Defy	--	--	--	--	82	--	--	--	--	--	60.8	--	--	--	--	--	--	--	--	--	38	--	--	--	--	52	--
CDC Vantta	--	--	--	--	58	--	--	--	--	--	56.1	--	--	--	--	--	--	--	--	--	34	--	--	--	--	58	--
AC Commander	75	65	59	42	--	--	61.0	58.8	54.7	58.7	--	--	1.0	3.8	1.8	0.4	1.8	30	30	25	--	--	57	49	58	--	--
Ben	76	68	75	46	--	--	62.3	60.7	59.5	59.8	--	--	2.3	6.2	4.0	3.5	4.0	35	37	33	--	--	57	49	60	--	--
Grenora	87	70	84	49	--	--	62.1	59.1	58.4	59.1	--	--	0.8	6.7	5.8	4.3	4.4	32	35	29	--	--	56	48	61	--	--
Lebsock	77	70	75	45	--	--	63.0	61.1	60.4	60.0	--	--	3.8	5.7	3.8	2.0	3.8	33	35	29	--	--	56	48	61	--	--
Pierce	91	70	76	45	--	--	62.7	60.9	59.1	59.7	--	--	3.0	6.6	5.3	3.7	4.7	33	36	29	--	--	57	49	61	--	--
Alzada	55	59	48	39	--	--	59.9	58.7	54.1	57.3	--	--	0.0	3.0	0.3	0.4	0.9	29	31	26	--	--	56	48	59	--	--
CDC Verona	80	67	61	52	--	--	61.7	60.2	54.9	59.4	--	--	0.8	5.7	6.0	4.8	4.3	34	35	30	--	--	58	50	62	--	--
VT Peak	82	72	80	49	--	--	62.4	61.7	59.6	60.8	--	--	0.5	4.3	4.3	0.8	2.5	35	38	31	--	--	57	50	61	--	--
Trial Mean	84	70	74	48	79		62.2	60.5	58.3	59.8	61.3		1.7	6.1	5.9	3.3		34	37	30	38		58	50	62	55	
C.V. %	8.4	5.6	8.6	7.1	6.4		0.8	0.8	1.8	0.5	1.6		114	14.9	31.8	52.6		3.5	4.2	1.9	4.0		1.0	1.3	1.9	1.5	
LSD 5%	9.8	5.5	8.8	3.1	7.1		0.7	0.7	1.5	0.2	1.4		NS	1.3	2.6	2.4		1.7	2.2	1.0	2.1		0.8	0.9	1.0	1.1	
LSD 10%	8.2	4.6	7.4	2.6	5.9		0.6	0.6	1.3	0.2	1.2		2.2	1.1	2.2	2.0		1.4	1.8	0.9	1.8		0.7	0.7	0.9	0.9	

Average Data by Crop and Year Across Sites

HRSW	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)						Height (in)					Days to Head					Lodging (0-9)			
No. Sites	4	5	5	3[1]	5	13	4	5	5	5	5	15	4	5	5	5	5	15	5	5	4	5	14	5	5	3	5	13	4	1	1	6
Variety	18	19	20	21	22	3yr	18	19	20	21	22	3yr	18	19	20	21	22	3yr	19	20	21	22	3yr	19	20	21	22	3yr	19	20	22	3yr
Faller	86	85	69	62	70	67	61.8	59.5	58.6	59.3	59.7	59.2	13.6	13.9	14.4	14.5	14.0	14.3	33	32	27	33	31	55	49	58	48	51	2.2	2.0	2.6	2.1
SY Ingmar	74	78	65	53	64	61	62.3	60.2	60.0	60.5	60.2	60.2	14.8	14.4	15.4	15.6	15.1	15.4	29	29	24	30	28	52	47	56	46	50	0.1	0.0	1.5	0.1
SY Valda	86	80	71	59	72	67	61.6	59.5	59.6	59.7	59.9	59.7	13.6	13.5	14.3	14.7	14.0	14.3	29	29	25	30	28	53	47	57	46	50	1.6	0.5	2.0	1.1
LCS Trigger	88	89	75	65	72	71	62.0	59.8	59.9	59.2	60.4	59.8	11.8	12.1	12.3	13.0	12.6	12.6	34	33	26	34	31	58	53	61	52	55	1.4	3.7	1.8	2.6
TCG-Spitfire	79	79	69	56	71	66	61.3	58.9	58.7	58.9	59.2	58.9	13.9	13.8	14.1	15.3	14.1	14.5	31	30	27	32	30	56	50	58	49	52	0.0	0.3	1.5	0.2
Ambush	--	75	64	58	71	64	--	60.0	59.9	60.8	58.8	59.8	--	15.0	15.6	15.5	14.3	15.1	31	30	25	32	29	53	47	56	47	50	0.5	0.2	2.4	0.4
Ballistic	--	88	66	66	63	65	--	59.3	57.6	58.9	60.1	58.9	--	13.9	14.9	14.7	15.1	14.9	33	32	27	30	30	54	48	58	45	50	1.4	1.9	2.0	1.7
Commander	--	81	66	54	63	61	--	59.9	59.3	60.2	59.5	59.7	--	14.0	14.6	15.0	14.5	14.7	31	30	25	31	29	52	46	55	44	48	0.2	0.0	1.0	0.1
LCS Cannon	--	80	66	54	63	61	--	60.0	60.1	61.0	60.6	60.6	--	14.0	14.6	14.9	14.4	14.6	31	29	23	29	27	50	44	53	42	47	0.6	0.0	0.0	0.3
MN-Washburn	--	73	63	56	66	62	--	59.6	59.2	59.5	59.6	59.4	--	14.5	14.7	15.2	14.6	14.8	30	29	25	30	28	55	49	57	49	52	0.1	0.0	0.0	0.1
SY 611 CL2	--	79	66	58	67	64	--	60.7	59.8	60.4	60.0	60.1	--	14.0	15.1	15.5	14.6	15.1	28	28	23	29	27	52	47	55	46	49	0.2	0.2	1.3	0.2
TCG-Heartland	--	73	59	55	60	58	--	60.6	59.5	60.9	60.3	60.2	--	15.0	15.7	16.1	15.5	15.8	29	28	24	28	27	52	46	55	45	49	0.0	0.0	0.8	0.0
AP Murdock	--	80	73	52	69	65	--	58.8	59.7	59.6	59.6	59.6	--	14.0	14.3	14.9	14.0	14.4	30	29	25	30	28	53	48	56	46	50	1.1	0.6	1.9	0.9
MN-Torgy	--	--	68	59	65	64	--	--	59.4	60.0	59.9	59.8	--	--	15.5	15.4	15.2	15.4	--	31	26	33	30	--	50	58	49	53	--	2.4	1.0	--
ND Frohberg	--	--	64	54	63	60	--	--	60.3	60.4	60.6	60.4	--	--	15.1	15.6	14.6	15.1	--	32	26	33	30	--	46	56	46	49	--	1.2	0.9	--
TCG-Wildcat	--	--	66	60	67	65	--	--	60.2	60.5	60.2	60.3	--	--	15.4	15.5	15.0	15.3	--	30	24	31	28	--	47	56	47	50	--	0.2	0.9	--
AP Smith	--	--	65	59	66	64	--	--	59.0	59.9	59.1	59.3	--	--	14.9	15.2	14.6	14.9	--	28	23	29	27	--	47	57	47	51	--	--	0.4	--
CP3530	83	78	--	62	69	--	61.5	59.3	--	59.0	59.7	--	14.1	14.9	--	14.8	14.9	--	35	--	26	33	--	55	--	60	48	--	1.9	--	2.5	--
AP Gunsmoke CL2	--	--	--	58	69	--	--	--	--	59.3	59.1	--	--	--	--	15.5	14.9	--	--	--	25	30	--	--	--	56	45	--	--	--	2.5	--
CP3119A	--	--	--	63	65	--	--	--	--	56.7	56.3	--	--	--	--	13.4	13.1	--	--	--	28	33	--	--	--	61	52	--	--	--	0.8	--
CP3188	--	--	--	53	66	--	--	--	--	57.8	58.7	--	--	--	--	13.4	13.4	--	--	--	25	31	--	--	--	57	46	--	--	--	2.8	--
MS Cobra	--	--	--	58	59	--	--	--	--	59.7	58.9	--	--	--	--	15.5	14.8	--	--	--	24	30	--	--	--	55	45	--	--	--	2.2	--
CP3099A	--	--	--	--	72	--	--	--	--	--	58.5	--	--	--	--	--	13.0	--	--	--	--	34	--	--	--	--	50	--	--	--	0.9	--
LCS Ascent	--	--	--	--	67	--	--	--	--	--	59.9	--	--	--	--	--	13.7	--	--	--	--	30	--	--	--	--	43	--	--	--	4.4	--
LCS Dual	--	--	--	--	60	--	--	--	--	--	60.1	--	--	--	--	--	14.0	--	--	--	--	31	--	--	--	--	45	--	--	--	0.1	--
MN-Rothsay	--	--	--	--	64	--	--	--	--	--	59.0	--	--	--	--	--	14.6	--	--	--	--	30	--	--	--	--	49	--	--	--	1.9	--
MS Charger	--	--	--	--	75	--	--	--	--	--	59.4	--	--	--	--	--	12.9	--	--	--	--	30	--	--	--	--	43	--	--	--	2.5	--
ND Heron	--	--	--	--	57	--	--	--	--	--	60.6	--	--	--	--	--	15.4	--	--	--	--	31	--	--	--	--	43	--	--	--	4.4	--
LCS Rebel	78	79	67	58	--	--	62.6	60.7	60.9	60.4	--	--	14.1	14.6	15.3	15.7	--	--	33	32	26	--	--	52	45	54	--	--	2.2	5.4	--	--
MS Barracuda	79	81	61	50	--	--	61.9	59.6	58.6	59.5	--	--	14.4	14.4	15.6	15.7	--	--	29	28	23	--	--	51	45	53	--	--	0.6	0.1	--	--
SY McCloud	--	77	63	56	--	--	--	60.8	60.4	61.1	--	--	--	14.8	15.5	16.0	--	--	30	31	24	--	--	52	48	56	--	--	0.3	0.0	--	--
LCS Buster	--	--	72	61	--	--	--	--	57.6	57.7	--	--	--	--	12.5	13.0	--	--	--	33	26	--	--	--	53	59	--	--	--	2.7	--	--
Driver	--	--	--	58	--	--	--	--	--	60.3	--	--	--	--	--	14.8	--	--	--	--	27	--	--	--	--	58	--	--	--	--	--	--
Linkert	68	69	60	--	--	--	61.4	59.4	59.6	--	--	--	14.9	15.3	15.5	--	--	--	29	28	--	--	--	54	48	--	--	--	0.0	0.1	--	--
Bolles	70	73	55	--	--	--	61.1	59.2	57.3	--	--	--	15.5	15.9	16.7	--	--	--	31	32	--	--	--	55	50	--	--	--	0.9	0.6	--	--
Shelly	80	79	62	--	--	--	62.1	59.5	57.7	--	--	--	13.6	14.0	15.2	--	--	--	30	29	--	--	--	55	48	--	--	--	0.9	0.1	--	--
ND VitPro	71	75	63	--	--	--	63.0	61.7	61.1	--	--	--	14.7	15.2	15.5	--	--	--	32	31	--	--	--	52	47	--	--	--	1.1	0.7	--	--
Lang-MN	74	74	67	--	--	--	61.9	60.6	59.8	--	--	--	14.8	15.4	15.0	--	--	--	34	33	--	--	--	55	50	--	--	--	3.0	2.5	--	--
CP3055	--	--	64	--	--	--	--	--	54.9	--	--	--	--	--	13.5	--	--	--	--	32	--	--	--	--	53	--	--	--	--	1.3	--	--
CP3915	--	--	67	--	--	--	--	--	60.2	--	--	--	--	--	14.6	--	--	--	--	30	--	--	--	--	46	--	--	--	--	0.0	--	--
Velocity	--	--	61	--	--	--	--	--	60.1	--	--	--	--	--	16.1	--	--	--	--	29	--	--	--	--	47	--	--	--	--	0.0	--	--
MS Ranchero	--	--	62	--	--	--	--	--	56.5	--	--	--	--	--	14.7	--	--	--	--	33	--	--	--	--	52	--	--	--	--	5.8	--	--

[1]Average of three locations. Langdon was excluded due to low yields caused by drought conditions. In addition, shattering occurred at both Langdon and Nelson County due to uneven emergence resulting in uneven maturity, delayed harvest, and high winds prior to harvest.

HRSW Summary, Langdon 2018-2022

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)					
Variety	**18**	**19**	**20**	**21**	**22**	**3yr[1]**	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**
Faller	98	84	81	28	86	83	62.3	60.4	59.7	58.6	61.4	59.9	12.7	13.7	14.1	15.3	13.6	14.3
Glenn	76	75	74	27	68	72	62.9	63.2	62.5	61.3	62.7	62.2	14.4	15.0	15.2	17.1	15.0	15.8
Bolles	82	73	68	15	71	70	61.3	60.3	58.8	59.4	60.4	59.5	14.9	15.3	16.6	18.5	15.8	17.0
SY Ingmar	91	81	77	21	75	78	62.9	61.5	60.6	60.9	61.5	61.0	14.2	14.2	15.2	17.1	15.0	15.8
SY Valda	100	80	79	28	86	82	62.3	60.6	59.9	60.4	60.8	60.4	13.1	13.0	14.2	16.4	14.1	14.9
CP3530	99	78	83	32	87	83	62.2	60.1	60.1	59.8	61.0	60.3	13.0	14.2	15.3	16.5	14.7	15.5
TCG-Spitfire	92	79	80	25	83	80	61.7	60.2	60.1	59.2	60.0	59.8	12.9	13.6	14.0	16.5	13.6	14.7
ND VitPro	78	73	76	21	71	73	63.2	63.0	62.2	60.7	62.7	61.9	14.1	14.8	15.1	17.4	14.8	15.8
LCS Rebel	93	81	76	22	77	78	63.1	61.7	61.5	59.6	62.3	61.1	13.6	14.4	15.4	17.4	14.6	15.8
LCS Trigger	110	87	81	23	94	87	62.6	60.5	60.2	59.5	61.4	60.4	11.1	11.9	12.6	14.3	12.1	13.0
Ambush	88	76	68	17	78	74	63.2	61.5	59.6	60.1	59.5	59.7	14.2	14.9	15.6	17.3	14.4	15.8
SY McCloud	83	78	76	23	75	77	62.9	61.8	61.2	61.1	61.9	61.4	13.7	14.7	15.1	18.0	15.0	16.0
SY 611 CL2	84	83	78	23	82	81	61.6	62.3	60.4	60.7	61.3	60.8	13.3	13.6	14.9	17.5	14.6	15.7
MS Barracuda	93	83	66	15	73	74	62.9	61.3	57.9	58.4	60.6	59.0	14.2	14.3	14.8	17.4	15.0	15.7
LCS Cannon	90	81	73	23	76	77	63.5	61.8	59.8	60.8	61.7	60.8	13.7	13.8	14.8	16.5	14.6	15.3
MN-Washburn	85	76	78	22	80	78	61.2	60.7	60.0	59.6	61.1	60.2	13.4	14.3	14.4	16.8	14.1	15.1
Ballistic	--	90	73	24	76	80	--	60.7	56.7	58.8	61.5	59.0	--	13.5	15.1	16.0	15.0	15.4
Commander	--	80	74	17	75	76	--	61.2	59.2	59.7	60.3	59.7	--	13.7	14.7	16.5	14.2	15.1
TCG-Heartland	--	75	67	23	68	70	--	61.9	59.8	60.9	61.0	60.6	--	14.7	15.7	17.7	15.4	16.3
SY Longmire	--	79	78	26	70	76	--	61.5	59.4	60.9	60.1	60.1	--	14.0	15.2	17.4	15.2	15.9
AP Murdock	--	82	87	21	93	87	--	60.5	59.7	59.6	61.7	60.3	--	14.1	14.0	16.8	13.7	14.8
MN-Torgy	--	84	70	28	82	79	--	61.2	59.1	60.2	61.5	60.3	--	14.6	15.5	16.8	14.7	15.7
CP3915	--	78	80	29	84	81	--	61.7	61.1	60.5	61.4	61.0	--	14.3	14.9	16.6	14.5	15.3
ND Heron	--	80	65	24	68	71	--	62.1	59.9	60.4	62.1	60.8	--	14.5	15.7	17.1	15.1	16.0
MN Rothsay	--	--	63	21	77	--	--	--	58.2	60.3	60.1	59.5	--	--	15.3	16.7	14.6	15.5
Allegiant 822	--	--	72	28	81	--	--	--	61.4	61.2	62.2	61.6	--	--	14.4	17.1	13.8	15.1
Allegiant 8432	--	--	74	22	67	--	--	--	58.8	60.6	59.4	59.6	--	--	15.2	17.2	14.7	15.7
Dagmar	--	--	66	24	69	--	--	--	58.9	58.7	59.6	59.1	--	--	16.2	16.5	15.6	16.1
Driver	--	--	73	29	82	--	--	--	60.0	60.6	62.1	60.9	--	--	14.5	15.9	13.9	14.8
Lanning	--	--	57	28	61	--	--	--	55.1	58.6	58.2	57.3	--	--	16.6	17.4	15.3	16.4
LCS Buster	--	--	73	22	86	--	--	--	57.0	57.8	59.1	58.0	--	--	12.8	13.9	12.5	13.1
MS Ranchero	--	--	62	33	76	--	--	--	54.6	58.9	59.1	57.5	--	--	15.4	15.1	14.2	14.9
ND Frohberg	--	--	73	14	77	--	--	--	61.0	59.9	61.8	60.9	--	--	14.7	17.2	14.2	15.4
TCG-Wildcat	--	--	74	23	79	--	--	--	60.5	60.4	61.9	60.9	--	--	15.2	17.0	15.2	15.8
AP Gunsmoke CL2	--	--	77	24	81	--	--	--	58.0	59.4	60.4	59.3	--	--	15.5	17.4	14.8	15.9
AP Smith	--	--	76	24	80	--	--	--	59.6	60.9	60.6	60.4	--	--	14.9	16.6	14.7	15.4
WB9590	--	--	--	22	74	--	--	--	--	59.3	60.3	--	--	--	--	17.8	15.0	--
CP3119A	--	--	--	31	75	--	--	--	--	57.5	57.6	--	--	--	--	14.0	12.9	--
AAC Brandon	--	--	--	30	75	--	--	--	--	60.0	61.5	--	--	--	--	17.0	15.0	--
CAG Justify	--	--	--	23	93	--	--	--	--	57.9	60.0	--	--	--	--	15.2	13.1	--
CAG Reckless	--	--	--	24	82	--	--	--	--	59.9	61.5	--	--	--	--	16.7	14.3	--
CP3099A	--	--	--	31	82	--	--	--	--	59.2	58.9	--	--	--	--	13.9	12.5	--
CP3188	--	--	--	27	81	--	--	--	--	58.2	59.9	--	--	--	--	14.2	13.0	--
MS Cobra	--	--	--	20	68	--	--	--	--	59.9	60.2	--	--	--	--	16.9	15.0	--
Allegiant 8175	--	--	--	21	75	--	--	--	--	60.0	61.7	--	--	--	--	17.0	14.0	--
Shelly	88	82	58	--	76	--	62.2	61.1	55.5	--	60.2	--	13.1	13.5	16.1	--	14.1	--
AAC Starbuck	--	--	--	--	80	--	--	--	--	--	61.2	--	--	--	--	--	15.3	--
AAC Wheatland	--	--	--	--	76	--	--	--	--	--	61.0	--	--	--	--	--	15.5	--
Ascend-SD	--	--	--	--	90	--	--	--	--	--	62.3	--	--	--	--	--	14.1	--
CAG Recoil	--	--	--	--	86	--	--	--	--	--	60.8	--	--	--	--	--	14.4	--
LCS Ascent	--	--	--	--	85	--	--	--	--	--	61.4	--	--	--	--	--	13.6	--
LCS Dual	--	--	--	--	73	--	--	--	--	--	61.4	--	--	--	--	--	13.9	--
LCS Hammer AX	--	--	--	--	80	--	--	--	--	--	61.0	--	--	--	--	--	14.4	--
MS Charger	--	--	--	--	90	--	--	--	--	--	60.2	--	--	--	--	--	12.5	--
SK Rush	--	--	--	--	76	--	--	--	--	--	60.2	--	--	--	--	--	14.9	--
SY Soren	80	78	71	18	--	--	61.5	61.5	59.5	60.5	--	--	13.4	14.4	15.1	18.0	--	--
Lang-MN	79	77	73	26	--	--	61.9	61.4	59.8	60.3	--	--	14.3	15.0	15.6	16.5	--	--
PFS-Buns	--	--	--	33	--	--	--	--	--	57.4	--	--	--	--	--	15.0	--	--
WB9479	--	--	--	18	--	--	--	--	--	59.9	--	--	--	--	--	18.6	--	--
Elgin-ND	89	81	66	--	--	--	61.7	60.7	59.1	--	--	--	13.6	13.9	14.7	--	--	--
Linkert	75	69	69	--	--	--	61.0	60.5	59.8	--	--	--	14.3	15.1	15.8	--	--	--
Trial Mean	87	79	71	24	79		62.2	61.2	59.1	59.7	60.8		13.7	14.2	15.1	16.6	14.3	
C.V. %	4.1	4.7	8.1	9.3	7.7		0.7	0.8	1.8	0.5	1.1		2.8	2.4	3.0	1.1	2.8	
LSD 5%	4.9	5.2	8.1	2.0	8.4		0.6	0.7	1.5	0.3	0.9		0.5	0.5	0.6	0.2	0.6	
LSD 10%	4.1	4.4	6.8	1.7	7.1		0.5	0.6	1.2	0.2	0.8		0.4	0.4	0.5	0.1	0.5	

[1]Average of 2019, 2020, and 2022. 2021 was excluded due to low yields caused by drought conditions. In addition, shattering occurred due to uneven emergence resulting in uneven maturity, delayed harvest, and high winds prior to harvest.

HRSW Summary, Langdon 2018-2022

	Days to Head						Height (in)						Shatter (0-9)[1]	Lodging (0-9)
Variety	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**2021**	**2020**
Faller	50	57	48	63	51	54	33	31	34	24	34	31	1.3	2.0
Glenn	46	55	45	59	47	50	35	33	35	21	35	30	1.6	1.3
Bolles	50	58	50	62	52	55	33	30	33	23	33	30	4.1	0.6
SY Ingmar	49	56	47	59	50	52	29	28	31	20	31	27	0.9	0.0
SY Valda	49	56	47	62	50	53	30	27	32	21	32	28	1.5	0.5
CP3530	50	57	48	63	52	54	34	33	36	22	36	31	0.9	1.2
TCG-Spitfire	51	59	50	62	52	55	31	30	33	22	32	29	1.3	0.3
ND VitPro	48	55	46	59	48	51	33	31	34	21	33	29	0.5	0.7
LCS Rebel	46	55	45	58	48	50	34	31	35	22	33	30	0.9	5.4
LCS Trigger	53	61	53	64	55	57	35	32	35	20	35	30	0.0	3.7
Ambush	47	54	46	61	51	53	31	30	32	21	33	29	2.2	0.2
SY McCloud	49	55	47	60	48	52	29	29	33	20	32	28	0.2	0.0
SY 611 CL2	49	55	47	61	48	52	29	28	30	18	30	26	0.0	0.2
MS Barracuda	45	54	44	58	46	49	29	28	29	19	29	26	1.2	0.1
LCS Cannon	44	53	43	58	46	49	30	29	30	20	30	27	1.4	0.0
MN-Washburn	51	57	49	62	53	55	32	29	31	21	32	28	0.6	0.0
Ballistic	--	56	47	63	48	53	--	31	34	24	32	30	2.7	1.9
Commander	--	55	46	59	48	51	--	30	31	21	32	28	2.1	0.0
TCG-Heartland	--	54	46	60	48	51	--	28	31	20	30	27	1.3	0.0
SY Longmire	--	56	46	60	50	52	--	29	31	21	31	28	1.2	0.0
AP Murdock	--	56	47	61	50	53	--	28	31	21	31	28	2.1	0.6
MN-Torgy	--	56	49	64	51	55	--	30	34	21	34	30	0.9	2.4
CP3915	--	55	46	61	50	52	--	29	32	21	32	28	0.1	0.0
ND Heron	--	54	45	59	47	50	--	30	34	21	32	29	0.3	2.7
MN Rothsay	--	--	50	64	52	55	--	--	30	21	31	27	3.3	0.1
Allegiant 822	--	--	46	61	49	52	--	--	31	19	30	27	0.4	0.5
Allegiant 8432	--	--	45	59	47	50	--	--	32	21	30	28	3.7	0.0
Dagmar	--	--	46	59	49	51	--	--	32	21	32	28	1.5	3.7
Driver	--	--	48	62	51	54	--	--	34	22	34	30	1.3	0.6
Lanning	--	--	49	62	49	53	--	--	32	21	32	28	0.4	0.2
LCS Buster	--	--	53	63	54	57	--	--	35	22	35	31	3.4	2.7
MS Ranchero	--	--	51	63	52	55	--	--	34	21	35	30	0.3	5.8
ND Frohberg	--	--	47	60	49	52	--	--	35	21	34	30	4.8	1.2
TCG-Wildcat	--	--	47	59	50	52	--	--	32	18	31	27	2.0	0.2
AP Gunsmoke CL2	--	--	46	61	49	52	--	--	33	19	30	27	2.0	2.0
AP Smith	--	--	48	60	52	53	--	--	30	18	31	26	1.7	0.0
WB9590	--	--	--	60	48	--	--	--	--	19	28	--	1.6	--
CP3119A	--	--	--	63	55	--	--	--	--	23	35	--	1.1	--
AAC Brandon	--	--	--	61	50	--	--	--	--	22	32	--	0.6	--
CAG Justify	--	--	--	62	52	--	--	--	--	22	34	--	2.4	--
CAG Reckless	--	--	--	61	49	--	--	--	--	20	35	--	3.6	--
CP3099A	--	--	--	63	54	--	--	--	--	22	35	--	0.3	--
CP3188	--	--	--	61	50	--	--	--	--	20	33	--	1.2	--
MS Cobra	--	--	--	60	49	--	--	--	--	20	31	--	1.5	--
Allegiant 8175	--	--	--	60	50	--	--	--	--	22	32	--	0.6	--
Shelly	51	58	48	--	51	--	30	28	31	--	30	--	--	0.1
AAC Starbuck	--	--	--	--	49	--	--	--	--	--	33	--	--	--
AAC Wheatland	--	--	--	--	49	--	--	--	--	--	33	--	--	--
Ascend-SD	--	--	--	--	51	--	--	--	--	--	36	--	--	--
CAG Recoil	--	--	--	--	56	--	--	--	--	--	32	--	--	--
LCS Ascent	--	--	--	--	47	--	--	--	--	--	31	--	--	--
LCS Dual	--	--	--	--	48	--	--	--	--	--	32	--	--	--
LCS Hammer AX	--	--	--	--	49	--	--	--	--	--	31	--	--	--
MS Charger	--	--	--	--	48	--	--	--	--	--	31	--	--	--
SK Rush	--	--	--	--	51	--	--	--	--	--	37	--	--	--
SY Soren	48	55	46	60	--	--	28	27	30	18	--	--	0.3	0.0
Lang-MN	51	58	50	63	--	--	35	33	35	22	--	--	0.9	2.5
PFS-Buns	--	--	--	66	--	--	--	--	--	21	--	--	1.6	--
WB9479	--	--	--	60	--	--	--	--	--	18	--	--	1.7	--
Elgin-ND	48	55	45	--	--	--	36	33	36	--	--	--	--	2.8
Linkert	50	56	47	--	--	--	29	27	29	--	--	--	--	0.1
Trial Mean	49	56	47	61	50		31	30	33	21	32		1.4	1.1
C.V. %	1.7	1.4	1.2	0.9	1.6		3.3	3.9	3.3	6.7	3.2		56.1	88
LSD 5%	1.1	1.1	0.8	0.4	1.1		1.5	1.7	1.5	1.2	1.4		0.7	1.4
LSD 10%	1.0	0.9	0.7	0.4	1.0		1.2	1.4	1.3	1.0	1.2		0.6	1.1

[1]Relative Rating 0-9

There was significant negative correlation between yield and shatter of *-0.47.

HRSW Summary, Nelson County 2019-2022

	Yield (bu/a)					Test Weight (lbs/bu)					Protein (%)					Lodging (0-9)	Shatter (0-9)[2]		
Variety	**19**	**20**	**21**	**22**	**2yr[1]**	**19**	**20**	**21**	**22**	**3yr**	**19**	**20**	**21**	**22**	**3yr**	**19**	**21**	**22**	**2yr**
Faller	86	51	44	67	59	58.1	55.3	59.0	58.2	57.5	14.1	15.0	14.9	13.6	14.5	5.2	2.3	0.5	1.4
SY Ingmar	76	57	45	60	59	58.5	58.5	60.2	59.2	59.3	14.6	15.6	16.0	14.6	15.4	0.0	2.0	0.8	1.4
SY Valda	79	65	53	69	67	58.4	58.7	58.8	58.3	58.6	13.9	14.6	14.8	13.6	14.3	3.2	1.7	0.8	1.3
LCS Trigger	91	71	61	55	63	58.7	58.3	58.6	58.9	58.6	12.3	12.2	13.7	12.9	12.9	3.5	1.7	2.5	2.1
TCG-Spitfire	74	59	50	68	64	56.6	57.3	58.5	57.7	57.8	13.9	14.3	15.8	13.9	14.7	0.0	1.0	0.3	0.7
SY 611 CL2	76	54	57	61	57	58.6	57.4	59.7	59.2	58.8	14.3	15.9	15.6	13.8	15.1	0.5	0.7	1.2	1.0
Ambush	72	53	41	68	60	57.7	58.6	60.2	57.6	58.8	15.0	15.6	15.9	14.1	15.2	0.3	2.0	1.9	2.0
Ballistic	87	46	49	59	53	57.1	54.4	58.2	59.8	57.5	13.9	15.0	14.8	14.6	14.8	4.0	3.3	2.4	2.9
Commander	80	55	27	56	55	58.2	57.8	59.6	59.1	58.8	13.9	15.0	15.0	14.0	14.7	0.0	6.7	3.8	5.3
LCS Cannon	83	50	58	61	55	58.5	56.8	60.6	60.6	59.3	14.0	14.9	15.4	14.1	14.8	1.5	1.3	1.1	1.2
MN-Washburn	67	49	56	61	55	58.1	57.6	59.1	58.4	58.4	15.0	15.4	15.4	14.6	15.1	0.0	0.0	0.1	0.1
TCG-Heartland	68	50	54	64	57	58.8	56.3	60.5	60.1	59.0	15.0	15.8	16.8	15.0	15.9	0.0	2.0	0.7	1.4
AP Murdock	83	69	37	56	62	57.3	58.6	59.4	58.2	58.7	13.8	14.5	15.3	13.9	14.6	2.5	4.0	3.0	3.5
MN-Torgy	--	56	55	54	55	--	57.4	59.6	57.6	58.2	--	16.1	16.1	15.5	15.9	--	3.0	0.8	1.9
ND Frohberg	--	53	20	60	56	--	58.8	59.8	60.0	59.5	--	15.3	16.0	14.2	15.2	--	6.0	2.5	4.3
TCG-Wildcat	--	65	44	61	63	--	59.0	60.0	58.9	59.3	--	14.9	15.9	14.2	15.0	--	4.3	1.9	3.1
AP Smith	--	57	48	58	58	--	57.4	59.1	57.8	58.1	--	15.2	15.4	14.0	14.9	--	3.0	3.7	3.4
AP Gunsmoke CL2	--	--	59	74	--	--	--	57.9	58.5	--	--	--	15.6	14.3	--	--	0.7	0.8	0.8
CP3119A	--	--	47	56	--	--	--	55.8	54.1	--	--	--	14.4	13.5	--	--	2.7	1.0	1.9
MS Cobra	--	--	41	52	--	--	--	59.1	58.8	--	--	--	15.7	14.4	--	--	4.3	2.6	3.5
CP3188	--	--	50	64	--	--	--	56.7	57.7	--	--	--	13.9	13.6	--	--	1.3	1.1	1.2
CP3530	79	--	54	71	--	57.6	--	58.9	58.8	--	15.2	--	15.4	14.4	--	4.0	1.0	0.4	0.7
CP3099A	--	--	--	59	--	--	--	--	57.3	--	--	--	--	13.3	--	--	--	1.2	--
LCS Ascent	--	--	--	61	--	--	--	--	59.0	--	--	--	--	13.8	--	--	--	3.2	--
LCS Dual	--	--	--	52	--	--	--	--	60.3	--	--	--	--	13.1	--	--	--	2.8	--
MN-Rothsay	--	--	--	50	--	--	--	--	58.6	--	--	--	--	14.2	--	--	--	3.8	--
MS Charger	--	--	--	76	--	--	--	--	58.9	--	--	--	--	12.2	--	--	--	0.4	--
ND Heron	--	--	--	52	--	--	--	--	59.9	--	--	--	--	14.8	--	--	--	1.4	--
LCS Rebel	76	64	48	--	--	58.5	60.3	59.8	--	--	15.1	15.4	16.1	--	--	5.0	2.3	--	--
MS Barracuda	81	42	39	--	--	57.7	55.1	59.2	--	--	14.8	16.3	16.5	--	--	2.0	2.7	--	--
SY McCloud	74	53	51	--	--	58.7	59.4	60.7	--	--	14.9	15.5	16.3	--	--	0.0	2.3	--	--
LCS Buster	--	60	40	--	--	--	54.9	57.3	--	--	--	12.9	13.6	--	--	--	3.0	--	--
Driver	--	--	57	--	--	--	--	59.6	--	--	--	--	15.2	--	--	--	2.0	--	--
Linkert	64	52	--	--	--	56.5	57.7	--	--	--	15.1	15.8	--	--	--	0.0	0.0	--	--
Bolles	73	49	--	--	--	57.4	56.5	--	--	--	15.6	16.9	--	--	--	3.3	--	--	--
Shelly	82	46	--	--	--	57.4	53.9	--	--	--	13.8	16.1	--	--	--	2.8	--	--	--
ND VitPro	71	52	--	--	--	60.2	59.3	--	--	--	15.4	15.7	--	--	--	2.2	--	--	--
Lang-MN	71	54	--	--	--	58.9	58.5	--	--	--	15.9	15.6	--	--	--	6.3	--	--	--
CP3055	--	42	--	--	--	--	49.5	--	--	--	--	14.9	--	--	--	--	--	--	--
CP3915	--	51	--	--	--	--	56.8	--	--	--	--	14.8	--	--	--	--	--	--	--
Velocity	--	51	--	--	--	--	58.0	--	--	--	--	16.5	--	--	--	--	--	--	--
MS Ranchero	--	43	--	--	--	--	53.2	--	--	--	--	15.2	--	--	--	--	--	--	--
Trial Mean	74	54	48	61		61.3	57.8	59.1	58.5		14.7	15.2	15.4	14.0		2.0	2.4	1.7	
C.V. %	4.9	7.8	10.1	5.7		0.8	1.1	0.4	0.4		2.0	2.8	1.3	1.4		45	35.5	38.9	
LSD 5%	5.1	5.9	4.6	3.0		0.7	0.9	0.2	0.2		0.4	0.6	0.2	0.2		1.3	1.4	0.6	
LSD 10%	4.3	5.0	3.9	2.5		0.6	0.7	0.2	0.2		0.4	0.5	0.2	0.1		1.1	1.2	0.5	

[1]Average of 2020 and 2022. 2021 excluded due to shattering.

[2]Relative Rating 0-9.

HRSW Summary, Pembina County 2019-2022

	Yield (bu/a)					Test Weight (lbs/bu)					Protein (%)				
Variety	**19**	**20**	**21**	**22**	**3yr**	**19**	**20**	**21**	**22**	**3yr**	**19**	**20**	**21**	**22**	**3yr**
Faller	88	75	50	64	63	61.0	59.2	57.9	58.1	58.4	14.2	13.1	12.5	13.6	13.1
SY Ingmar	75	69	44	56	56	61.8	59.6	58.9	58.4	59.0	14.5	14.3	13.9	14.4	14.2
SY Valda	78	71	48	65	62	60.9	59.5	57.8	58.6	58.6	13.7	13.6	12.8	14.3	13.6
Ambush	77	70	47	66	61	62.0	60.2	59.8	56.6	58.9	15.2	14.6	13.8	13.5	14.0
Ballistic	88	79	58	50	62	63.2	58.5	58.2	57.2	58.0	14.1	13.5	13.0	15.3	13.9
Commander	83	70	47	60	59	61.7	59.3	58.8	56.9	58.3	14.2	13.8	13.1	14.4	13.8
LCS Cannon	85	70	46	52	56	62.2	59.6	59.6	58.2	59.1	14.2	13.7	12.5	14.4	13.5
LCS Trigger	87	78	59	65	67	61.1	60.3	57.6	58.4	58.8	12.2	11.5	11.2	12.8	11.8
MN-Washburn	72	71	49	59	60	60.7	59.6	57.8	57.9	58.4	14.7	14.0	13.2	14.6	13.9
SY 611 CL2	80	72	58	60	63	62.4	60.1	59.1	57.6	58.9	14.4	14.3	13.4	14.8	14.2
TCG-Heartland	77	58	47	48	51	62.2	59.0	59.5	57.5	58.7	15.4	15.0	14.3	15.5	14.9
TCG-Spitfire	79	69	48	67	61	60.5	58.4	58.0	57.5	58.0	13.9	13.4	13.7	13.6	13.6
AP Murdock	80	74	41	59	58	60.7	59.1	58.2	58.0	58.4	14.3	13.4	13.2	14.0	13.5
MN-Torgy	--	77	49	58	61	--	59.8	58.3	58.4	58.8	--	14.3	12.9	14.8	14.0
ND Frohberg	--	65	46	51	54	--	60.1	59.2	58.9	59.4	--	13.7	13.6	14.5	13.9
TCG-Wildcat	--	73	51	58	61	--	59.9	59.2	58.9	59.3	--	14.0	13.5	14.6	14.0
AP Smith	--	72	52	61	62	--	59.0	58.0	56.6	57.9	--	13.8	13.4	14.3	13.8
CP3530	78	--	50	56	--	60.5	--	57.2	57.9	--	15.3	--	12.8	14.4	--
AP Gunsmoke CL2	--	--	44	51	--	--	--	58.0	56.2	--	--	--	13.5	14.9	--
CP3119A	--	--	57	60	--	--	--	55.4	54.5	--	--	--	11.6	13.2	--
CP3188	--	--	44	53	--	--	--	56.4	56.6	--	--	--	12.0	13.8	--
MS Cobra	--	--	52	47	--	--	--	58.2	55.4	--	--	--	13.6	15.2	--
ND Heron	--	--	47	48	--	--	--	59.5	58.0	--	--	--	13.6	15.2	--
CP3099A	--	--	--	66	--	--	--	--	57.1	--	--	--	--	12.9	--
LCS Ascent	--	--	--	58	--	--	--	--	58.0	--	--	--	--	14.0	--
LCS Dual	--	--	--	49	--	--	--	--	56.3	--	--	--	--	14.4	--
MN-Rothsay	--	--	--	57	--	--	--	--	56.1	--	--	--	--	14.5	--
MS Charger	--	--	--	65	--	--	--	--	57.3	--	--	--	--	13.3	--
LCS Rebel	78	71	47	--	--	62.0	60.9	59.3	--	--	14.8	14.5	13.4	--	--
MS Barracuda	85	68	41	--	--	61.4	58.7	58.6	--	--	14.7	15.1	13.5	--	--
SY McCloud	75	70	52	--	--	62.5	60.0	59.6	--	--	15.2	14.6	13.8	--	--
LCS Buster	--	79	51	--	--	--	57.9	55.8	--	--	--	11.4	11.5	--	--
Driver	--	--	47	--	--	--	--	58.8	--	--	--	--	12.9	--	--
Bolles	73	62	--	--	--	61.2	58.7	--	--	--	17.0	15.6	--	--	--
Linkert	72	60	--	--	--	61.9	59.4	--	--	--	15.8	14.9	--	--	--
Shelly	80	71	--	--	--	61.5	58.5	--	--	--	14.6	13.5	--	--	--
ND VitPro	80	62	--	--	--	62.5	61.1	--	--	--	15.9	14.7	--	--	--
Lang-MN	78	67	--	--	--	61.7	59.6	--	--	--	15.5	14.7	--	--	--
CP3055	--	74	--	--	--	--	56.2	--	--	--	--	12.6	--	--	--
CP3915	--	75	--	--	--	--	60.8	--	--	--	--	14.1	--	--	--
Velocity	--	60	--	--	--	--	59.7	--	--	--	--	15.2	--	--	--
MS Ranchero	--	67	--	--	--	--	57.6	--	--	--	--	14.2	--	--	--
WB9590	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
WB9479	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Trial Mean	79	70	49	58		61.6	59.3	58.2	57.3		14.9	14.0	13.1	14.3	
C.V. %	5.2	5.0	6.4	7.8		1.3	0.8	0.6	0.9		1.1	2.2	2.5	1.5	
LSD 5%	5.8	5.0	3.3	6.4		1.1	0.7	0.3	0.7		0.2	0.4	0.5	0.3	
LSD 10%	4.8	4.2	2.8	5.3		0.9	0.5	0.2	0.6		0.2	0.4	0.4	0.3	

No trial data from 2018.

HRSW Summary, Towner County 2018-2022

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)					
Variety	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**
Faller	66	77	59	76	67	67	61.0	57.0	58.3	58.8	60.4	59.2	15.0	13.8	15.7	14.4	15.4	15.2
SY Ingmar	63	75	54	66	63	61	61.8	57.9	60.0	59.9	60.8	60.2	15.3	14.2	16.7	15.2	16.4	16.1
SY Valda	66	75	65	72	71	69	60.8	56.4	60.2	59.2	61.0	60.1	14.4	13.6	15.6	14.4	15.3	15.1
LCS Trigger	66	84	65	69	75	70	61.4	57.4	60.8	57.9	61.4	60.0	13.6	12.4	13.9	12.9	13.2	13.3
TCG-Spitfire	63	79	63	67	72	67	61.6	56.9	59.3	58.1	60.3	59.2	14.7	13.6	15.1	15.4	15.2	15.2
AP Murdock	--	74	57	68	66	64	--	55.7	59.8	58.8	60.0	59.5	--	14.1	16.4	14.6	15.2	15.4
Commander	--	75	59	65	64	62	--	57.2	59.5	60.2	60.5	60.1	--	14.2	15.4	14.8	15.9	15.4
Ambush	--	69	57	74	72	68	--	57.6	59.9	61.1	59.9	60.3	--	15.1	17.1	15.1	15.6	15.9
Ballistic	--	77	58	80	67	68	--	55.2	58.4	57.7	61.1	59.1	--	14.2	16.1	14.1	16.4	15.5
LCS Cannon	--	67	62	67	58	62	--	56.1	61.4	60.4	61.6	61.1	--	14.5	15.8	14.7	15.4	15.3
MN-Washburn	--	67	50	67	67	61	--	57.6	58.4	59.1	60.1	59.2	--	14.1	15.9	14.7	15.3	15.3
SY 611 CL2	--	76	57	65	70	64	--	58.4	60.5	59.6	61.0	60.4	--	14.2	15.6	15.3	15.4	15.4
TCG-Heartland	--	68	56	73	61	63	--	58.2	60.8	60.7	61.6	61.0	--	14.9	16.9	15.9	16.4	16.4
MN-Torgy	--	--	61	72	64	66	--	--	60.0	59.6	60.7	60.1	--	--	16.9	15.2	16.2	16.1
AP Smith	--	--	55	72	62	63	--	--	59.7	59.4	60.2	59.8	--	--	15.9	14.6	15.5	15.3
ND Frohberg	--	--	59	63	67	63	--	--	60.1	60.3	61.5	60.6	--	--	16.5	15.0	16.5	16.0
TCG-Wildcat	--	--	51	74	69	65	--	--	60.5	60.1	60.4	60.3	--	--	17.4	15.4	16.5	16.4
CP3530	62	71	--	78	62	--	60.4	57.7	--	57.9	60.2	--	15.6	14.5	--	14.3	16.7	--
AP Gunsmoke CL2	--	--	--	77	71	--	--	--	--	59.2	60.8	--	--	--	--	15.3	16.5	--
CP3119A	--	--	--	65	73	--	--	--	--	55.0	57.3	--	--	--	--	13.7	13.6	--
MS Cobra	--	--	--	70	63	--	--	--	--	59.4	60.1	--	--	--	--	15.0	15.7	--
CP3188	--	--	--	61	71	--	--	--	--	56.4	60.1	--	--	--	--	13.3	13.8	--
ND Heron	--	--	--	70	60	--	--	--	--	60.5	61.9	--	--	--	--	15.7	16.7	--
CP3099A	--	--	--	--	78	--	--	--	--	--	58.9	--	--	--	--	--	13.6	--
LCS Ascent	--	--	--	--	63	--	--	--	--	--	61.1	--	--	--	--	--	14.4	--
LCS Dual	--	--	--	--	66	--	--	--	--	--	61.4	--	--	--	--	--	15.3	--
MN-Rothsay	--	--	--	--	69	--	--	--	--	--	60.5	--	--	--	--	--	16.2	--
MS Charger	--	--	--	--	74	--	--	--	--	--	60.5	--	--	--	--	--	13.9	--
LCS Rebel	64	78	60	75	--	--	61.5	58.7	60.8	60.1	--	--	15.4	14.3	16.4	15.1	--	--
MS Barracuda	62	74	62	62	--	--	60.9	56.2	60.2	59.4	--	--	15.3	14.5	17.0	15.4	--	--
SY McCloud	--	75	54	66	--	--	--	59.0	59.6	60.9	--	--	--	14.4	16.3	16.1	--	--
LCS Buster	--	--	66	69	--	--	--	--	59.7	56.2	--	--	--	--	14.1	12.7	--	--
Driver	--	--	--	77	--	--	--	--	--	59.8	--	--	--	--	--	14.6	--	--
Linkert	58	64	54	--	--	--	61.9	56.7	59.6	--	--	--	15.3	15.1	16.2	--	--	--
Bolles	60	66	37	--	--	--	60.7	56.3	54.0	--	--	--	16.9	15.7	17.9	--	--	--
Shelly	67	67	58	--	--	--	62.1	56.3	59.8	--	--	--	14.7	14.2	16.0	--	--	--
ND VitPro	58	73	58	--	--	--	62.1	60.4	60.8	--	--	--	15.6	15.0	16.7	--	--	--
Lang-MN	68	72	67	--	--	--	61.8	59.4	59.8	--	--	--	15.1	15.2	15.8	--	--	--
CP3055	--	--	68	--	--	--	--	--	58.1	--	--	--	--	--	13.9	--	--	--
CP3915	--	--	60	--	--	--	--	--	61.1	--	--	--	--	--	15.4	--	--	--
Velocity	--	--	58	--	--	--	--	--	60.6	--	--	--	--	--	16.8	--	--	--
MS Ranchero	--	--	62	--	--	--	--	--	57.7	--	--	--	--	--	15.5	--	--	--
WB9590	63	--	--	--	--	--	61.2	--	--	--	--	--	15.3	--	--	--	--	--
WB9479	60	--	--	--	--	--	61.6	--	--	--	--	--	16.0	--	--	--	--	--
Trial Mean	63	71	58	70	67		61.4	57.3	59.7	59.1	60.4		15.1	14.5	16.0	14.7	15.5	
C.V. %	6.2	5.4	8.3	7.0	7.6		0.7	1.0	0.8	0.5	0.5		1.9	2.4	2.4	1.1	2.5	
LSD 5%	5.5	5.4	6.8	4.2	7.3		0.6	0.8	0.7	0.3	0.5		0.4	0.5	0.5	0.1	0.5	
LSD 10%	4.6	4.5	5.7	3.6	6.0		0.5	0.7	0.6	0.2	0.4		0.3	0.4	0.5	0.1	0.4	

HRSW Summary, Walsh County 2018-2022

	Yield (bu/a)						Test Weight (lbs/bu)						Protein (%)						Lodging (0-9)		
Variety	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**19**	**22**	**2yr**
Faller	85	91	80	60	65	68	62.5	61.0	60.3	62.2	60.6	61.0	12.8	13.6	14.0	15.2	13.6	14.3	2.5	2.6	2.6
SY Ingmar	61	82	67	50	67	61	62.6	61.2	61.5	62.5	61.0	61.7	14.8	14.3	15.2	15.7	14.9	15.3	0.2	1.5	0.9
SY Valda	81	86	73	57	68	66	62.1	61.0	59.8	62.4	60.9	61.0	12.9	13.5	13.5	15.1	13.7	14.1	0.8	2.0	1.4
LCS Trigger	83	95	80	68	73	74	62.4	61.3	60.0	62.5	61.7	61.4	10.9	11.7	11.1	12.9	11.9	12.0	1.5	1.8	1.7
SY 611 CL2	71	82	71	50	64	62	62.6	61.9	60.8	62.7	61.0	61.5	13.5	13.6	14.7	15.8	14.5	15.0	0.1	1.3	0.7
TCG-Spitfire	74	82	74	54	68	65	61.4	60.4	58.2	60.8	60.5	59.8	14.1	13.8	13.8	15.2	14.0	14.3	0.0	1.5	0.8
Ambush	--	80	70	51	72	65	--	61.2	61.3	62.7	60.6	61.5	--	14.9	15.1	15.6	13.9	14.9	1.7	2.4	2.1
Ballistic	--	98	74	60	61	65	--	60.5	59.9	61.5	61.1	60.8	--	13.7	14.8	15.7	14.1	14.9	0.7	2.0	1.4
Commander	--	89	74	51	61	62	--	61.2	60.6	62.5	60.7	61.3	--	14.1	14.3	15.7	14.2	14.7	0.7	1.0	0.9
LCS Cannon	--	85	73	48	67	62	--	61.5	62.9	63.4	61.1	62.5	--	13.7	14.0	15.6	13.7	14.4	0.8	0.0	0.4
MN-Washburn	--	81	65	52	63	60	--	61.1	60.5	61.8	60.3	60.9	--	14.5	13.9	15.7	14.2	14.6	0.3	0.0	0.2
TCG-Heartland	--	77	63	46	56	55	--	62.1	61.4	62.9	61.4	61.9	--	14.9	15.3	15.9	15.1	15.4	0.0	0.8	0.4
AP Murdock	--	84	76	48	72	65	--	59.7	61.1	61.9	60.0	61.0	--	13.8	13.4	14.8	13.1	13.8	2.0	1.9	2.0
MN-Torgy	--	--	77	54	66	66	--	--	60.5	62.1	61.3	61.3	--	--	14.5	15.8	14.6	15.0	--	1.0	--
ND Frohberg	--	--	70	53	60	61	--	--	61.4	62.8	60.9	61.7	--	--	15.2	16.1	13.6	15.0	--	0.9	--
TCG-Wildcat	--	--	69	55	68	64	--	--	60.9	62.6	60.9	61.5	--	--	15.6	15.6	14.4	15.2	--	0.9	--
AP Smith	--	--	67	54	69	64	--	--	59.2	61.9	60.5	60.5	--	--	14.7	15.8	14.5	15.0	--	0.4	--
CP3530	77	82	--	59	68	--	62.3	60.6	--	61.1	60.6	--	14.0	15.1	--	15.0	14.5	--	2.7	2.5	2.6
AP Gunsmoke CL2	--	--	--	54	67	--	--	--	--	61.8	59.8	--	--	--	--	15.6	13.9	--	--	2.5	--
CP3119A	--	--	--	67	62	--	--	--	--	59.9	58.2	--	--	--	--	13.5	12.5	--	--	0.8	--
CP3188	--	--	--	56	61	--	--	--	--	61.4	59.0	--	--	--	--	13.7	12.7	--	--	2.8	--
MS Cobra	--	--	--	51	62	--	--	--	--	61.9	60.2	--	--	--	--	16.3	13.9	--	--	2.2	--
ND Heron	--	--	--	49	57	--	--	--	--	63.2	61.1	--	--	--	--	16.4	14.9	--	--	4.4	--
CP3099A	--	--	--	--	76	--	--	--	--	--	60.5	--	--	--	--	--	12.8	--	--	0.9	--
LCS Ascent	--	--	--	--	68	--	--	--	--	--	60.1	--	--	--	--	--	12.9	--	--	4.4	--
LCS Dual	--	--	--	--	58	--	--	--	--	--	61.2	--	--	--	--	--	13.5	--	--	0.1	--
MN-Rothsay	--	--	--	--	67	--	--	--	--	--	59.7	--	--	--	--	--	13.6	--	--	1.9	--
MS Charger	--	--	--	--	71	--	--	--	--	--	60.1	--	--	--	--	--	12.8	--	--	2.5	--
LCS Rebel	71	84	66	52	--	--	63.3	62.5	61.0	63.1	--	--	13.2	14.3	14.8	16.5	--	--	2.7	--	--
MS Barracuda	70	80	69	47	--	--	62.7	61.3	60.9	61.8	--	--	13.6	13.9	14.6	15.8	--	--	0.5	--	--
SY McCloud	68	84	60	51	--	--	63.1	61.8	61.7	63.1	--	--	14.8	14.7	15.9	16.0	--	--	1.3	--	--
LCS Buster	--	--	82	62	--	--	--	--	58.4	61.2	--	--	--	--	11.5	13.5	--	--	--	--	--
Driver	--	--	--	50	--	--	--	--	--	62.7	--	--	--	--	--	15.4	--	--	--	--	--
Linkert	67	75	66	--	--	--	62.2	61.2	61.7	--	--	--	14.9	15.2	14.8	--	--	--	0.0	--	--
Bolles	64	82	61	--	--	--	61.5	60.8	58.5	--	--	--	14.6	15.7	16.3	--	--	--	0.3	--	--
Shelly	73	85	75	--	--	--	62.9	61.1	60.8	--	--	--	13.1	13.8	14.1	--	--	--	0.2	--	--
ND VitPro	66	76	66	--	--	--	63.8	62.5	62.0	--	--	--	14.0	15.0	15.2	--	--	--	0.0	--	--
Lang-MN	74	74	72	--	--	--	62.8	61.5	61.3	--	--	--	14.4	15.2	14.9	--	--	--	3.2	--	--
CP3055	--	--	76	--	--	--	--	--	57.4	--	--	--	--	--	12.0	--	--	--	--	--	--
CP3915	--	--	69	--	--	--	--	--	61.3	--	--	--	--	--	13.9	--	--	--	--	--	--
Velocity	--	--	64	--	--	---	--	--	61.9	--	--	---	--	--	15.8	--	--	---	--	--	--
MS Ranchero	--	--	75	--	--	--	--	--	59.5	--	--	--	--	--	13.3	--	--	--	--	--	--
Trial Mean	72	82	71	54	65		62.5	61.2	60.6	62.1	60.4		13.8	14.4	14.3	15.3	13.8		1.1	1.7	
C.V. %	8.5	4.2	6.9	4.0	6.1		0.7	0.6	1.2	0.5	0.5		5.4	2.6	3.1	1.9	2.2		87	65	
LSD 5%	8.6	4.8	6.9	1.8	3.6		0.6	0.5	1.0	0.2	0.3		1.1	0.5	0.6	0.2	0.3		1.4	0.9	
LSD 10%	7.2	4.0	5.7	1.5	3.0		0.5	0.4	0.8	0.2	0.2		0.9	0.4	0.5	0.2	0.2		1.2	0.8	

HRWW Summary, Langdon 2017-2022*

	Yield (bu/a)					Test Weight (lbs/bu)					Winter Survival	Julian Days to Head	Height (in)	Protein (%)				
Variety	**17**	**19**	**20**	**22**	**3yr**	**17**	**19**	**20**	**22**	**3yr**	**22**	**22**	**22**	**17**	**19**	**20**	**22**	**3yr**
AC Emerson	90	87	41	71	66	60.2	60.4	59.5	61.1	60.3	94	174	32	11.9	11.5	14.7	13.4	13.2
Jerry	17	84	44	81	70	46.7	59.1	58.9	60.8	59.6	99	174	33	12.9	11.2	14.3	12.8	12.8
Northern	83	90	43	62	65	55.0	59.2	58.3	57.9	58.5	79	175	29	11.6	11.1	14.3	13.3	12.9
SY Monument	81	85	36	61	61	54.4	58.3	56.3	56.4	57.0	94	174	28	12.1	11.0	35.8	12.8	19.9
Keldin	84	89	36	62	62	56.8	60.5	58.5	58.4	59.1	90	175	29	11.2	10.9	14.0	13.0	12.6
SY Wolverine	--	85	39	50	58	--	59.7	58.9	58.5	59.0	74	169	24	--	11.5	14.4	13.2	13.0
ND Noreen	--	87	48	85	73	--	59.7	61.6	62.8	61.4	100	174	33	--	11.6	14.1	13.0	12.9
AAC Wildfire	--	--	45	70	--	--	--	58.7	57.4	--	93	177	33	--	--	14.0	13.5	--
AAC Vortex	--	--	--	91	--	--	--	--	61.6	--	98	173	32	--	--	--	13.0	--
AP Bigfoot	--	--	--	61	--	--	--	--	59.8	--	79	170	26	--	--	--	12.4	--
Draper	--	--	--	72	--	--	--	--	60.4	--	78	171	28	--	--	--	12.6	--
MS Iceman	--	--	--	44	--	--	--	--	59.6	--	64	172	25	--	--	--	14.9	--
MS Maverick	--	--	--	67	--	--	--	--	60.8	--	89	173	24	--	--	--	12.9	--
Ray	--	--	--	63	--	--	--	--	54.1	--	77	177	34	--	--	--	13.1	--
SD Andes	--	--	--	87	--	--	--	--	61.2	--	99	173	31	--	--	--	12.3	--
SD Midland	--	--	--	79	--	--	--	--	61.2	--	93	173	31	--	--	--	12.6	--
WB4309	--	--	--	69	--	--	--	--	60.0	--	93	172	27	--	--	--	13.8	--
WB4510CLP	--	--	--	59	--	--	--	--	60.9	--	84	174	30	--	--	--	12.7	--
Winner	--	--	--	82	--	--	--	--	61.9	--	98	170	29	--	--	--	12.4	--
Ideal	16	86	43	--	--	44.3	59.7	59.2	--	--	--	--	--	12.4	11.0	13.3	--	--
Peregrine	80	90	44	--	--	57.0	60.3	60.2	--	--	--	--	--	10.8	10.4	13.2	--	--
SY Wolf	67	87	41	--	--	53.3	59.5	59.5	--	--	--	--	--	12.5	11.5	14.3	--	--
SY Sunrise	86	82	24	--	--	56.6	59.4	57.9	--	--	--	--	--	11.6	11.4	13.4	--	--
Oahe	105	83	39	--	--	60.7	59.7	59.3	--	--	--	--	--	11.3	11.5	14.0	--	--
Thompson	--	90	40	--	--	--	59.9	58.6	--	--	--	--	--	--	10.9	13.8	--	--
TCG-Boomlock	--	79	41	--	--	--	60.3	59.9	--	--	--	--	--	--	11.6	14.2	--	--
WB4462	--	80	35	--	--	--	60.0	58.1	--	--	--	--	--	--	11.8	13.8	--	--
WB4595	--	89	21	--	--	--	61.8	59.4	--	--	--	--	--	--	10.3	13.5	--	--
CP7017AX	--	--	40	--	--	--	--	57.7	--	--	--	--	--	--	--	13.0	--	--
CP7050AX	--	--	32	--	--	--	--	59.6	--	--	--	--	--	--	--	14.9	--	--
CP7909	--	--	27	--	--	--	--	59.2	--	--	--	--	--	--	--	13.8	--	--
Loma	72	78	--	--	--	53.7	58.3	--	--	--	--	--	--	11.9	11.3	--	--	--
AC Broadview	25	--	--	--	--	43.9	--	--	--	--	--	--	--	11.6	--	--	--	--
Accipiter	43	--	--	--	--	51.8	--	--	--	--	--	--	--	11.2	--	--	--	--
Decade	28	--	--	--	--	45.5	--	--	--	--	--	--	--	12.2	--	--	--	--
Flourish	75	--	--	--	--	54.9	--	--	--	--	--	--	--	11.5	--	--	--	--
Lyman	35	--	--	--	--	47.3	--	--	--	--	--	--	--	12.7	--	--	--	--
Moats	96	--	--	--	--	60.6	--	--	--	--	--	--	--	12.3	--	--	--	--
Overland	44	--	--	--	--	51.1	--	--	--	--	--	--	--	11.5	--	--	--	--
WB Matlock	20	--	--	--	--	47.3	--	--	--	--	--	--	--	12.9	--	--	--	--
AC Gateway	59	--	--	--	--	53.6	--	--	--	--	--	--	--	12.3	--	--	--	--
CDC Chase	96	--	--	--	--	60.3	--	--	--	--	--	--	--	12.1	--	--	--	--
Redfield	53	--	--	--	--	50.7	--	--	--	--	--	--	--	12.2	--	--	--	--
Ruth	85	--	--	--	--	56.1	--	--	--	--	--	--	--	11.2	--	--	--	--
WB4614	57	--	--	--	--	54.7	--	--	--	--	--	--	--	12.5	--	--	--	--
Trial Mean	63	84	39	69		53.3	59.7	58.9	59.7		90	173	29	11.9	11.3	14.0	12.9	
C.V. %	9.8	3.6	12.4	9.5		2.7	0.6	1.1	1.3		15.8	0.3	3.3	3.2	1.9	2.4	2.7	
LSD 5%	8.7	4.3	6.8	6.3		2.0	0.5	1.0	0.7		20.2	0.5	0.9	0.5	0.3	0.5	0.5	
LSD 10%	7.2	3.6	5.7	5.2		1.7	0.4	0.8	0.6		16.8	0.4	0.7	0.4	0.3	0.4	0.4	

No lodging in the 2019, 2020, and 2022 trials.

Snowfall on October 11-12, 2019 was 20 inches. Air temperatures were 6.6°F lower than average for October 2019.

Overwinter leaf stage ranged from 1.5 to 2 leaf.

Fungicides were not used in any of the trials above.

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

*The 2018 and 2021 trials were lost due to winter kill.

Buckwheat, Langdon 2022

Variety	Days to Flower	Plant Height (in)	Lodging (0-9)	1000 KWT (g)	Test Weight (lbs/bu)	Yield 2022 (lbs/a)	Yield 2 yr Avg (lbs/a)
Devyatka	39	50	7.2	33	46.8	2155	1649
Green Testa	45	55	5.2	36	51.0	2982	1895
Horizon	45	54	3.3	40	48.9	2826	2110
Koma	46	52	5.5	36	50.2	2539	1863
Kota	45	55	4.3	40	49.2	2976	2181
Manor	44	55	6.2	34	48.9	2682	1941
Springfield	45	53	4.3	39	48.6	2930	2185
Mean	44	53	5.1	37	49.1	2727	
C.V. %	1.0	3.2	16.0	1.7	0.7	13.2	
LSD 5%	0.4	1.7	0.8	0.6	0.3	329	
LSD 10%	0.3	1.4	0.7	0.5	0.3	272	

Rye, Langdon 2022

Variety	Winter Survival	Julian Days to Head	Plant Height (in)	Lodging (0-9)	Test Weight (lbs/bu)	Yield 2022 (bu/a)	Yield 2 yr avg. (bu/a)	Yield 3 yr avg. (bu/a)
Aroostok	100	159	55	0.5	53.7	53.4	56.7	50.7
Danko	100	162	44	0.0	56.8	75.6	71.9	57.2
Hazlet	100	162	47	0.0	56.8	82.6	79.1	71.0
ND Dylan	100	163	51	0.8	55.5	71.5	69.3	66.0
ND Gardner	100	159	53	1.5	54.0	52.9	59.8	56.2
Rymin	100	162	49	0.0	55.1	68.9	67.8	63.3
Spooner	100	161	54	1.0	55.7	53.9	56.2	52.4
Serafino	94	163	41	0.0	56.1	94.9	94.9	--
Tayo	99	163	42	0.0	54.3	99.4	105.6	--
Receptor	99	163	42	0.0	55.7	99.7	--	--
Trial Mean	99	162	48	0	55.4	75.3		
C.V. %	2.4	0.4	3.3	158.0	1.2	12.9		
LSD 5%	3.4	0.9	2.3	0.9	1.0	14.0		
LSD 10%	2.8	0.7	1.9	0.7	0.8	11.5		

Corn Grain, Langdon 2022

Brand	Hybrid	RM[1]	Hybrid Traits[1]	Insect Traits	Days to Silk	Harvest Moisture	Test Weight	Yield	
						(%)	(lbs/bu)	2022 (bu/a)	2yr Avg (bu/a)
Innvictis	A7837VT2PRIB	78	GT	VT Double Pro	74	23.9	51.2	137.7	141.1
Innvictis	A7988VT2PRIB	79	GT	VT Double Pro	71	27.6	49.5	148.8	161.2
Integra	2508R	75	RR2		71	24.0	54.1	146.3	--
Integra	3009VT2	80	RR2	CB	70	28.4	49.2	158.1	--
Legacy	LC275-21	77	GT		75	36.3	49.0	112.6	--
Legacy	LC295-21	79	GT/LL	3010	73	29.6	52.6	137.5	135.5
Legacy	LC304-21	80	GT/LL	PWE	75	35.0	47.1	124.2	128.9
Legacy	LC311-20	81	RR2	VT2P	75	26.4	48.6	147.5	148.6
Legacy	LCX275-22	80	GT/LL/Enlist	VT2P	76	25.2	48.5	136.4	--
Pioneer	P7417AM	74	RR2Y/LL	ACREMAX	71	22.5	49.8	151.3	151.8
Pioneer	P7844AM	78	RR2Y/LL	ACREMAX	72	24.9	48.8	150.9	159.3
Pioneer	P7861AM	78	RR2Y/LL	ACREMAX	71	26.4	48.8	129.8	145.7
Proseed	1974	74	RR2		70	25.1	51.8	161.6	152.9
Proseed	2078	78	GT		74	25.0	47.0	141.3	139.9
Proseed	2181	81	GT	VT2P	74	24.5	49.6	153.5	--
REA	1B750	75	RR2	VT2Pro	72	25.5	52.4	159.0	153.2
REA	1B771	77	RR2	VT2Pro	73	28.9	47.1	136.3	155.4
REA	1R710	71	RR2		71	24.7	50.7	161.4	162.6
Stine	9003-20	77	GT		71	28.6	53.4	132.3	--
Stine	9140-G	81	GT		75	32.8	46.2	135.8	145.0
Thunder	T4072 RR	72	RR2		67	23.0	51.2	149.6	141.8
Thunder	T6181 VT2P	81	RR2	VT2P	75	24.9	48.2	141.5	147.1
Thunder	T6278 VT2P	78	RR2	VT2P	70	25.2	49.6	161.7	161.1
Thunder	T6977 VT2P	77	RR2	VT2P	70	24.1	49.9	154.4	--
Trial Mean					72	26.8	49.8	144.6	
C.V. %					1.3	6.7	1.4	6.0	
LSD 5%					1.3	2.3	0.9	11.1	
LSD 10%					1.1	1.9	0.7	9.2	

[1]Relative maturity and hybrid traits as submitted by the company.

Yield reported at 15.5% moisture.

GDD from May 24 to Oct. 6 were 1804. Normal is 1684.

Approximate GDD to reach RM for 75 day corn is 1800, 80 day corn is 1920.

Barley Summary, Langdon 2018-2022

	Height (in)						Protein (%)						Days to Head					
Variety	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**
Tradition*	27	28	28	24	32	28	14.3	12.8	12.9	13.5	10.9	12.4	50	55	47	57	50	51
Pinnacle	27	29	27	23	30	27	12.8	12.1	11.5	13.7	10.0	11.7	51	56	49	61	52	54
ND Genesis	29	29	28	26	33	29	11.9	11.3	10.6	12.5	9.7	10.9	51	57	50	61	54	55
AAC Synergy	29	28	27	26	30	28	13.1	12.4	12.1	13.6	10.4	12.0	52	59	51	62	54	56
Explorer	24	24	24	22	24	23	13.4	12.4	12.4	13.9	9.7	12.0	50	57	50	61	55	55
Conlon	27	25	28	25	29	27	13.8	13.0	11.9	14.1	10.5	12.2	47	54	47	58	51	52
AAC Connect	--	27	26	24	28	26	--	13.1	12.5	14.5	10.3	12.4	--	58	50	62	106	73
ABI Cardinal	--	26	25	22	29	25	--	12.0	12.8	14.2	10.3	12.4	--	58	51	61	57	56
Brewski	--	--	26	24	30	27	--	--	11.6	13.0	10.1	11.6	--	--	50	61	54	55
CDC Fraser	--	--	--	25	29	--	--	--	--	13.7	10.3	--	--	--	--	62	57	--
BC Ellinor	--	--	--	22	28	--	--	--	--	13.0	10.5	--	--	--	--	62	57	--
BC Lexy	--	--	--	22	27	--	--	--	--	13.1	10.0	--	--	--	--	62	57	--
LCS Diablo	--	--	--	--	27	--	--	--	--	--	10.3	--	--	--	--	--	58	--
Lacey*	28	29	--	--	30	--	14.3	12.7	--	--	11.0	--	50	55	--	--	50	--
BC Leandra	--	--	--	--	27	--	--	--	--	--	9.5	--	--	--	--	--	56	--
CDC Bow	--	--	28	23	--	--	--	--	12.5	14.2	--	--	--	--	52	63	--	--
ABI Balster	28	25	--	--	--	--	13.4	12.2	--	--	--	--	51	59	--	--	--	--
Trial Mean	26	27	27	23	29		13.4	12.1	11.5	13.2	10.0		51	56	49	61	53	
C.V. %	6.3	5.5	4.1	7.3	5.4		3.4	3.5	3.6	3.7	4.6		2.1	1.5	1.4	2.2	2.1	
LSD 5%	2.3	2.1	1.6	2.0	2.2		0.6	0.6	0.6	0.6	0.7		1.5	1.2	0.9	2.0	1.6	
LSD 10%	2.0	1.8	1.3	2.0	1.9		0.5	0.5	0.5	0.4	0.6		1.3	1.0	0.4	1.0	1.4	

*6-row

Barley Summary, Langdon 2018-2022

	Yield (bu/a)						Test Weight (lbs/bu)						Lodging (0-9)				Plump (%)					
Variety	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**17**	**19**	**20**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**
Tradition*	131	121	119	79	99	99	49.8	48.3	46.4	47.2	50.0	47.9	2.3	0.0	0.2	0.8	96	92	90	93	95	93
Pinnacle	130	127	106	84	99	96	52.0	50.6	45.3	50.2	51.6	49.0	0.0	0.0	0.1	0.0	99	99	85	99	97	94
ND Genesis	139	123	131	91	100	108	50.4	48.7	46.7	48.8	48.8	48.1	0.0	0.3	0.5	0.3	97	97	92	98	95	95
AAC Synergy	147	123	132	92	105	110	51.2	50.1	46.2	48.2	50.5	48.3	3.5	1.3	2.7	2.5	97	97	86	94	97	92
Explorer	125	123	99	80	106	95	51.0	49.1	43.6	48.2	48.9	46.9	0.0	0.0	0.1	0.0	96	96	76	96	95	89
Conlon	111	110	109	57	100	89	51.7	51.0	48.4	49.9	51.1	49.8	--	1.8	0.3	--	98	98	90	98	98	95
AAC Connect	--	120	127	90	100	106	--	49.7	45.5	47.1	49.5	47.4	--	0.5	2.0	--	--	97	77	90	95	87
ABI Cardinal	--	120	109	83	103	98	--	49.3	46.5	46.9	50.6	48.0	--	1.0	1.7	--	--	96	87	93	97	92
Brewski	--	--	120	91	109	107	--	--	45.4	48.3	50.1	47.9	--	--	1.1	--	--	--	82	98	96	92
CDC Fraser	--	--	--	82	105	--	--	--	--	46.3	49.4	--	--	--	--	--	--	--	--	95	97	--
BC Ellinor	--	--	--	92	98	--	--	--	--	48.1	47.8	--	--	--	--	--	--	--	--	99	95	--
BC Lexy	--	--	--	90	117	--	--	--	--	47.1	47.9	--	--	--	--	--	--	--	--	97	95	--
LCS Diablo	--	--	--	--	103	--	--	--	--	--	47.8	--	--	--	--	--	--	--	--	--	97	--
Lacey*	133	124	--	--	98	--	50.4	48.9	--	--	49.3	--	0.3	0.0	--	--	98	95	--	--	95	--
BC Leandra	--	--	--	73	112	--	--	--	--	46.0	47.3	--	--	--	--	--	--	--	--	92	96	--
CDC Bow	--	--	130	82	--	--	--	--	48.6	47.8	--	--	--	--	0.3	--	--	--	92	96	--	--
ABI Balster	142	124	--	--	--	--	50.5	49.5	--	--	--	--	3.3	0.0	--	--	93	94	--	--	--	--
Trial Mean	130	123	124	85	107		50.1	49.4	46.3	47.7	49.5		1.7	0.5	0.5		96	97	89	96	96	
C.V. %	6.0	3.4	4.2	9.9	5.0		2.3	0.7	0.9	1.5	1.1		122	149	126		1.5	1.3	2.4	2.8	1.8	
LSD 5%	11.0	5.9	7.5	9.9	7.6		1.6	0.5	0.6	0.8	0.8		2.8	1.0	0.9		2.0	1.8	3.0	3.0	2.4	
LSD 10%	9.2	4.9	6.2	7.7	6.3		1.4	0.4	0.5	0.6	0.7		2.4	0.9	0.7		1.7	1.5	2.5	2.0	2.0	

*6-row

Oat Summary, Langdon 2017-2022

	Yield (bu/a)						Test Weight (lbs/bu)						Days to Head					
Variety	**17**	**18**	**19**	**20**	**22**	**3yr**	**17**	**18**	**19**	**20**	**22**	**3yr**	**17**	**18**	**19**	**20**	**22**	**3yr**
Beach	201	164	152	185	160	166	41.2	41.6	40.6	39.9	43.2	41.2	60	51	58	47	50	52
HiFi	191	179	155	188	185	176	40.9	40.8	38.5	36.5	41.1	38.7	60	52	59	50	51	53
Killdeer	192	192	185	199	189	191	38.6	39.8	38.0	36.3	40.0	38.1	58	51	57	48	49	51
Otana	185	192	175	181	165	174	37.9	41.0	39.5	35.1	41.0	38.5	61	53	59	50	51	53
Rockford	192	178	168	170	182	173	42.5	41.7	40.4	37.7	42.8	40.3	60	52	59	50	52	54
CDC Minstrel	219	181	177	199	189	188	37.7	40.2	37.2	34.5	40.2	37.3	59	52	58	49	50	52
Newburg	179	178	167	195	205	189	40.0	40.0	37.8	34.9	40.5	37.7	59	52	58	50	51	53
Leggett	194	195	189	193	186	189	40.7	41.2	39.5	36.6	41.5	39.2	60	52	59	49	50	53
Jury	176	208	192	191	183	189	41.0	40.3	37.6	35.4	40.8	37.9	60	52	61	49	50	53
Paul*	165	149	129	146	126	134	46.2	47.4	44.1	44.0	46.8	45.0	63	52	61	51	53	55
Deon	204	182	184	223	185	197	39.9	40.4	38.0	36.6	41.0	38.5	61	52	60	51	52	54
CS Camden	229	208	188	209	197	198	37.5	38.7	36.3	33.6	38.9	36.3	61	52	59	49	49	52
ND Heart	178	171	157	194	175	175	40.8	40.7	39.5	37.3	41.5	39.4	59	51	58	48	50	52
Warrior	--	--	163	179	169	170	--	--	38.7	35.8	41.2	38.6	--	--	56	46	48	50
AAC Douglas	--	--	--	--	187	--	--	--	--	--	39.8	--	--	--	--	--	49	--
MN-Pearl	--	--	--	--	192	--	--	--	--	--	39.7	--	--	--	--	--	50	--
SD Buffalo	--	--	--	--	189	--	--	--	--	--	41.2	--	--	--	--	--	48	--
CDC Dancer	192	182	189	192	--	--	39.5	41.0	39.5	36.9	--	--	61	52	59	49	--	--
Hytest	142	139	160	181	--	--	41.5	42.5	40.5	38.9	--	--	56	51	57	47	--	--
Souris	189	165	166	186	--	--	39.9	39.9	38.5	36.7	--	--	60	51	58	48	--	--
Stallion	169	183	165	170	--	--	40.9	42.1	40.8	38.3	--	--	60	53	58	48	--	--
Hayden	195	169	177	181	--	--	43.2	41.2	40.3	38.0	--	--	59	52	58	48	--	--
AC Pinnacle	191	184	151	--	--	--	37.6	40.9	38.9	--	--	--	62	52	58	--	--	--
Trial Mean	186	181	170	192	182		40.7	41.0	39.2	37.2	41.5		60	52	59	49	51	
C.V. %	6.6	5.8	4.1	3.7	3.7		2.4	1.1	1.1	1.6	0.8		1.1	1.2	1.0	1.5	1.2	
LSD 5%	17.2	17.2	11.5	11.7	9.4		1.3	0.7	0.7	1.0	0.5		0.9	1.0	1.0	1.2	0.8	
LSD 10%	14.4	14.3	9.6	9.8	7.9		1.1	0.6	0.6	0.8	0.4		0.8	0.8	0.8	1.0	0.7	

*Hull-less variety

The 2021 trial was not harvested.

Oat Summary, Langdon 2016-2022

	Height (in)						Protein (%)					Lodging (0-9)				
Variety	**17**	**18**	**19**	**20**	**22**	**3yr**	**16**	**17**	**18**	**19**	**3yr**	**16**	**17**	**19**	**20**	**3yr**
Beach	53	35	38	42	43	41	9.5	10.1	13.3	13.6	12.3	4.0	3.4	0.2	2.5	2.0
HiFi	52	36	42	40	44	42	8.6	10.2	11.5	11.1	10.9	5.5	3.4	0.0	2.6	2.0
Killdeer	46	32	35	38	40	38	8.2	9.3	11.5	10.9	10.6	5.5	5.2	0.0	2.4	2.5
Otana	51	38	42	42	45	43	8.4	9.7	12.3	11.5	11.2	6.7	6.1	1.3	5.3	4.2
Rockford	52	37	39	44	45	43	9.4	10.6	12.3	12.3	11.7	4.7	5.4	0.2	2.4	2.7
CDC Minstrel	50	33	36	42	42	40	7.3	7.4	9.2	9.3	8.6	3.7	3.4	0.1	0.2	1.2
Newburg	55	38	42	43	43	43	7.7	9.3	11.4	10.8	10.5	7.5	6.3	1.1	4.3	3.9
Leggett	49	35	37	40	42	40	10.0	11.7	12.8	12.4	12.3	4.3	5.4	0.2	2.5	2.7
Jury	55	38	40	45	47	44	8.0	9.9	10.5	9.6	10.0	6.5	5.3	0.7	4.8	3.6
Paul*	55	38	40	47	45	44	13.4	13.8	17.1	16.7	15.9	6.0	5.0	0.1	1.7	2.3
Deon	52	36	39	47	44	43	8.7	10.0	12.7	11.9	11.5	4.3	3.6	0.0	0.9	1.5
CS Camden	49	35	36	42	39	39	8.9	9.5	11.4	10.6	10.5	2.5	0.5	0.0	0.5	0.3
ND Heart	51	37	39	42	45	42	9.6	11.1	12.6	12.3	12.0	4.7	6.3	0.5	3.6	3.5
Warrior	--	--	35	39	39	38	--	--	--	13.3	--	--	--	0.0	1.0	--
AAC Douglas	--	--	--	--	42	--	--	--	--	--	--	--	--	--	--	--
MN-Pearl	--	--	--	--	42	--	--	--	--	--	--	--	--	--	--	--
SD Buffalo	--	--	--	--	43	--	--	--	--	--	--	--	--	--	--	--
CDC Dancer	52	36	40	44	--	--	7.9	7.9	9.9	9.3	9.0	5.7	5.0	0.0	2.3	2.4
Hytest	51	37	41	44	--	--	11.4	12.8	14.2	14.1	13.7	7.2	4.3	0.8	1.6	2.2
Souris	47	34	37	39	--	--	8.0	9.3	11.2	11.3	10.6	3.0	2.6	0.1	0.0	0.9
Stallion	52	38	39	43	--	--	10.1	10.9	12.8	12.9	12.2	8.0	5.1	0.1	2.7	2.6
Hayden	52	35	40	41	--	--	8.3	10.5	11.8	11.9	11.4	6.0	4.3	0.1	2.3	2.2
AC Pinnacle	51	40	42	--	--	--	7.9	8.5	11.9	11.2	10.5	5.5	6.7	1.0	--	--
Trial Mean	52	37	40	42	44		--	--	--	--		5.1	4.4	0.2	2.1	
C.V. %	2.7	4.3	4.1	4.3	3.2		--	--	--	--		35.2	37.6	234	76	
LSD 5%	1.9	2.6	2.6	3.0	2.0		--	--	--	--		2.5	2.3	0.8	2.6	
LSD 10%	1.6	2.1	2.2	2.5	1.7		--	--	--	--		2.1	2.0	0.7	2.2	

*Hull-less variety

The 2021 trial was not harvested.

Flax Summary, Langdon 2018-2022

	Yield (bu/a)						Test Weight (lbs/bu)						Lodging (0-9)			Height (in)						Days to Flower					
Variety	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**17**	**22**	**2yr**	**18**	**19**	**20**	**21**	**22**	**3yr**	**18**	**19**	**20**	**21**	**22**	**3yr**
Carter*	38	42	43	21	57	40	53.0	53.2	53.1	53.1	53.7	53.3	0.0	0.4	0.2	24	25	25	21	28	25	49	53	47	52	48	49
CDC Glas	43	42	50	21	65	45	51.8	50.6	52.0	51.2	52.9	52.0	0.1	0.0	0.1	27	22	25	19	29	24	49	53	51	54	50	52
Omega*	39	39	40	21	50	37	53.4	53.4	53.2	53.2	53.8	53.4	0.4	1.9	1.2	22	23	20	19	27	22	48	54	45	54	50	50
Webster	44	42	46	23	59	42	52.9	52.5	53.7	52.6	54.0	53.4	0.6	0.0	0.3	27	24	26	21	30	26	50	52	50	52	51	51
York	42	43	48	20	63	44	52.5	51.7	53.4	52.3	53.6	53.1	0.0	0.0	0.0	25	28	25	20	31	25	48	52	47	53	48	49
Gold ND*	43	41	48	21	56	41	53.1	52.7	53.4	53.0	52.6	53.0	0.1	0.6	0.4	27	25	23	20	31	25	52	53	49	55	51	52
CDC Neela	38	43	43	22	59	41	52.4	51.4	53.0	52.1	53.7	52.9	0.0	0.5	0.3	23	23	24	20	29	24	49	51	50	53	50	51
ND Hammond	39	38	40	21	58	40	52.5	51.5	52.9	52.3	53.0	52.7	0.0	0.0	0.0	25	24	23	21	32	25	48	52	46	52	48	49
AAC Bright*	--	38	51	21	62	45	--	48.9	51.1	51.0	51.0	51.0	--	0.0	--	--	23	25	20	29	25	--	52	49	54	51	51
CDC Dorado*	--	--	38	18	55	37	--	--	52.8	51.8	53.9	52.8	--	0.1	--	--	--	23	19	29	24	--	--	43	51	49	48
AAC Marvelous	--	--	--	22	64	--	--	--	--	52.5	53.9	--	--	0.1	--	--	--	--	20	28	--	--	--	--	53	49	--
CDC Rowland	--	--	--	21	68	--	--	--	--	52.5	53.4	--	--	0.1	--	--	--	--	17	29	--	--	--	--	55	49	--
CDC Kernen	--	--	--	--	57	--	--	--	--	--	53.7	--	--	1.8	--	--	--	--	--	29	--	--	--	--	--	51	--
CDC Plava	--	40	39	21	--	--	--	51.6	52.1	52.1	--	--	0.0	--	--	--	22	26	19	--	--	--	52	46	53	--	--
CDC Buryu	--	42	40	21	--	--	--	52.9	53.1	52.4	--	--	--	--	--	--	24	26	19	--	--	--	52	48	52	--	--
Prairie Thunder	43	43	44	--	--	--	52.4	52.1	53.2	--	--	--	0.1	--	--	27	26	28	--	--	--	53	54	50	--	--	--
CDC Melyn	--	35	--	--	--	--	--	47.4	--	--	--	--	--	--	--	--	23	--	--	--	--	--	54	--	--	--	--
CDC Bethune	42	--	--	--	--	--	52.7	--	--	--	--	--	0.0	--	--	26	--	--	--	--	--	48	--	--	--	--	--
CDC Sanctuary	44	--	--	--	--	--	52.4	--	--	--	--	--	1.2	--	--	23	--	--	--	--	--	48	--	--	--	--	--
CDC Sorrel	41	--	--	--	--	--	52.7	--	--	--	--	--	1.1	--	--	25	--	--	--	--	--	49	--	--	--	--	--
Nekoma	42	--	--	--	--	--	52.7	--	--	--	--	--	0.2	--	--	23	--	--	--	--	--	50	--	--	--	--	--
Pembina	43	--	--	--	--	--	53.0	--	--	--	--	--	0.2	--	--	24	--	--	--	--	--	49	--	--	--	--	--
Prairie Blue	39	--	--	--	--	--	52.4	--	--	--	--	--	0.0	--	--	25	--	--	--	--	--	49	--	--	--	--	--
Prairie Sapphire	46	--	--	--	--	--	51.9	--	--	--	--	--	0.0	--	--	24	--	--	--	--	--	50	--	--	--	--	--
Rahab 94	43	--	--	--	--	--	52.3	--	--	--	--	--	0.0	--	--	25	--	--	--	--	--	50	--	--	--	--	--
Trial Mean	42	41	45	21	58		52.6	52.2	53.1	52.6	53.5		0.2	0.6		25	25	25	20	30		50	53	48	53	50	
C.V. %	7.9	5.8	5.2	5.0	5.0		0.5	0.8	0.5	0.3	0.7		340	131		6.2	5.0	6.9	4.0	3.3		2.2	1.3	1.8	0.7	1.5	
LSD 5%	NS	3.9	3.9	1.4	4.7		0.4	0.6	0.4	0.2	0.6		1.1	1.2		2.5	2.0	2.8	1.1	1.6		1.8	1.1	1.4	0.6	1.2	
LSD 10%	NS	3.2	3.3	1.2	4.0		0.3	0.5	0.4	0.2	0.5		0.9	1.0		2.1	1.7	2.4	0.9	1.3		1.5	0.9	1.2	0.5	1.0	

*Yellow seeded.

Canola - Liberty Link and Clearfield Varieties, Langdon 2021-2022

Company/Brand	Variety	Type[1]	Blackleg Rating[2]	Clubroot Resistant[4]	Days to First Flower			Flower Duration (days)			Days to Mature			% Cover[3]		
					21	22	2yr	21	22	2yr	21	22	2yr	21	22	2yr
BASF	InVigor L233P	LL	R	No	41	41	41	17	20	19	79	93	86	75	98	87
BASF	InVigor L345PC	LL	R	Yes	44	41	43	16	20	18	82	93	88	83	99	91
BASF	InVigor L340PC	LL	R	Yes	44	40	42	17	20	19	82	91	87	74	100	87
BASF	InVigor LR344PC	LL/RR	R	Yes	42	42	42	16	21	19	83	94	89	79	99	89
Bayer	DKTFLL21SC	TFLL	R	No	41	37	39	18	21	20	80	87	84	70	95	83
Bayer	DKLL82SC	LL	R	No	41	38	40	19	21	20	82	88	85	75	100	88
CANTERRA SEEDS	CS4000 LL	LL	R	Yes	43	40	42	18	20	19	84	93	89	67	101	84
BASF	InVigor L350PC	LL	R	Yes	--	45	--	--	19	--	--	98	--	--	99	--
BASF	InVigor LR354PC	LL/RR	R	Yes	--	47	--	--	17	--	--	98	--	--	96	--
BASF	InVigor L343PC	LL	R	Yes	--	40	--	--	19	--	--	92	--	--	98	--
Bayer	DKLL83SC	LL	R	No	--	38	--	--	19	--	--	88	--	--	97	--
CROPLAN	CP7130LL	LL	R	Yes	--	41	--	--	21	--	--	92	--	--	99	--
CROPLAN	CP7144LL	LL	R	Yes	--	40	--	--	20	--	--	92	--	--	99	--
Pioneer	P505MSL	LL	R	Yes	--	40	--	--	19	--	--	92	--	--	99	--
Trial Mean					43	41		17	20		83	92		75	99	
C.V. %					1.7	1.9		4.5	5.0		0.9	1.1		7.2	1.8	
LSD 5%					0.6	1.1		0.7	1.4		0.7	1.4		5.3	2.5	
LSD 10%					0.5	0.9		0.6	1.2		0.6	1.2		4.5	2.0	

All varieties are traditional oil type and commercially available.

[1]LL-Liberty Link, TFLL-Roundup Ready Truflex- Liberty Link stacked, LL/RR- stacked.

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

[3] % 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.

[4]Has clubroot resistance gene(s).

Canola - Liberty Link and Clearfield Varieties, Langdon 2020-2022

Company/Brand	Variety	Height (in)			Lodging (0-9)			Oil[1] (%)			Yield[1] (lbs/a)			
		21	22	2yr	20	22	2yr	21	22	2yr	2020	2021	2022	2yr[2]
BASF	InVigor L233P	36	48	42	5.8	4.5	5.2	42.1	42.7	42.4	3565	1436	3171	3368
BASF	InVigor L345PC	40	47	44	6.3	4.1	5.2	42.3	41.8	42.1	3135	1512	3734	3435
BASF	InVigor L340PC	36	47	42	5.3	4.2	4.8	41.3	41.4	41.4	3414	1351	3573	3494
BASF	InVigor LR344PC	36	46	41	6.5	5.5	6.0	42.8	42.1	42.5	3020	1485	3227	3124
Bayer	DKTFLL21SC	35	46	41	4.8	2.9	3.9	43.2	43.2	43.2	3327	978	2793	3060
Bayer	DKLL82SC	36	45	41	4.5	5.0	4.8	43.2	41.4	42.3	3169	812	3094	3132
CANTERRA SEEDS	CS4000 LL	36	50	43	--	4.0	--	42.4	42.9	42.7	--	1076	3237	--
BASF	InVigor L350PC	--	51	--	--	1.7	--	--	45.2	--	--	--	3615	--
BASF	InVigor LR354PC	--	56	--	--	1.1	--	--	44.1	--	--	--	3351	--
BASF	InVigor L343PC	--	47	--	--	3.8	--	--	41.6	--	--	--	3627	--
Bayer	DKLL83SC	--	49	--	--	3.9	--	--	43.5	--	--	--	3182	--
CROPLAN	CP7130LL	--	52	--	--	4.2	--	--	42.7	--	--	--	3228	--
CROPLAN	CP7144LL	--	48	--	--	2.7	--	--	42.9	--	--	--	3178	--
Pioneer	P505MSL	--	53	--	--	5.8	--	--	41.9	--	--	--	2647	--
Trial Mean		38	49		5.2	3.8		42.7	42.7		2881	1308	3261	
C.V. %		4.4	5.5		18.4	12.9		1.0	1.2		8.2	17.6	3.9	
LSD 5%		1.4	3.9		1.3	0.5		0.4	0.7		331	204	122	
LSD 10%		1.2	3.2		1.1	0.4		0.3	0.6		277	172	102	

[1]8.5% moisture

[2]Average of 2020 and 2022 data.

Canola - Roundup Ready, Langdon 2021-2022

Company	Variety	Type[1]	Blackleg Rating[2]	Oil Type[3]	Clubroot Resistant[5]	Days to First Flower			Flower Duration (days)			Days to Mature			% Cover[4]		
						21	22	2yr	21	22	2yr	21	22	2yr	21	22	2yr
CANTERRA SEEDS	CS2600 CR-T	TF	R	Trad.	Yes	39	38	39	19	19	19	80	88	84	76	99	88
CROPLAN	CP9978TF	TF	R	Trad.	No	40	39	40	18	20	19	82	92	87	80	98	89
Integra	7361RC	TF	R	Trad.	Yes	41	40	41	18	20	19	82	91	87	85	97	91
Star	StarFlex	TF	R	Trad.	No	41	40	41	17	21	19	82	93	88	88	97	93
Bayer	DKTFLL21SC	TFLL	R	Trad.	No	39	38	39	19	21	20	79	89	84	91	99	95
BrettYoung	BY 6211TF	TF	R	Trad.	No	41	39	40	18	21	20	82	91	87	85	99	92
CANTERRA SEEDS	CS3000 TF	TF	R	Trad.	Yes	38	37	38	19	20	20	81	90	86	81	98	90
Nuseed	NC155 TF	TF	R	Trad.	No	40	38	39	19	24	22	82	91	87	84	100	92
Nuseed	NC471 TF	TF	R	Trad.	No	42	40	41	17	20	19	84	92	88	89	100	95
Nuseed	NC527CR TF	TF	R	Trad.	Yes	41	39	40	18	22	20	84	92	88	93	99	96
BASF	LR344PC	LL/RR	R	Trad.	Yes	--	41	--	--	21	--	--	94	--	--	99	--
CANTERRA SEEDS	CS3100 TF	TF	R	Trad.	Yes	--	44	--	--	20	--	--	97	--	--	98	--
Cargill	V25-3T	TF	R	HO	Yes	--	43	--	--	21	--	--	94	--	--	100	--
Cargill	V25-5T	TF	R	HO	Yes	--	45	--	--	18	--	--	96	--	--	100	--
Pioneer	45M35	RR	MR	Trad.	No	--	41	--	--	21	--	--	92	--	--	99	--
Trial Mean						41	41		18	21		82	92		86	99	
C.V. %						1.4	1.4		3.4	4.7		0.8	1.4		4.1	1.7	
LSD 5%						0.5	0.8		0.5	1.4		0.6	1.8		3.4	2.5	
LSD 10%						0.4	0.7		0.5	1.1		0.5	1.5		2.8	2.0	

[1]All varieties are Hybrids. RR-Roundup Ready, TF-Roundup Ready TruFlex, TFLL-Roundup Ready Truflex-Liberty Link stacked, LL/RR-stacked.

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

[3] Trad.-Traditional, HO-High Oleic.

[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]Has clubroot resistance gene(s).

Canola - Roundup Ready, Langdon 2020-2022

Company	Variety	Height (in)			Lodging (0-9)			Oil[1] (%)			Yield[1] (lbs/a)			
		21	22	2yr	20	22	2yr	21	22	2yr	20	21	22	2yr[2]
CANTERRA SEEDS	CS2600 CR-T	34	46	40	6.5	3.7	5.1	43.9	41.5	42.7	3325	1367	2409	2867
CROPLAN	CP9978TF	34	45	40	5.9	3.8	4.9	41.9	41.7	41.8	3543	1313	2710	3127
Integra	7361RC	35	45	40	6.6	3.6	5.1	42.8	40.9	41.9	3249	1676	2657	2953
Star	StarFlex	36	45	41	5.6	2.0	3.8	43.4	41.8	42.6	3076	1519	3149	3113
Bayer	DKTFLL21SC	34	45	40	--	3.4	--	43.0	40.9	42.0	--	1438	3148	--
BrettYoung	BY 6211TF	34	45	40	--	2.8	--	41.0	40.6	40.8	--	1262	3295	--
CANTERRA SEEDS	CS3000 TF	32	45	39	--	3.6	--	43.4	41.5	42.5	--	1484	2929	--
Nuseed	NC155 TF	32	49	41	--	2.0	--	40.9	41.6	41.3	--	1244	2963	--
Nuseed	NC471 TF	35	47	41	--	1.8	--	42.4	42.3	42.4	--	1438	2360	--
Nuseed	NC527CR TF	34	48	41	--	3.2	--	43.3	42.0	42.7	--	1700	2797	--
BASF	LR344PC	--	45	--	--	3.1	--	--	41.5	--	--	--	2954	--
CANTERRA SEEDS	CS3100 TF	--	48	--	--	2.3	--	--	42.2	--	--	--	3382	--
Cargill	V25-3T	--	51	--	--	0.3	--	--	41.9	--	--	--	3072	--
Cargill	V25-5T	--	55	--	--	0.0	--	--	43.3	--	--	--	3675	--
Pioneer	45M35	--	48	--	--	2.3	--	--	44.1	--	--	--	3511	--
Trial Mean		35	48		5.5	2.5		42.9	42.0		3209	1537	3245	
C.V. %		4.2	5.9		13.7	15.1		0.7	1.0		8.4	8.0	7.1	
LSD 5%		1.4	4.1		1.1	0.3		0.3	0.6		384	123	204	
LSD 10%		1.1	3.4		0.9	0.3		0.2	0.5		320	103	170	

[1] 8.5% Moisture

[2]Average of 2020 and 2022 data.

Dry Bean Summary, Langdon 2020-2022

Variety	Market Class	Days to Maturity	Plant Height	100 Seed Weight	Yield					
					2020	2021	2022	2 yr Avg.	3 yr Avg.	4 yr Avg.
			(in)	(g)	(lbs/a)					
LaPaz	Pinto	108	20	34.8	3693	1827	3155	2491	2892	2178
Lariat	Pinto	108	22	36.2	3455	1714	3026	2370	2732	2058
Monterrey	Pinto	109	19	34.6	3807	2105	3189	2647	3034	2284
ND-Falcon	Pinto	107	23	32.7	3114	1695	3278	2486	2696	2030
ND-Palomino	Pinto	110	18	32.2	3020	1585	2632	2108	2412	1817
Stampede	Pinto	106	20	32.2	3899	2028	3432	2730	3120	2348
Torreon	Pinto	107	22	36.2	3804	2165	3558	2862	3176	2391
Vibrant	Pinto	109	23	30.7	4033	2114	3626	2870	3258	2451
Windbreaker	Pinto	105	19	33.8	3876	1587	2490	2039	2651	1997
Cowboy	Pinto	107	21	34.3	--	1638	3074	2356	--	--
Blizzard	Navy	109	22	17.9	3321	1962	3350	2656	2878	2163
HMS Medalist	Navy	113	19	15.5	3891	2197	2847	2522	2978	2238
T9905	Navy	109	20	20.1	3781	1835	3326	2580	2981	2240
Armada	Navy	108	20	20.5	--	--	3194	--	--	--
ND-Polar	Navy	113	20	16.9	--	--	3172	--	--	--
Black Tails	Black	109	20	18.8	3759	2063	3463	2763	3095	2326
Eclipse	Black	108	19	18.6	3634	2049	3132	2590	2938	2208
ND-Twilight	Black	106	20	19.2	3205	1522	2901	2211	2543	--
Zorro	Black	108	20	18.4	--	1899	2421	2160	--	--
ND-Pegasus	Great Northern	111	23	34.5	--	2320	4098	3209	--	--
Rosetta	Pink	112	20	32.2	--	2044	2580	2312	--	--
Merlot	Small Red	110	20	33.3	3089	2036	2875	2456	2667	2008
Viper	Small Red	110	22	26.1	3329	2587	3422	3004	3113	2341
Trial Mean		109	21	27.0	3470	1937	3160			
C.V. %		1.5	7.2	2.6	7.8	9.5	8.9			
LSD 5%		2.6	2.5	1.2	446	235	463			
LSD 10%		2.2	2.0	1.0	371	197	336			

Days to mature (R9) at least 80% of pods showing yellow and mostly ripe.
Trials were direct harvested in 2021 and 2022.

Field Pea, Langdon 2020-2022

Variety	Days to 1st Flower	Mature	Canopy Ht. at Harvest	Harvest Ease[1]	1000 KWT	Seeds/ Pound	Test Weight	Protein[2]	Yield 2020	Yield 2021	Yield 2022	Yield 2 yr Avg.	Yield 3 yr Avg.
		(days)	(in)	(0-9)	(g)		(lbs/bu)	(%)	-----	-----	bu/a -----	-----	-----
Yellow Cotyledon Type													
AAC Asher	46	83	15	6.5	236	1927	64.1	25.0	64.2	42.9	54.2	48.6	53.8
AAC Chrome	47	87	15	5.6	232	1959	64.9	25.7	76.7	61.8	70.8	66.3	69.8
AAC Profit	49	90	14	6.6	213	2133	64.3	27.9	74.5	49.5	73.4	61.5	65.8
Agassiz	45	85	15	6.7	227	2001	64.9	27.0	76.3	44.2	66.0	55.1	62.2
CDC Amarillo	49	91	19	5.8	222	2047	65.2	26.5	70.4	53.1	71.3	62.2	64.9
CDC Inca	49	87	22	4.0	203	2234	64.1	26.7	74.4	50.4	71.0	60.7	65.3
CDC Spectrum	48	90	15	6.5	213	2131	64.0	27.5	55.9	45.4	61.0	53.2	54.1
DL Apollo	46	81	19	2.4	221	2053	64.5	26.3	59.6	41.5	61.7	51.6	54.3
DS Admiral	48	86	18	4.0	201	2262	64.5	25.9	73.0	39.6	70.3	54.9	61.0
Hyline	47	84	16	7.3	229	1977	63.6	26.2	62.1	53.1	55.6	54.4	56.9
ND Dawn	47	79	11	8.1	186	2435	63.1	24.6	59.7	38.4	46.4	42.4	48.2
Orchestra	46	83	14	5.3	279	1629	63.9	27.4	72.4	41.8	55.9	48.9	56.7
Salamanca	46	83	19	5.6	250	1816	64.5	28.0	74.5	46.4	64.1	55.2	61.7
AAC Julius	47	82	17	5.7	194	2352	64.6	25.8	--	53.3	58.6	56.0	--
MS GrowPro	48	87	24	2.2	304	1500	64.0	28.2	--	52.9	69.9	61.4	--
EP_8971	46	88	16	6.7	218	2088	64.0	30.3	--	46.2	48.4	47.3	--
LG Stunner	44	84	17	5.1	203	2245	64.3	28.2	--	45.2	66.7	56.0	--
PSTSP39	47	84	17	5.5	245	1864	64.5	25.0	--	49.6	54.8	52.2	--
PSTSPS51	47	90	17	5.0	242	1878	64.6	24.8	--	44.8	66.9	55.8	--
CP5222Y	45	83	19	6.0	288	1579	63.5	27.2	--	--	71.2	--	--
CP5244Y	43	88	19	3.3	223	2036	64.0	26.7	--	--	64.0	--	--
EP_1401S42	49	91	9	8.7	170	2677	63.1	29.9	--	--	55.4	--	--
EP_2311B1	44	83	13	6.8	203	2239	63.3	27.4	--	--	53.1	--	--
EP_6301S3	49	92	20	5.8	188	2426	63.4	29.7	--	--	55.1	--	--
PSTSP46	45	81	18	5.2	316	1440	64.6	26.3	--	--	77.2	--	--
PSTSP47	46	91	23	2.4	275	1653	64.5	27.4	--	--	70.4	--	--
PSTSP50	47	85	20	5.1	305	1490	64.3	27.5	--	--	77.5	--	--
Green Cotyledon Type													
Aragorn	44	77	8	9.0	188	2421	63.4	26.1	53.2	34.7	40.4	37.5	42.8
Arcadia	46	81	8	9.0	196	2321	63.7	25.1	64.6	39.5	43.9	41.7	49.3
CDC Striker	47	80	13	7.9	216	2105	64.4	27.0	59.6	44.6	46.6	45.6	50.3
Shamrock	49	87	17	5.6	226	2004	64.1	26.3	58.9	48.0	61.4	54.7	56.1
PSTSP38	45	89	16	6.3	210	2169	64.1	26.7	--	50.8	51.1	51.0	--
ND Victory	51	92	20	4.1	145	3142	64.3	26.6	--	--	44.9	--	--
PSTSP49	49	87	21	3.5	228	1983	65.3	25.3	--	--	69.6	--	--
Maple Cotyledon Type													
PSTSP48	47	85	20	3.7	250	1820	63.4	26.2	--	--	61.7	--	--
Trial Mean	47	86	17	5.6	226	2062	64.2	26.8	64.0	45.9	60.9		
C.V. %	0.9	1.4	12.2	16.3	4.1	4.3	1.1	2.1	8.7	13.3	7.4		
LSD 5%	0.5	1.5	2.5	1.1	15.0	144.7	1.1	0.7	9.1	10.0	6.0		
LSD 10%	0.4	1.3	2.1	0.9	12.5	120.8	0.9	0.6	7.6	8.3	5.0		

[1] Harvest Ease: 0=plants standing erect, 9=plants laying horizontal.

[2] 0% moisture basis

Faba Bean, Langdon 2022

Company	Variety	Days to 1st Flower (DAP[1])	Days to Mature (DAP[1])	Plant Height (in)	1000 KWT (g)	Seeds/lb	Protein[2] (%)	Test Weight (lbs/bu)	Seed Yield[2] 2020 (bu/a)	2021 (bu/a)	2022 (bu/a)	2-yr Avg. (bu/a)	3-yr Avg. (bu/a)
Premier Genetics	Fabelle	43	117	45	511	890	29.2	65.4	74.7	40.1	111.9	76.0	75.6
Premier Genetics	Tiffany	45	116	46	497	916	28.5	65.4	85.6	42.2	108.3	75.3	78.7
Valesco Genetics	Boxer	43	119	52	532	855	26.9	65.4	85.5	42.2	101.9	72.0	76.5
Valesco Genetics	Victus	42	118	47	552	825	28.1	65.9	94.7	37.3	112.5	74.9	81.5
Premier Genetics	Allison	41	116	46	487	932	27.5	65.3	--	42.4	99.9	71.2	--
Premier Genetics	Bolivia	43	119	45	438	1033	28.5	66.0	--	41.5	105.0	73.3	--
Premier Genetics	Escada	45	116	48	517	881	27.2	64.8	--	50.1	107.7	78.9	--
Valesco Genetics	Casanova	43	118	49	540	841	28.0	65.3	--	45.2	112.4	78.8	--
Valesco Genetics	Dosis	42	114	45	503	904	26.5	65.2	--	32.0	93.9	63.0	--
Valesco Genetics	Futura	42	119	47	434	1057	31.5	64.0	--	39.2	101.9	70.5	--
Valesco Genetics	Synergy	43	116	46	488	931	28.7	65.4	--	46.1	109.7	77.9	--
Trial Mean		43	117	47	500	915	28.2	65.3	80.0	38.8	105.9		
C.V. %		1.1	1.0	2.9	2.2	2.4	1.1	0.6	8.5	6.7	3.2		
LSD 5%		0.6	1.6	1.8	15.0	28.1	0.4	0.5	10.1	3.4	4.9		
LSD 10%		0.5	1.3	1.5	12.4	23.3	0.3	0.4	8.4	2.8	4.1		

[1] DAP - Days after planting

[2] Yield and protein at 16% moisture.

Soybean - RR2X, RR2XF, Enlist, and GT, Langdon 2022 *(page 1 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Lodging (0-9)	Protein (%)	Oil (%)	Yield 2022 (bu/a)	Yield 2 yr Avg. (bu/a)	Yield 2-site Avg.[4] (bu/a)
Dahlman	AE0300	Enlist E3	0.1	9/22	36	3.0	34.9	15.0	70.1	67.3	63.8
Dahlman	7301XF	RR2XF	0.1	9/22	45	2.4	35.7	14.9	67.7	--	67.8
Dairyland	DSR-0220E	Enlist E3	0.2	9/25	33	1.7	34.7	15.4	65.7	--	--
Dak-Sota	DE5301	Enlist E3	0.1	9/27	35	4.9	35.1	15.5	64.3	--	64.0
Dyna-Gro	S006XF83	RR2XF	00.6	9/12	32	1.6	32.9	16.2	67.9	--	70.3
Dyna-Gro	S009XF33	RR2XF	00.9	9/17	30	0.5	34.3	15.2	62.3	--	66.2
Dyna-Gro	S01XF43	RR2XF	0.1	9/17	34	0.6	35.7	14.8	70.8	--	69.8
Dyna-Gro	S02EN71	Enlist E3	0.2	9/22	30	1.7	35.0	15.2	68.8	68.3	71.1
Golden H.	GH00973E3	Enlist E3	00.9	9/18	34	1.2	37.1	14.9	71.3	--	72.6
Golden H.	GH00982XF	RR2XF	00.9	9/17	32	0.9	34.3	15.6	69.2	66.2	69.8
Golden H.	GH0213E3	Enlist E3	0.2	9/24	33	1.7	36.0	14.8	70.3	--	71.3
Innvictis	A00821XF	RR2XF	00.8	9/19	34	2.8	34.7	15.3	60.4	--	58.0
Innvictis	A00979X	RR2X	00.9	9/20	32	2.4	35.8	15.4	60.8	63.7	60.7
Innvictis	B00730E	Enlist E3	00.7	9/18	34	3.8	33.7	16.2	60.8	--	62.7
Integra	40089N	Enlist E3	00.8	9/22	34	4.1	34.9	15.6	55.5	60.2	57.4
Integra	40113N	Enlist E3	0.1	9/19	31	2.5	36.0	15.0	70.6	--	67.6
Integra	70082N	RR2XF	00.9	9/18	34	2.2	35.1	15.1	65.2	--	60.2
Legacy	LS-00930 RR2X	RR2X	00.9	9/20	32	1.7	36.1	15.3	65.2	64.3	64.6
Legacy	LS012-21E	Enlist E3	0.1	9/24	37	3.9	34.5	16.0	64.9	65.9	65.0
Legacy	LS014-22 XF	RR2XF	0.1	9/22	44	3.2	35.6	15.1	68.1	--	69.5
Legacy	LS-0239 RR2X	RR2X	0.2	9/21	37	4.0	34.6	15.0	70.4	68.6	69.2
Legacy	LS-0320 E3	Enlist E3	0.2	9/24	35	2.1	34.9	15.1	70.3	--	72.2
Legacy	LS032-22 E	Enlist E3	0.3	9/27	36	3.7	34.4	15.5	68.6	--	65.3
LG Seeds	LGS00663RX	RR2X	00.6	9/15	33	0.8	34.4	15.3	68.6	65.2	69.6
LG Seeds	LGS00838XF	RR2XF	00.8	9/16	38	2.0	35.3	15.3	63.3	60.6	60.0
LG Seeds	LGS0111RX	RR2X	0.1	9/21	39	2.6	35.6	15.5	68.7	68.0	70.6
NDSU	ND17009GT	GT	00.9	9/16	36	3.2	36.0	16.2	62.2	59.2	62.7
NDSU	ND21008GT20	GT	00.8	9/16	37	3.7	34.8	15.7	64.7	62.1	61.7
NK Seeds	NK009-G7E3	Enlist E3	00.9	9/18	32	1.7	36.6	14.7	69.3	--	71.7
NK Seeds	NK009-T1XF	RR2XF	00.9	9/18	34	1.7	34.5	15.8	71.9	67.6	70.1
NK Seeds	NK02-M4XF	RR2XF	0.2	9/17	35	1.5	33.6	16.0	69.3	--	70.9
NK Seeds	NK02-T4E3	Enlist E3	0.2	9/20	31	1.9	35.6	14.9	66.0	--	71.8
Pioneer	P005A59E	Enlist E3	00.5	9/14	31	1.2	35.3	15.8	59.7	--	--
Pioneer	P005A83X	RR2X	00.5	9/12	34	2.8	34.1	15.9	61.0	59.0	--
Pioneer	P007A08X	RR2X	00.7	9/15	35	1.6	34.6	15.9	60.3	--	--

[1]Herbicide Trait - RR2X, RR2XF=Xtend + Flex (Liberty Link), Enlist=Enlist E3, GT=Glyphosate Tolerant.

[2]Maturity Group provided by company.

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

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

Yield, oil and protein reported at 13% moisture.

Soybean - RR2X, RR2XF, Enlist, and GT, Langdon 2022 *(page 2 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Lodging (0-9)	Protein (%)	Oil (%)	Yield 2022	Yield 2 yr Avg.	Yield 2-site Avg.[4]
									----------bu/a----------		
Pioneer	P009T18E	Enlist E3	00.9	9/19	34	3.1	33.5	16.2	53.8	58.3	54.0
Pioneer	P00A49X	RR2X	0.0	9/19	35	2.4	33.6	16.2	63.4	63.0	--
Pioneer	P01A84X	RR2X	0.1	9/20	34	2.2	33.7	16.1	60.1	60.6	--
Proseed	EL30-13	Enlist E3	0.1	9/25	37	5.1	34.9	15.9	62.6	--	63.6
Proseed	XF30-062	RR2XF	00.6	9/12	33	1.5	32.7	16.1	64.6	--	67.7
Proseed	XF30-082	RR2XF	00.8	9/15	30	1.5	34.9	15.1	62.2	--	66.4
Proseed	XF30-092N	RR2XF	00.9	9/20	36	2.0	34.5	15.7	77.1	--	77.5
Proseed	XF30-12	RR2XF	0.1	9/17	34	1.4	35.3	15.3	68.5	--	70.3
Proseed	XT80-20	RR2X	0.2	9/25	38	5.2	35.1	14.7	66.2	65.9	67.5
REA	R0112XF	RR2XF	0.1	9/21	44	3.3	34.8	15.5	67.3	67.9	71.9
REA	RX00912	RR2X	00.9	9/17	37	1.0	33.4	16.1	67.8	63.6	66.4
Stine	002EE06	Enlist E3	00.2	9/9	33	1.7	35.6	15.3	47.9	47.7	48.4
Stine	008EE02	Enlist E3	00.8	9/22	31	2.2	34.0	16.5	56.2	--	56.0
Thunder	TB7101N	Enlist E3	0.1	9/24	29	1.5	34.5	15.3	63.6	--	69.1
Thunder	SB87009	RR2X	00.9	9/18	39	2.5	35.6	14.5	64.7	63.4	66.6
Thunder	TE7302N	Enlist E3	0.2	9/21	30	2.4	35.2	15.2	67.2	--	67.7
Thunder	TX82008N	RR2XF	00.8	9/20	35	2.4	35.7	15.2	59.4	61.3	59.9
Thunder	TX8301	RR2XF	0.1	9/16	31	0.3	34.7	15.2	62.9	--	66.8
Xitavo	XO 0101E	Enlist E3	0.1	9/21	35	3.0	35.8	15.2	62.5	--	63.0
Xitavo	XO 0213E	Enlist E3	0.2	9/25	36	4.2	35.0	15.5	60.8	--	60.8
Trial Mean				9/19	35	2.4	34.9	15.5	64.8		
C.V. %				1.6	4.8	38.4	1.4	1.7	6.7		
LSD 5%				2.6	2.3	1.3	1.0	0.5	6.1		
LSD 10%				2.2	1.9	1.1	0.8	0.4	5.1		

[1]Herbicide Trait - RR2X, RR2XF=Xtend + Flex (Liberty Link), Enlist=Enlist E3, GT=Glyphosate Tolerant.

[2]Maturity Group provided by company.

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

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

Yield, oil and protein reported at 13% moisture.

Soybean - RR2X, RR2XF, Enlist, and GT, Pembina County 2022 *(page 1 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Lodging (0-9)	Protein (%)	Oil (%)	Yield 2022	Yield 2 yr Avg.	Yield 2-site Avg.[4]
									bu/a		
Dahlman	AE0300	Enlist E3	0.1	10/2	32	0.9	32.8	15.9	57.4	67.3	63.8
Dahlman	7301XF	RR2XF	0.1	10/4	41	2.1	33.6	15.6	67.9	--	67.8
Dak-Sota	DE5301	Enlist E3	0.1	10/4	35	3.6	33.1	16.5	63.7	--	64.0
Dyna-Gro	S006XF83	RR2XF	00.6	9/24	36	1.1	32.4	16.9	72.7	--	70.3
Dyna-Gro	S009XF33	RR2XF	00.9	9/26	29	0.6	32.8	15.6	70.0	--	66.2
Dyna-Gro	S01XF43	RR2XF	0.1	9/26	32	0.3	34.2	15.5	68.7	--	69.8
Dyna-Gro	S02EN71	Enlist E3	0.2	10/2	29	0.1	32.8	15.9	73.3	61.3	71.1
Golden H.	GH00973E3	Enlist E3	00.9	9/26	31	1.1	33.9	15.7	73.8	--	72.6
Golden H.	GH00982XF	RR2XF	00.9	9/25	33	0.2	33.1	16.0	70.4	57.3	69.8
Golden H.	GH0213E3	Enlist E3	0.2	10/4	30	0.4	33.1	15.7	72.3	--	71.3
Innvictis	A00821XF	RR2XF	00.8	9/27	32	3.3	33.4	15.9	55.5	--	58.0
Innvictis	A00979X	RR2X	00.9	10/2	29	0.3	33.8	15.9	60.5	53.0	60.7
Innvictis	B00730E	Enlist E3	00.7	9/28	30	1.9	32.2	16.9	64.6	--	62.7
Integra	70063	RR2XF	00.6	9/25	34	1.8	32.3	16.4	67.6	--	--
Integra	40089N	Enlist E3	00.8	9/30	33	3.1	32.2	16.5	59.3	51.2	57.4
Integra	40113N	Enlist E3	0.1	10/1	29	1.6	33.7	16.2	64.6	--	67.6
Integra	70082N	RR2XF	00.9	9/26	34	2.3	33.2	15.9	55.2	--	60.2
Legacy	LS-00930 RR2X	RR2X	00.9	9/29	31	0.0	33.9	16.0	63.9	57.1	64.6
Legacy	LS012-21E	Enlist E3	0.1	10/2	32	5.7	33.5	16.4	65.1	57.9	65.0
Legacy	LS014-22 XF	RR2XF	0.1	10/3	41	4.8	34.4	15.6	70.9	--	69.5
Legacy	LS-0239 RR2X	RR2X	0.2	10/1	37	5.1	33.5	15.2	67.9	61.2	69.2
Legacy	LS-0320 E3	Enlist E3	0.2	10/2	32	1.6	33.2	15.7	74.1	--	72.2
Legacy	LS032-22 E	Enlist E3	0.3	10/5	33	2.7	32.9	16.1	61.9	--	65.3
LG Seeds	LGS00663RX	RR2X	00.6	9/26	32	0.8	33.3	15.8	70.6	56.3	69.6
LG Seeds	LGS00838XF	RR2XF	00.8	9/26	34	2.9	34.0	15.5	56.6	48.6	60.0
LG Seeds	LGS0111RX	RR2X	0.1	10/3	37	3.3	33.9	15.9	72.5	60.9	70.6
NDSU	ND17009GT	GT	00.9	9/27	36	4.4	35.3	16.4	63.1	52.3	62.7
NDSU	ND21008GT20	GT	00.8	9/26	40	6.9	34.2	15.8	58.7	49.9	61.7
NK Seeds	NK009-G7E3	Enlist E3	00.9	9/27	30	0.8	34.3	15.6	74.1	--	71.7
NK Seeds	NK009-T1XF	RR2XF	00.9	9/26	30	0.3	33.2	16.2	68.2	57.3	70.1

[1]Herbicide Trait - RR2X, RR2XF=Xtend + Flex (Liberty Link), Enlist=Enlist E3, GT=Glyphosate Tolerant.

[2]Maturity Group provided by company.

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

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

Yield, oil and protein reported at 13% moisture.

Soybean - RR2X, RR2XF, Enlist, and GT, Pembina County 2022 *(page 2 of 2)*

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Lodging (0-9)	Protein (%)	Oil (%)	Yield 2022	Yield 2 yr Avg.	Yield 2-site Avg.[4]
									----------bu/a----------		
NK Seeds	NK02-M4XF	RR2XF	0.2	9/27	32	1.6	32.6	16.3	72.4	--	70.9
NK Seeds	NK02-T4E3	Enlist E3	0.2	10/3	31	0.0	33.7	15.7	77.5	--	71.8
Pioneer	P009T18E	Enlist E3	00.9	10/1	30	1.9	31.9	16.8	54.2	48.8	54.0
Pioneer	P03A17X	RR2X	0.2	10/4	33	1.4	31.8	16.7	63.7	56.3	--
Pioneer	P03A26X	RR2X	0.3	10/6	37	0.8	31.8	16.3	66.5	60.4	--
Pioneer	P03T87E	Enlist E3	0.3	10/4	27	0.0	33.0	15.8	70.2	56.8	--
Pioneer	P04A98E	Enlist E3	0.4	10/6	29	0.3	33.1	15.8	67.0	--	--
Proseed	EL30-13	Enlist E3	0.1	10/4	34	3.8	33.6	16.3	64.5	--	63.6
Proseed	XF30-062	RR2XF	00.6	9/24	34	1.3	32.7	16.4	70.8	--	67.7
Proseed	XF30-082	RR2XF	00.8	9/25	29	0.2	33.5	15.8	70.6	--	66.4
Proseed	XF30-092N	RR2XF	00.9	9/28	36	4.9	33.1	15.9	77.9	--	77.5
Proseed	XF30-12	RR2XF	0.1	9/25	30	0.3	34.6	15.3	72.1	--	70.3
Proseed	XT80-20	RR2X	0.2	10/2	36	5.1	33.6	15.3	68.8	--	67.5
REA	R0112XF	RR2XF	0.1	10/3	39	3.6	34.2	15.2	76.5	62.1	71.9
REA	RX00912	RR2X	00.9	10/2	35	1.3	31.9	16.2	64.9	54.4	66.4
Stine	002EE06	Enlist E3	00.2	9/22	32	0.6	34.2	15.9	48.9	37.7	48.4
Stine	008EE02	Enlist E3	00.8	10/3	31	0.7	31.0	17.2	55.8	--	56.0
Thunder	TE7101N	Enlist E3	0.1	10/3	29	0.7	33.2	16.1	74.5	--	69.1
Thunder	SB87009	RR2X	00.9	9/27	37	4.2	34.3	14.8	68.4	--	66.6
Thunder	TE7302N	Enlist E3	0.2	9/29	29	2.6	33.8	15.6	68.2	--	67.7
Thunder	TX82008N	RR2XF	00.8	9/26	33	2.7	33.5	15.8	60.3	53.1	59.9
Thunder	TX8301	RR2XF	0.1	9/24	29	0.5	33.3	16.0	70.7	--	66.8
Xitavo	XO 0101E	Enlist E3	0.1	9/29	29	3.6	33.3	15.9	63.5	--	63.0
Xitavo	XO 0213E	Enlist E3	0.2	10/6	35	2.4	33.2	16.1	60.8	--	60.8
Trial Mean				9/29	33	2.1	33.3	16.0	66.4		
C.V. %				1.5	8.9	53.2	1.3	1.7	7.5		
LSD 5%				2.4	4.1	1.5	0.9	0.6	6.9		
LSD 10%				2.0	3.4	1.3	0.7	0.5	5.8		

[1]Herbicide Trait - RR2X, RR2XF=Xtend + Flex (Liberty Link), Enlist=Enlist E3, GT=Glyphosate Tolerant.

[2]Maturity Group provided by company.

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

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

Yield, oil and protein reported at 13% moisture.

Soybean - RR2X, RR2XF, Enlist, and GT, Walsh County 2022

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Lodging (0-9)	Protein (%)	Oil (%)	Yield 2022	Yield 2 yr Avg.	Yield 2-site Avg.[4]
									bu/a		
Dahlman	7203XF	RR2XF	0.3	9/18	44	1.5	36.2	15.6	79.5	55.1	66.5
Dahlman	7304XF	RR2XF	0.4	9/23	35	0.0	37.3	15.0	81.5	--	70.7
Dyna-Gro	S01XF43	RR2XF	0.1	9/10	36	0.3	35.7	15.6	76.7	--	64.1
Dyna-Gro	S02EN71	Enlist E3	0.2	9/16	31	0.0	34.9	15.9	80.4	52.5	67.9
Dyna-Gro	S04XT91	RR2X	0.4	9/20	36	0.0	35.4	15.8	85.2	59.3	73.1
Golden H.	GH0213E3	Enlist E3	0.2	9/18	33	0.0	36.4	15.5	82.8	--	68.5
Golden H.	GH0272XF	RR2XF	0.2	9/13	35	0.3	35.0	15.9	76.9	53.5	62.8
Golden H.	GH0363E3	Enlist E3	0.3	9/20	35	2.5	36.5	15.3	85.8	--	71.9
Integra	40511	Enlist E3	0.4	9/23	38	0.8	36.5	15.8	76.0	--	62.6
Integra	70212	RR2XF	0.2	9/18	45	0.7	35.6	15.9	81.0	--	67.6
Integra	40113N	Enlist E3	0.1	9/12	34	0.5	35.1	16.0	78.5	--	63.4
Integra	70082N	RR2XF	00.9	9/11	34	0.5	35.4	15.7	67.5	--	54.4
Legacy	LS012-21E	Enlist E3	0.1	9/21	35	1.0	35.0	16.5	73.6	55.4	60.8
Legacy	LS014-22 XF	RR2XF	0.1	9/16	44	1.2	36.3	15.7	81.1	--	67.7
Legacy	LS-0239 RR2X	RR2X	0.2	9/19	36	2.5	35.1	15.4	83.1	53.2	69.7
Legacy	LS-0320 E3	Enlist E3	0.3	9/16	35	0.0	35.4	15.7	77.6	53.7	64.8
Legacy	LS032-22 E	Enlist E3	0.3	9/21	37	2.0	35.2	16.3	77.2	--	64.7
Legacy	LS044-21 XF	RR2XF	0.4	9/25	46	2.3	35.0	15.5	81.1	--	69.6
LG Seeds	LGS0111RX	RR2X	0.1	9/21	41	0.5	35.7	15.8	76.7	52.4	65.0
LG Seeds	LGS0400RX	RR2X	0.4	9/23	40	0.3	33.9	16.0	80.5	56.9	67.5
NDSU	ND17009GT	GT	00.9	9/13	40	1.3	36.7	16.3	69.6	46.6	57.5
NDSU	ND21008GT20	GT	00.8	9/10	37	4.0	34.7	16.3	72.7	45.6	60.0
NK Seeds	NK009-G7E3	Enlist E3	00.9	9/13	32	0.0	36.5	15.6	83.0	--	70.3
NK Seeds	NK009-T1XF	RR2XF	00.9	9/9	35	0.0	35.2	15.9	79.9	52.5	66.8
NK Seeds	NK02-M4XF	RR2XF	0.2	9/14	38	0.8	34.7	15.9	78.6	--	64.3
NK Seeds	NK02-T4E3	Enlist E3	0.2	9/17	34	0.0	35.8	16.0	77.8	--	66.1
NK Seeds	NK03-V5E3	Enlist E3	0.3	9/19	36	1.8	37.0	15.2	79.5	--	69.1
Pioneer	P009T18E	Enlist E3	00.9	9/12	32	1.0	34.1	16.6	63.7	--	--
Pioneer	P03A17X	RR2X	0.2	9/16	34	0.0	34.5	16.8	70.5	50.1	--
Pioneer	P03A26X	RR2X	0.3	9/22	39	1.5	34.8	15.8	82.2	55.4	--
Pioneer	P03T87E	Enlist E3	0.3	9/18	30	0.0	35.4	15.9	77.8	53.0	--
Pioneer	P04A98E	Enlist E3	0.4	9/21	33	0.0	35.3	15.6	76.2	--	--
Proseed	EL30-13	Enlist E3	0.1	9/22	38	2.0	35.2	16.3	73.9	--	63.1
Proseed	XF30-062	RR2XF	00.6	9/8	34	1.8	32.7	16.9	70.5	--	57.0
Proseed	XF30-082	RR2XF	00.8	9/9	32	0.0	34.6	15.8	75.5	--	62.9
Proseed	XF30-092N	RR2XF	00.9	9/14	37	2.5	34.0	16.4	89.8	--	75.0
Proseed	XF30-12	RR2XF	0.1	9/9	35	0.0	35.2	15.6	75.2	--	65.0
Proseed	XT80-20	RR2X	0.2	9/20	36	2.8	34.7	15.5	79.0	54.4	62.3
REA	R0112XF	RR2XF	0.1	9/17	44	0.7	35.9	15.9	78.2	53.3	66.9
REA	R0422XF	RR2XF	0.4	9/23	38	0.0	37.0	15.3	82.2	--	71.3
REA	RX00912	RR2X	00.9	9/13	36	0.5	33.6	16.3	75.4	50.1	60.8
Stine	002EE06	Enlist E3	00.2	9/6	32	0.0	35.7	15.5	51.1	29.1	--
Stine	008EE02	Enlist E3	00.8	9/21	31	0.0	35.0	16.8	63.0	--	52.8
Xitavo	XO 0101E	Enlist E3	0.1	9/15	34	0.2	35.8	15.6	75.0	--	62.4
Xitavo	XO 0213E	Enlist E3	0.2	9/20	36	1.3	35.5	16.2	67.8	--	58.4
Trial Mean				9/17	36	0.9	35.4	15.9	76.7		
C.V. %				1.8	5.4	82.6	1.1	1.4	5.9		
LSD 5%				2.9	2.8	1.0	0.8	0.5	6.3		
LSD 10%				2.4	2.3	0.8	0.6	0.4	5.2		

[1]Herbicide Trait - RR2X, RR2XF=Xtend + Flex (Liberty Link), Enlist=Enlist E3, GT=Glyphosate Tolerant

[2]Maturity Group provided by company.

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

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

Yield, oil and protein reported at 13% moisture.

Soybean - RR2X, RR2XF, Enlist, and GT, Nelson County 2022

Brand	Variety	Herb. Trait[1]	Maturity Group[2]	Maturity date[3]	Plant Height (in)	Lodging (0-9)	Protein (%)	Oil (%)	Yield 2022	Yield 2 yr Avg.	Yield 2-site Avg.[4]
									bu/a		
Dahlman	7203XF	RR2XF	0.3	9/18	34	0.7	34.0	16.4	53.5	54.2	66.5
Dahlman	7304XF	RR2XF	0.4	9/24	27	0.4	34.6	16.5	59.9	--	70.7
Dyna-Gro	S01XF43	RR2XF	0.1	9/17	26	0.7	34.9	15.6	51.4	--	64.1
Dyna-Gro	S02EN71	Enlist E3	0.2	9/22	22	0.3	34.7	15.9	55.3	52.4	67.9
Dyna-Gro	S04XT91	RR2X	0.4	9/23	27	0.0	33.7	16.8	61.0	58.0	73.1
Golden H.	GH0213E3	Enlist E3	0.2	9/22	26	0.0	35.0	15.8	54.2	--	68.5
Golden H.	GH0272XF	RR2XF	0.2	9/18	25	0.1	33.5	16.7	48.6	46.4	62.8
Golden H.	GH0363E3	Enlist E3	0.3	9/20	25	0.4	35.3	15.9	58.0	--	71.9
Integra	40511	Enlist E3	0.4	9/25	27	0.2	34.7	16.0	49.1	--	62.6
Integra	70212	RR2XF	0.2	9/17	36	1.5	34.5	16.3	54.2	--	67.6
Integra	40089N	Enlist E3	00.8	9/18	24	0.2	33.9	16.3	44.6	--	--
Integra	40113N	Enlist E3	0.1	9/18	22	0.1	35.0	16.2	48.3	--	63.4
Integra	70082N	RR2XF	00.9	9/18	25	0.1	34.8	15.7	41.2	--	54.4
Legacy	LS012-21E	Enlist E3	0.1	9/20	29	1.3	33.9	16.6	47.9	51.5	60.8
Legacy	LS014-22 XF	RR2XF	0.1	9/17	31	1.0	34.3	16.4	54.3	--	67.7
Legacy	LS-0239 RR2X	RR2X	0.2	9/19	28	0.3	33.6	15.5	56.3	56.0	69.7
Legacy	LS-0320 E3	Enlist E3	0.3	9/19	25	0.3	34.0	15.8	52.0	49.4	64.8
Legacy	LS032-22 E	Enlist E3	0.3	9/22	26	1.2	33.8	16.7	52.1	--	64.7
Legacy	LS044-21 XF	RR2XF	0.4	9/25	37	1.4	33.4	15.9	58.0	--	69.6
LG Seeds	LGS0111RX	RR2X	0.1	9/19	29	1.2	34.9	16.1	53.2	54.4	65.0
LG Seeds	LGS0338E3	Enlist E3	0.3	9/19	25	0.5	34.2	15.9	57.8	--	--
LG Seeds	LGS0400RX	RR2X	0.4	9/23	28	0.5	33.3	16.2	54.5	58.1	67.5
NDSU	ND17009GT	GT	00.9	9/14	28	0.7	36.4	16.5	45.3	45.3	57.5
NDSU	ND21008GT20	GT	00.8	9/14	27	0.7	34.0	16.4	47.2	42.9	60.0
NK Seeds	NK009-G7E3	Enlist E3	00.9	9/16	23	0.6	35.5	16.0	57.6	--	70.3
NK Seeds	NK009-T1XF	RR2XF	00.9	9/16	28	0.7	34.1	16.3	53.7	52.5	66.8
NK Seeds	NK02-M4XF	RR2XF	0.2	9/17	28	0.2	33.5	16.5	49.9	--	64.3
NK Seeds	NK02-T4E3	Enlist E3	0.2	9/21	25	0.0	34.7	16.0	54.4	--	66.1
NK Seeds	NK03-V5E3	Enlist E3	0.3	9/20	24	0.4	35.2	15.6	58.6	--	69.1
NK Seeds	NK05-W3XF	RR2XF	0.5	9/25	30	0.8	34.5	15.6	61.2	--	--
Proseed	EL30-13	Enlist E3	0.1	9/21	25	0.4	33.9	16.6	52.3	--	63.1
Proseed	XF30-062	RR2XF	00.6	9/16	24	0.4	32.4	16.9	43.5	--	57.0
Proseed	XF30-082	RR2XF	00.8	9/16	25	0.0	33.9	15.9	50.3	--	62.9
Proseed	XF30-092N	RR2XF	00.9	9/16	27	0.5	33.2	16.7	60.2	--	75.0
Proseed	XF30-12	RR2XF	0.1	9/15	26	0.9	34.3	15.7	54.7	--	65.0
Proseed	XT80-20	RR2X	0.2	9/20	24	1.5	33.3	15.9	45.5	--	62.3
REA	R0112XF	RR2XF	0.1	9/17	33	1.8	34.5	16.0	55.5	54.3	66.9
REA	R0422XF	RR2XF	0.4	9/24	29	0.1	34.5	16.1	60.3	--	71.3
REA	RX00912	RR2X	00.9	9/16	27	0.2	32.9	16.5	46.2	42.8	60.8
Stine	008EE02	Enlist E3	00.8	9/19	20	0.2	33.8	17.3	42.5	--	52.8
Stine	03EB02	Enlist E3	0.3	9/20	26	0.9	34.2	16.1	55.9	54.8	--
Stine	04EE06	Enlist E3	0.4	9/24	26	0.2	34.8	16.4	55.2	--	--
Xitavo	XO 0101E	Enlist E3	0.1	9/18	26	0.2	35.6	15.7	49.8	--	62.4
Xitavo	XO 0213E	Enlist E3	0.2	9/24	25	1.2	34.1	16.4	49.0	--	58.4
Trial Mean				9/19	27	0.6	34.3	16.2	52.6		
C.V. %				1.6	7.5	114.9	1.2	1.6	8.0		
LSD 5%				2.5	2.8	0.9	0.8	0.5	5.9		
LSD 10%				2.1	2.3	0.7	0.6	0.4	4.9		

[1]Herbicide Trait - RR2X, RR2XF=Xtend + Flex (Liberty Link), Enlist=Enlist E3, GT=Glyphosate Tolerant

[2]Maturity Group provided by company

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

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

Yield, oil and protein reported at 13% moisture.

Soybean - Conventional, Langdon 2022

Brand	Variety	Maturity Group[1]	Maturity	Plant Height	Protein	Oil	Yield 2022	Yield 2 yr Avg.	Yield 2 -site Avg.[3]
Conventional:			**date[2]**	**(in)**	**(%)**	**(%)**	**---------bu/a--------**		
Legacy	LS0090-20C	00.8	9/18	32	39.1	14.7	51.8	50.9	51.1
NDSU	ND Rolette	00.9	9/19	37	35.4	15.8	67.9	63.2	68.7
Richland IFC	MK009	00.9	9/24	39	35.0	14.7	50.5	48.8	54.9
Richland IFC	MK0249	0.2	9/23	35	35.1	15.1	56.5	52.9	57.8
Trial Mean			9/22	38	36.4	15.2	60.1		
C.V. %			1.5	5.7	1.6	2.1	7.5		
LSD 5%			2.6	3.1	1.2	0.7	6.4		
LSD 10%			2.1	2.5	1.0	0.5	5.3		

[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.

Soybean - Conventional, Walsh County 2022

Brand	Variety	Maturity Group[1]	Maturity	Plant Height	IDC[4]	Protein	Oil	Yield 2022	Yield 2 yr Avg.	Yield 2-site Avg.[3]
Conventional:			**date[2]**	**(in)**	**(1-5)**	**(%)**	**(%)**	**---------bu/a--------**		
Legacy	LS0090-20C	00.8	9/18	29	2.6	39.1	15.2	50.3	36.5	51.1
NDSU	ND Rolette	00.9	9/10	37	1.0	35.0	16.5	69.5	48.0	68.7
Richland IFC	MK009	00.9	9/20	35	1.1	34.7	15.3	59.3	41.9	54.9
Richland IFC	MK0249	0.2	9/24	34	1.8	34.8	15.5	59.0	43.7	57.8
Trial Mean			9/17	34	1.8	36.0	15.9	65.0		
C.V. %			2.0	6.8	17.6	0.8	1.0	7.9		
LSD 5%			3.2	3.3	0.4	0.6	0.3	7.3		
LSD 10%			2.7	2.7	0.4	0.5	0.3	6.1		

[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)

[4]Relative Rating 1-5, with 1-green, 3-yellow tissue, 5-dead

Yield, oil and protein reported at 13% moisture.

Oil Sunflower, Langdon 2022

Brand	Hybrid	Hybrid Type[1]	Days to Flower (days)[2]	Days to Mature (days)[2]	Plant Height (in)	Oil (%)	Test Weight (lbs/bu)	Harvest Moist. (%)	Yield 2018 (lbs/a)	Yield 2020 (lbs/a)	Yield 2022 (lbs/a)	Yield 2yr Avg (lbs/a)	Yield 3yr Avg (lbs/a)
CROPLAN	CP3845	HO,CONV	74	112	63	46.2	31.2	8.5	2557	3269	2469	2869	2765
CROPLAN	CP432E	NS,EX,DM	71	113	59	43.6	31.6	9.3	2570	3414	2989	3201	2991
CROPLAN	CP450E	HO,EX,DM	76	119	62	45.2	31.0	13.1	2824	3785	2589	3187	3066
CROPLAN	CP455E	HO,EX,DM	74	116	64	44.9	31.2	10.6	2818	3426	2814	3120	3019
CROPLAN	CP545CL	NS,CL,DM	75	116	55	44.6	31.6	18.5	2451	3386	2574	2980	2804
Nuseed	Falcon	NS,EX	76	112	56	46.3	32.1	10.6	2090	2956	2550	2753	2532
Nuseed	N4H302 E	HO,EX	73	112	58	44.3	27.9	10.6	2611	3078	2550	2814	2746
Nuseed	N4H470 CLP	HO,CP,DM	76	117	56	48.4	31.6	15.4	2733	3124	2409	2766	2755
Proseed	12G25CL	HO,CL	73	113	62	45.2	30.9	10.3	2781	3088	2925	3006	2931
Proseed	50016	HO,CP,DM	75	116	64	44.9	30.4	11.3	2640	2805	2633	2719	2693
CROPLAN	CP4909E	NS,EX	76	114	58	45.4	32.9	10.8	--	3201	2621	2911	--
Dyna-Gro	H42HO18CL	HO,CL,DM	73	116	54	45.7	32.7	9.9	--	3209	2650	2929	--
Dyna-Gro	H45HO10EX	HO,EX,DM	73	113	58	44.4	28.1	10.5	--	3235	2437	2836	--
Dyna-Gro	H45NS16CL	NS,CL,DM	72	112	54	47.4	33.9	9.4	--	3616	3045	3331	--
Dyna-Gro	H49HO19CL	HO,CL,DM	77	116	58	45.8	29.3	14.0	--	3524	2734	3129	--
Nuseed	N4H422 CL	HO,CL,DM	73	114	61	44.5	30.1	11.1	--	3161	2720	2940	--
Pioneer	P63HE501	HO,EX,DM	75	113	58	38.1	29.9	9.8	--	3293	2009	2651	--
Proseed	E-91E	HO,EX,DM	76	113	71	45.9	31.9	10.1	--	3213	2622	2918	--
CROPLAN	CP7919CL	HO,CL,DM	75	117	62	48.2	29.7	18.0	--	--	2630	--	--
Dyna-Gro	H47HO11EX	HO,EX	75	115	69	43.5	32.9	13.6	--	--	2534	--	--
Dyna-Gro	H49NS14CL	NS,CL	77	115	57	46.1	31.3	16.3	--	--	2456	--	--
Dyna-Gro	H50HO20CP	HO,CP	76	116	59	47.6	31.6	15.1	--	--	2533	--	--
Pioneer	P63HE920	HO,EX,DM	75	114	61	42.2	32.6	12.4	--	--	2618	--	--
RAGT	AC2101	HO,CP,DM	74	114	65	42.8	29.0	11.3	--	--	2483	--	--
RAGT	AC2201	HO,CL,DM	75	116	65	45.4	31.6	12.3	--	--	2795	--	--
Sunrich	4415	HO,CP,DM	74	115	62	43.0	28.5	11.0	--	--	2651	--	--
Sunrich	4425 CL	MO,CL,CON	74	111	67	40.4	30.4	8.6	--	--	2768	--	--
USDA	894[3]	Trad	73	114	56	45.0	31.4	10.0	2607	3062	2797	2930	2822
Mat Check	HoneyComb[4]	NS	64	101	53	40.9	30.6	7.8	2888	3089	2489	2787	2822
Mat Check	8N270[4]	NS,CL,DM	68	107	57	44.7	32.4	8.5	--	3085	2008	2546	--
Mat Check	559CL[4]	NS,CL,DM	76	115	67	46.7	30.2	9.3	--	3400	2637	3018	--
Trial Mean			74	114	61	44.5	30.9	11.5	2578	3281	2584		
C.V. %			0.8	0.9	2.3	2.0	2.3	10.1	15.2	11.5	9.3		
LSD 5%			0.6	1.1	1.5	1.0	0.7	1.3	637	617	256		
LSD 10%			0.8	1.3	1.9	1.2	0.8	1.5	533	516	307		

[1]Type: HO = High Oleic, NS = NuSun, Trad. = Traditional (linoleic), CL = Clearfield, CP = Clearfield Plus, EX = ExpressSun, DM = Downy Mildew Resistant, CONV = Conventional, CON = ConOil, MO = Mid-Oleic

[2]Days after planting

[3]Long-term hybrid check [4]Maturity check

Oil and yield were adjusted to 10% moisture.

Confection (non-oil) Sunflower, Langdon 2022

Brand	Hybrid	Hybrid Type[1]	Days to Flower (days)[3]	Days to Mature (days)[3]	Plant Height (in)	Test Weight (lbs/bu)	Harvest Moist. (%)	Seed over screen 22/64 (% over)	Seed over screen 20/64 (% over)	Seed over screen 18/64 (% over)	Yield (lb/a)
Nuseed	Panther DMR	Trad., DMR	67	114	61	24.8	10.7	27	63	83	2099
Sunrich	SS90	Trad.	70	115	59	26.5	10.6	0	23	68	2953
Sunrich	SS91	Trad.	74	118	65	25.6	15.9	55	84	93	2392
USDA	924[2]	Trad.	72	113	63	26.9	12.2	3	24	64	2690
Trial Mean			72	113	61	25.5	11.5	34	67	86	2533
C.V. %			1.7	1.2	4.3	3.1	7.8	18.7	8.6	5.1	7.5
LSD 5%			1.7	2.0	3.9	1.2	1.3	9.3	8.3	6.3	193
LSD 10%			1.4	1.7	3.2	1.0	1.1	7.7	6.8	5.3	159

[1]Type: Trad. - no herbicide tolerance trait, DMR - Downy Mildew Resistant

[2]Long term hybrid check.

[3]Days after planting

Yield adjusted to 10% moisture.

Soybean Response to Row Spacing and Planting Rate, 2022

NDSU Langdon Research Extension Center

Bryan Hanson, Lawrence Henry, Rick Duerr

A field trial was conducted at the NDSU Langdon Research Extension Center to examine the response of soybean to row spacing and planting rate in northeast North Dakota. Experimental design was a randomized complete block split plot (whole plots = row spacing, sub-plot = planting rate) with four replications. A RR2X 00.7 maturity variety was planted on May 27 on a conventionally tilled Svea-Barnes loam soil in 24, 12 and 6-inch rows with planting rates of 125,000, 150,000, 175,000 and 200,000 pure live seeds (PLS)/acre. Harvest date was October 11.

There was no significant row spacing by planting rate interactions among the agronomic traits examined. Plant stands were greatest at the 6-inch spacing and highest seeding rate. No meaningful differences were observed for protein, oil or test weight for row spacing or planting rates (Table 1 and 2). Yields were the greatest at the 6- and 12-inch row spacing and the 175,000 and 200,000 planting rates. No visual differences were observed in the trial for lodging or plant maturity.

Previous research on soybean response to planting rates and row spacings across North Dakota (NDSU Extension publication A1961, June 2020) indicated that in eastern North Dakota row spacing of 15 inches or less at a planting rate of about 170,000 PLS/a provided optimum yields. Drier soil conditions at planting in the 2021 study may have increased seedling mortality and resulted in no significant differences in yield among row spacings.

Table 1. Soybean response to row spacing averaged over planting rates.

Row Spacing	Plant Stand	PLSE[1]	Protein	Oil	Test Weight	2021 Yield	2022 Yield
inches	plt/a	%	%	%	lbs/bu	bu/a	bu/a
6	150,099	94	34.4	15.9	56.5	43.1	64.2
12	120,827	75	34.5	15.9	56.6	46.9	61.3
24	137,413	85	34.3	16.0	56.5	44.2	52.3
LSD 5%	8,476	7.4	NS	NS	NS	NS	4.7
C.V. %	10.9	12.4	0.8	1.1	0.6	8.6	6.7

[1]Pure live seed emergence

Table 2. Soybean response to planting rate averaged over row spacings.

Planting Rate	Plant Stand	PLSE[1]	Protein	Oil	Test Weight	2021 Yield	2022 Yield
pls/acre	plt/a	%	%	%	lbs/bu	bu/a	bu/a
125,000	110,385	88	34.3	15.9	56.7	42.9	56.7
150,000	123,116	81	34.3	16.0	56.7	44.6	57.8
175,000	145,546	83	34.5	15.9	56.6	43.9	61.6
200,000	165,403	86	34.5	15.9	56.3	47.6	61.3
LSD 5%	12,387	NS	0.2	NS	NS	3.2	3.3

[1]Pure live seed emergence

Management of Clubroot (*Plasmodiophora brassicae*) with Non-Traditional Products

Venkat Chapara and Amanda Arens

Objective: To determine the effect of non-traditional products alone and in combination to manage clubroot on canola.

Methods: The following non-traditional products (OR-079-B, OR 009-A, OR-369-A and OR-329-H) were tested alone and in combination in a randomized complete block design (RCBD) with six replications under field conditions. The field had a natural soil population of *P. brassicae* of 5.5 million resting spores/g of soil. Treatments of non-traditional products and the fungicide Ranman® were applied in-furrow as soil drenches just before planting at the rate listed in Figure 1. A susceptible canola cultivar to clubroot 'InVigor L233P' was planted at a depth of one-half inch. The trial was planted the first week of June and was evaluated in the first week of August (exactly 60 days after planting) at growth stage BBCH-65. The trial was hand harvested the last week of August and yield data was calculated in lbs/a at 13.5% moisture.

Rating scale: A 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) was used for disease rating of incidence and severity. A Clubroot Disease Severity Index (DSI) has been calculated using the incidence and severity data of clubroot obtained.

Soil sampling to determine pH and resting spores: Soil samples were collected from all of the plots before application of soil treatments and on the day of clubroot evaluations to determine the effect of unit change in pH and their impact on clubroot control. Also to determine the resting spore population per gram of soil in the assigned treatment area.

Figure 1: Means of the Clubroot disease variables that were tested and their effect on the yield observed in various treatments of non-traditional products.

		Clubroot		Resting	Yield
Treatment	**Rate**	**Incidence %**	**DSI %**	**spores (g/soil)**	**(lbs/A)**
Non-Treated	Check	58.5	62	183,083	906
OR-079-B	4 pts/a	59.67	60	781,083	647
OR-079-B + OR-329-H	4 pts/a	57.67	60	306,666	1212
OR 009-A	4 pts/a	65.17	66	544,083	1023
OR-369-A	4 pts/a	84.8	62	190,333	569
RANMAN	20 fl. oz/a	50.67	53.3	532,500	807
	Mean	**58**	**60.5**	**343,083**	**861**
	P-Value(0.05)	**NS**	**NS**	**NS**	**NS**

Results: Statistically no significant differences were observed among the treatments for clubroot disease incidence, severity, DSI, resting spores per gram of soil or yield. Likewise, there were no differences observed in the soil pH (data not shown) from samples collected before application of treatments to those collected 60 days after application.

Acknowledgments: Funding from ORO Agri and the Northern Canola Growers Association. Thanks to all the product suppliers. Special thanks to Interns Jacob Kram (NDSU), Parker Rime, Brock Freer, Larissa Jennings and Iverson Peltier.

Evaluate Commercial Cultivars of Canola to Monitor the Breakdown of Resistance to Clubroot

Venkat Chapara

Objective: To monitor the resistance potential of commercial canola cultivars against the mutant clubroot pathotype in field conditions.

Canola cultivars/varieties: Seven commercial canola cultivars having resistance to the clubroot pathogen were planted to monitor the level of resistance against the known mutant pathotype in the research ground (Table 1). The field had a natural soil population of *P. brassicae* of 140,625 resting spores/g of soil. The clubroot susceptible canola cultivars, InVigor L233P and CP9978TF were planted as the checks.

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: 10 ft. x 5 ft.

Table 1: Commonly cultivated canola cultivars/varieties in North Dakota.

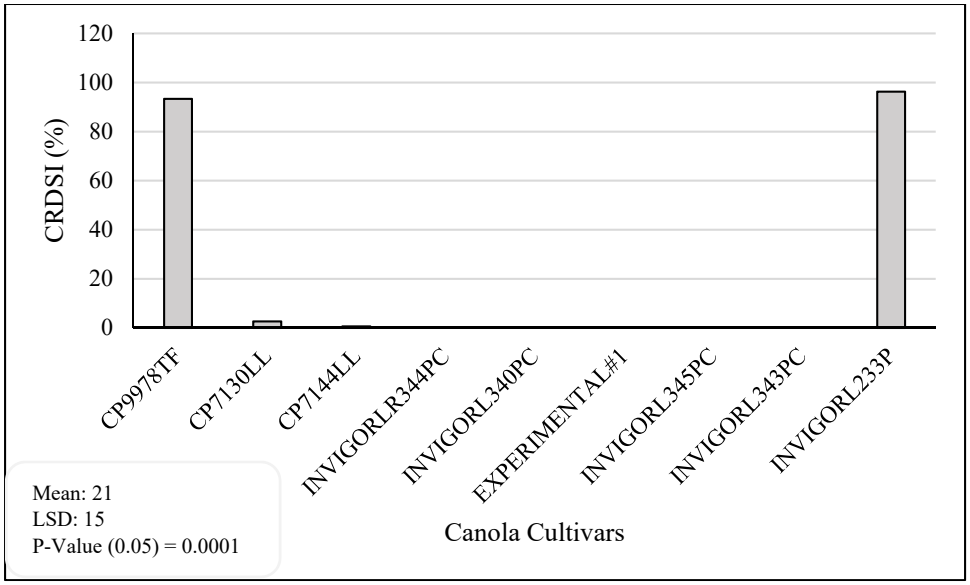
Cultivar	Description
CP9978TF	Croplan Genetics
CP7130LL	Croplan Genetics
CP7144LL	Croplan Genetics
InVigor LR344PC	BASF
InVigor L340PC	BASF
EXPERIMENTAL#1	BASF
InVigor L345PC	BASF
InVigor L343PC	BASF
InVigor L233PC	BASF

Clubroot Evaluated: Early August (60 days after planting).

Clubroot Disease Index (DSI):
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% disease index.

Figure 1: Mean clubroot disease index (%) recorded on various commercial cultivars of canola tested in 2022.



Results: Clubroot susceptible cultivars CP9978TF and InVigor L233P were used as reference checks to compare resistance levels. They showed 93 and 96 percent of DSI, respectively, indicating the validity of the trial. Canola cultivars CP7130LL, CP7144LL, InVigor LR344PC, InVigor L340PC, EXPERIMENTAL#1, InVigor L345PC, and InVigor L343PC showed resistance to clubroot and were significantly different from the susceptible cultivars tested.

Future research: Screening large numbers of commercial cultivars of canola will be helpful to growers. Monitoring clubroot resistance breakdown in commercially available resistant cultivars each year will be a crucial survey objective.

Canola Council of Canada's Monitoring Clubroot in Resistant Varieties

"***Growers using clubroot-resistant cultivars 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."

Ideal Recommendation: Practice longer crop rotations in clubroot endemic areas and use a clubroot resistant variety every three years minimum.

Acknowledgments: Funding from the Northern Canola Growers Association. Thanks to all the product suppliers. Special thanks to Interns Jacob Kram (NDSU), Parker Rime, Brock Freer, Larissa Jennings and Iverson Peltier.

Clubroot on Canola: Survey & Quantification of Resting Spores of *Plasmodiophora brassicae* from Field Collected Soil Samples in North Dakota

Principle Investigator: Venkat Chapara
Collaborators: Dante Marino, Ibukunoluwa Bankole, Amanda Arens, Travis J. Prochaska, Audrey Kalil, Jingwei Guo, Gongjun Shi, Zhaohui Liu, Luis del Rio, Kishore Chittem and Anitha Chirumamilla

Take Home Message: An ongoing clubroot survey for over six years in various counties of North Dakota indicates a threat to the canola crop if proper attention is not given towards longer crop rotations (one in three years). In addition, growers should consider growing an available clubroot resistant canola variety in endemic areas and following proper equipment sanitation. Cleaning equipment thoroughly after working in a clubroot infected field is highly recommended since the primary mechanism of spread between fields is the movement of infested soil on farm equipment.

Survey Procedure:

The survey involved three components: 1. visual survey, 2. soil sampling, and 3. molecular quantification of resting spores of the clubroot pathogen.

Components 1&2. Visual survey and soil sampling: A clubroot disease survey was conducted in fifty counties of North Dakota to determine prevalence of *Plasmodiophora brassicae*. The visual survey was done by inspecting canola crop roots. One field in every 5,000 acres was targeted for scouting in each county. Soil samples were collected from the visited fields to determine the pH of the soil and the number of resting spores per gram of soil. A minimum of three to ten fields per county were targeted for scouting.

The survey was done in two phases.

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

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

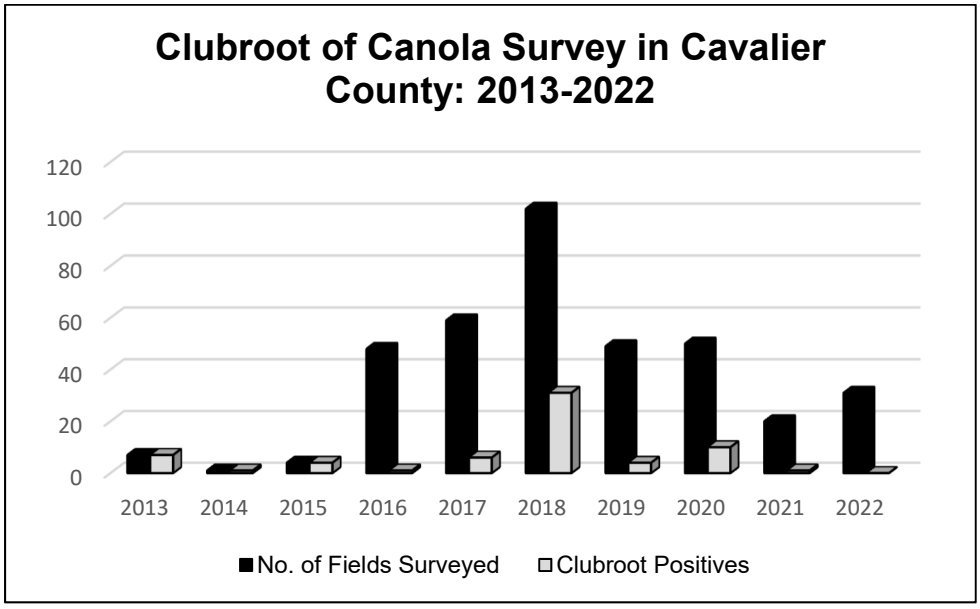
2nd phase: after swathing

Scouting at swathing was based on the methodology followed in Canada by the Alberta Agricultural and Rural Development (AARD) for their annual clubroot disease survey. Reports of AARD indicated that the probability of finding clubroot was higher if scouted at the field entrances. Hence, the survey was done starting from the main entrances/approaches in each field. The survey group walked in a "W" pattern stopping at five spots and uprooting ten consecutive stems from the ground at each spot. Each sampling point was separated by 100 meters or 328 feet. Roots of fifty stems were

evaluated for the presence of clubroot and incidence. After removing excess soil, roots were visually examined for the presence of galls. At sample sites where infection was observed or suspected, root specimens with galls, along with soil, were double bagged and labeled with the field location. Infected roots and soil samples from all the fields surveyed were collected and a representative sample was submitted to Dr. Zhaohui Liu's laboratory for molecular quantification of resting spores per gram of soil. An additional half-pound of soil was sent to the NDSU Soil Testing Laboratory for pH determination.

Results: During the two-year study of clubroot survey in North Dakota, only one field out of the fifty counties had canola roots with galls that were infused by clubroot pathogen (Figure 1). There is a declining trend in the number of clubroot infected canola fields since 2019. The decline in clubroot could be attributed to the change in crop production practices by the growers such as implementing longer rotations and the use of clubroot resistant cultivars.

Figure 1: Fields surveyed from 2013 to 2022 for prevalence of clubroot in Cavalier County, North Dakota.



Component 3. Molecular detection of soil samples to quantify *Plasmodiophora brassicae* (the clubroot pathogen) resting spores:

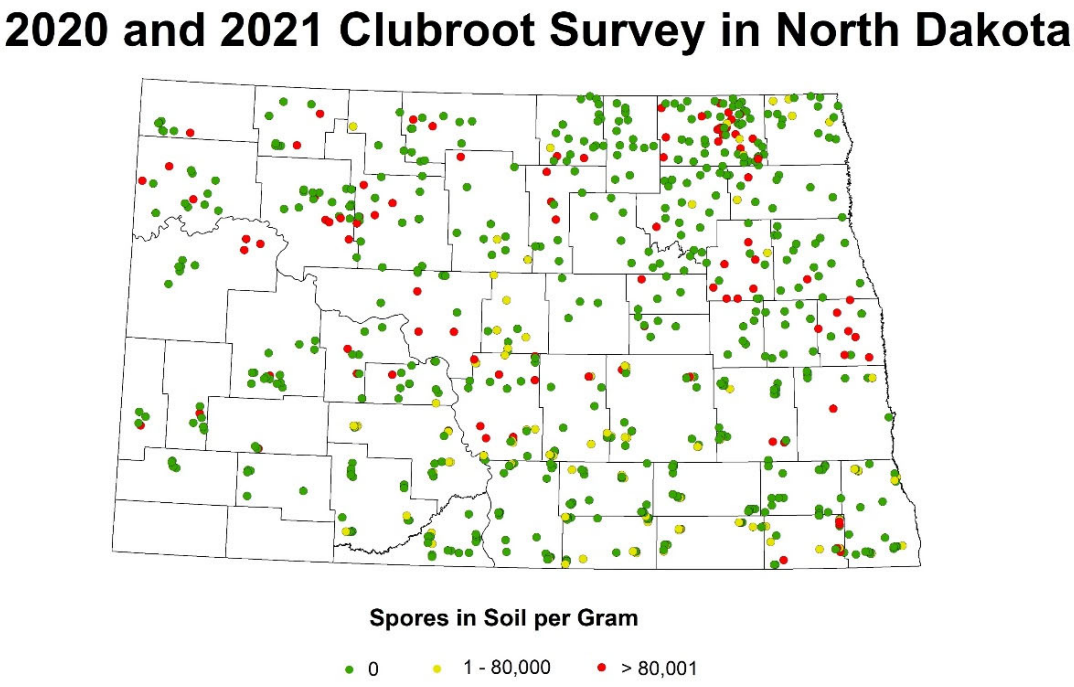
Over 500 samples were collected in fifty counties of North Dakota and were submitted for resting spore quantification and pH determination.

The main objective of this procedure is to quantify resting spores of the clubroot pathogen from the soil and to determine the pH of the soil. The information will be useful for growers to decide on the suitable crop for the rotation and to be aware of the infection levels of clubroot pathogen in their fields.

Results from molecular assays on soil samples: The molecular assays indicated that the clubroot pathogen resting spores have been found in 48 out of 50 counties (Figure 2) that were surveyed. Quantified resting spores of *P. brassicae* from those samples ranged from 500 to 40,000,000 spores per gram of soil (minimum detection limit of the assay being 10 resting spores/g of soil). Although there were no visible symptoms observed when the roots were uprooted in the surveyed fields, positives in the molecular soil quantification assay indicate either the resting spore population may not have reached required spores per gram of soil in acidic soils to show galls or the pH of the soil is basic (Figure 3). In general, clubroot infections are expressed on canola plants where soil resting spore population totals about 80,000 spores per gram of soil (Canadian Research). These results indicate that there is a need for continuous annual monitoring of clubroot spread in North Dakota.

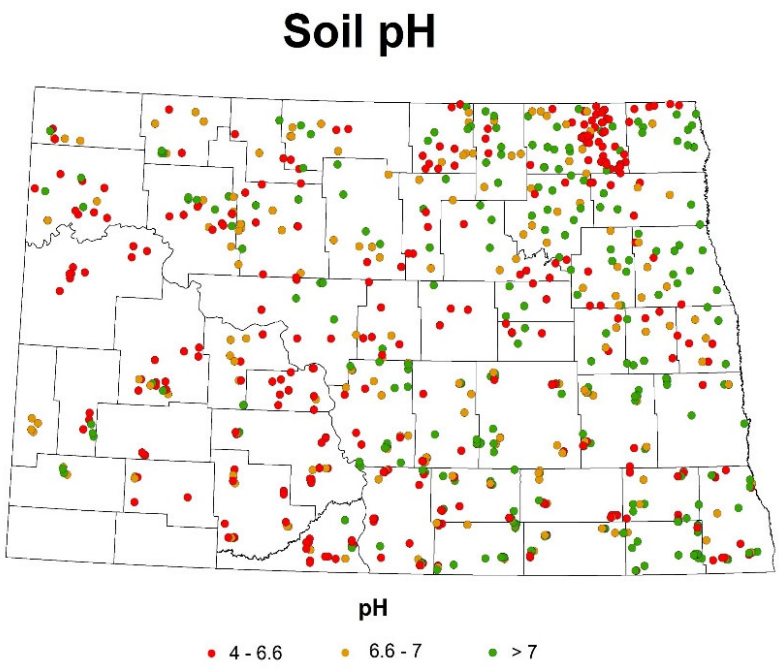
Notice: Growers who are curious about the presence of clubroot/resting spores in their field(s) are encouraged to contact Dr. Venkat Chapara at the Langdon REC (701-256-2582), NDSU Cavalier County Extension Office (701-256-2560), or NDSU Extension (701-231-8363).

Figure 2: Map of counties in North Dakota indicating the presence and the number of *Plasmodiophora brassicae* (the clubroot pathogen) resting spores (detected by molecular assays) in the soil.



Note: The green dot indicates zero, yellow dot indicates range of 1-80,000 and the red dot indicates more than 80,000 resting spores per gram of soil.

Figure 3: Map of counties in North Dakota indicating pH ranges detected by soil assays in the soil samples during the two-year survey.



Acknowledgments: Funding from the Northern Canola Growers Association and the Northern canola research program (USDA). Thanks to all the product suppliers and the NDSU Soil Testing Lab. Special thanks to Dr. Knodel, and Dr. Honggang, and interns Jacob Kram (NDSU), Parker Rime, Brock Freer, Larissa Jennings and Iverson Peltier.

Evaluation of Fungicides to Manage White Mold in Canola

Venkat Chapara and Amanda Arens

A research trial was conducted at the Langdon Research Extension Center with an objective to evaluate the performance of fungicides to manage white mold in canola. The trial was planted on May 27, 2022 with the Roundup Ready canola variety 'DKL DKTFLL21SC' in a randomized complete block design replicated four times. The trial followed state recommended practices for land preparation, fertilization, seeding rate and weed control. The plot size was 5 ft. wide x 16 ft. long with a canola border on either side 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. Fungicides were applied at 20% bloom using a CO_2-pressurized backpack style sprayer with a three-nozzle boom (XR-8002) at 20 GPA. 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 25) 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 = main stem girdled but plant produced good seed; 5 = main stem girdled, much reduced yield. A white mold mean disease severity index (MDS) was calculated with weighted mean of incidence and the 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	**(fl oz/A)**	**Incidence (%)**	**MDS (0-5)**	**(lbs/A)**	**(lbs/bu)**
Non-treated	Check	20	0.71	2057	52
Miravis NEO	13.7+.125	17	0.57	2261	52
Proline 480 SC	5.7+.125	10	0.25	2387	52
Priaxor	4+.125	11	0.5	2488	52
Experimental 1	0.315 l/ha+.125v/v	20	0.86	2365	53
Experimental 2	0.315 l/ha+.125v/v	8	0.34	2459	52
Experimental 3	0.315 l/ha	16	0.76	2314	52
	Mean	14	0.6	2333	52
	CV (%)	53	73	13	0.5
	LSD	NS	NS	NS	NS
	P-Value (0.05)	NS	NS	NS	NS

Non-Ionic Surfactant (NIS) was added to all the fungicide treatments @ 0.125 v/v except for Experimental 3.
NS: Statistically non-significant

Results: There were no significant differences in white mold incidence, mean disease severity, test weight and yield observed among the fungicides tested and the non-treated check (p-value non-significant).

Acknowledgements: Funding from LAB Sciences and the Northern Canola Growers Association. Special thanks to Interns Jacob Kram (NDSU), Parker Rime, Brock Freer, Larissa Jennings and Iverson Peltier.

Evaluation of Various Fungicide Treatments on
Two Cultivars of Barley to Manage Fusarium Head Blight

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 barley.

Methods:

Location: NDSU Langdon Research Extension Center

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

Previous crop: Canola

Cultivars of barley tested: ND Genesis (moderately susceptible/susceptible, released by NDSU) and AAC Synergy (moderately resistant, Syngenta)

Planting: 1.25 million pure live seeds/acre planted on May 25, 2022. 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 Bold @15 fl oz/A and Huskie FX @18 fl oz/A were applied on 6/17/2022.

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

Disease development: Supplemental moisture was provided for a month starting from boot to soft dough stage 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 treatments of Miravis Ace, Prosaro, Prosaro Pro, and Sphaerex were applied at full head emergence stage on July 13 and a treatment of Sphaerex was sprayed 5 days after the full head emergence (July 18) as per protocol requirements. Refer to Table 2 for the treatments, rates and application timings.

Disease assessment: FHB incidence and severity was obtained on fifty random heads showing FHB symptoms excluding two outer rows. FHB head severity was rated using 0-100% scale. FHB index (Index) was calculated using the formula: Index = (SEV*INC)/100.

Harvest: Plots were harvested on August 30 with a small plot combine and the yield was determined at 13.5% moisture.

Data analysis: Statistical analysis was done using GLM in Agrobase Generation II software. Fisher's least significant difference (LSD) was used to compare means at p ($\alpha = 0.05$).

Results: Among the two barley cultivars statistically significant differences were found among the variables of FHB incidence, severity, index and test weight (Table 1). Likewise, there were significant differences in FHB incidence, severity, index, DON, and test weight between non-treated check and the fungicide treatments tested (Table 2). There was a significant interaction effect found between the main plot (cultivars) and the subplot (fungicide) treatments in terms of FHB Index.

Table 1: Mean values of the variables tested on the barley cultivars ND Genesis and AAC Synergy obtained on application of fungicide treatments.

	Fusarium Head Blight				Yield	Test Weight	Plump
Cultivars	**Incidence (%)**	**Severity (%)**	**Index**	**DON (ppm)**	**(bu/A)**	**(lbs/bu)**	**(%)**
ND Genesis	27	7	3.37	0.2	74	46	93
AAC Synergy	19	4	1.43	0.3	72	47	93
Mean	23	6	2.4	0.3	82	46	93
CV (%)	42	64	74	97	9	2	3
LSD	4.7	3	1.5	NS	NS	0.4	NS
P-Value (0.05)	0.0047*	0.017*	0.0006*	NS	NS	0.00001*	NS

NS: Indicates the variables are statistically non-significant between the cultivars tested.

Table 2: Mean values of the variables tested on application of various fungicide treatments applied at different timings on two barley cultivars.

			Fusarium Head Blight						
	Application-	**Rate**	**Incidence**	**Severity**	**INDEX**	**DON**	**Yield**	**Test Weight**	**Plump**
Treatments	**timings**	**(fl.oz/a)**	**(%)**	**(%)**	**(0-100)**	**(ppm)**	**(bu/A)**	**(lbs/bu)**	**(%)**
Non-Treated	Check	CHK	55	17	10	0.93	80	46	94
Prosaro	Feekes 10.5 (full-head)	7.3	16	3	0.5	0.16	84	46	93
Miravis Ace	Feekes 10.5 (full-head)	13.5	13	2	0.4	0.1	86	47	95
Prosaro Pro	Feekes 10.5 (full-head)	13.7	18	5	1.4	0.2	82	46	94
Sphaerex	Feekes 10.5 (full-head)	7.3	18	3	0.9	0.19	78	46	92
Sphaerex	4-6 days after Feekes 10.5	7.3	16	4	0.8	0.05	82	46	92
	Mean		23	6	2	1.9	82	46	93
	CV%		42	65	74	97.5	9	1.7	3
	LSD		11	3	2	0.3	NS	0.7	NS
	P-Value (0.05)		0.00001*	0.0001*	0.0001*	0.00001*	NS	0.0026*	NS

* Indicates treatments are statistically significant.
Note: All treatments were applied with non-ionic surfactant (NIS) @ 0.125 v/v.

Acknowledgements: Funding from US Wheat and Barley Scab Initiative. Special thanks to Interns Jacob Kram (NDSU), Parker Rime, Brock Freer, Larissa Jennings and Iverson Peltier.

Management of Bacterial Blight in Field Pea Using Pesticide Compounds

Venkat Chapara and Amanda Arens

A research trial was conducted at the Langdon Research Extension Center with an objective to evaluate the performance of pesticide compounds to manage bacterial blight (BB) on field pea. The trial was planted on May 18, 2022 with the field pea variety 'Salamanca' in a randomized complete block design replicated four times. The trial followed state recommended practices for land preparation, fertilization, seeding rate, and weed control. The plot size was 5 ft. wide x 16 ft. long with a field pea border on either side of each plot. Pesticide compounds were applied at the Vn stage (nth true leaf unfolded at nth node with tendril present) using a CO_2-pressurized backpack style sprayer with a three-nozzle boom (XR-8002) at 20 GPA. Prevailing weather conditions were dry during the crop growth period so the second spray at R-stage was not applied. The amount of BB infection obtained in the research plots was based on natural infections. A rating scale of 0 – 9 was adopted from Chaudhary 1996, where the severity of BB in a plot was recorded as the percentage of tissue area infected out of total leaf area examined. Fifty leaves from each plot were sampled and measured for the average percentage of lesion area. The rating scale was 0 = 0, 1 = >1-10 %, 3 = >11-30 %, 5 = >31-50 %, 7 = >51-75 %, and 9 = >76-100 %.

A Disease Index (DI) was calculated based on severity ratings using the formula:

$$DI = \frac{n(1) + n(3) + n(5) + n(7) + n(9)}{tn}$$

Where: n (1), n (3), n (5), n (7) and n (9) = Number of leaves showing severity score of 1, 3, 5, 7 and 9. tn = total number of leaves scored.

Results: Favorable weather during the major part of the growth stages was congenial for bacterial blight incidence on field pea (Figure 1). There were no significant differences in the bacterial blight index (average ranged from 19 to 35%) on foliage, yield (at 13.5% moisture), and test weight (Table 1) among the pesticide compounds tested and on comparison to the non-treated check (p-value non-significant).

Figure 1: High levels of bacterial blight infections were observed on field pea plants.

Table 1: Efficacy of pesticide compounds in managing bacterial blight of field pea and their influence on yield and test weight.

		Bacterial Blight			Yield	Test Weight
Treatments	**Rate**	**Incidence (%)**	**Severity (%)**	**INDEX**	**(bu/A)**	**(lbs/bu)**
Kocide (Copper Hydroxide)	3-6 lbs/a	45	51	25	61	64
Copper Sulfate	3-6 lbs/a	47	47	23	55	65
Guarda	3.3 lts/A	43	55	26	65	64
Zinc Oxide	400 mg	43	49	23	54	64
Zinx Oxide	800 mg	49	70	35	62	64
Surround WP	½ lb/gallon of water	48	64	31	57	65
Resozurin Sodium Salt	10 mg/a	46	58	28	55	64
Kanamycin	50 µg/ml	50	62	31	58	65
Streptomycin sulfate	3-6 lbs/a	47	62	30	60	64
Oxidate	1% V/V	50	40	19	53	64
Non-treated Check	CHK	50	67	34	62	64
Mean		**46**	**57**	**28**	**58**	**64**
P-Value (0.05)		**NS**	**NS**	**NS**	**NS**	**NS**

* DI = Disease Index
NS: Non-significant

Reference: Chaudhary, R. C. 1996. Internationalization of elite germplasm for farmers: Collaborative mechanisms to enhance evaluation of rice genetic resources. Paper presented in: MAFF, International workshop on genetic resources held in Fukuyi, Japan Oct. 22-24, 1996; pp. 221. The 4th MAFF International Workshop on Genetic Resources: Characterization and Evaluation - New Approach for Improved Use of Plant Genetic Resources (affrc.go.jp)

Acknowledgements: Funding from North Dakota Product Harmonization Board and National Pulse Growers Association. Special thanks to Interns Jacob Kram (NDSU), Parker Rime, Brock Freer, Larissa Jennings and Iverson Peltier.

Efficacy of Fungicides at Different Application Timings to Manage Fusarium Head Blight in Hard Red Spring Wheat

Venkat Chapara, Amanda Arens and Andrew Friskop

Objective: To evaluate the efficacy of fungicides at different application timings to manage Fusarium head blight (FHB) in Hard Red Spring Wheat (HRSW).

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/acre planted on May 26, 2022. 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: Wide Match (1.33 pt/a) + Axial Bold (15 fl oz/a) + 2, 4-D Amine (1 pt/a) applied on June 17, 2022.

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

Disease development: Supplemental moisture was provided by running overhead irrigation from boot to soft dough stage 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 water volume at 20 GPA. Fungicides Prosaro, Caramba, Miravis Ace, Prosaro Pro, and Sphaerex were applied at 10% flowering (anthesis or 10.5.1 stage) on July 15 and five days after anthesis sprays were completed on July 20. Refer to Table 1 for the treatments, rates and application timings.

Disease assessment: FHB incidence was obtained on fifty random heads showing FHB symptoms at hard dough stage (8/5/2022). FHB head severity was rated using 0 -100% scale on fifty random heads, excluding two outer rows. FHB index (Index) was calculated using formula: Index = (SEV*INC)/100.

Harvest: Plots were harvested on September 15 with a small plot combine and the yield was determined at 13.5% moisture.

Data analysis: Statistical analysis was done using Agrobase Generation II software. Fisher's least significant difference (LSD) was used to compare means at p ($\alpha = 0.05$).

Results: There were significant differences found between the non-treated check and the fungicide treatments that were applied at different timings among the variables tested. Moreover, there were significant differences found among the application timings in the yield obtained among the fungicide treatments. Treatments that received sprays at the crop stage of early anthesis and four to six days after early anthesis had higher yields in comparison to that of non-treated check and fungicides applied only at early anthesis (Feekes 10.5.1) (Table 1).

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

	Application Details		FHB				Yield	Test Wt.
Treatments	Timing	Rate (Fl. Oz/A)	Incidence %	Severity %	Index	DON (ppm)	(bu/A)	(lbs/bu)
Non-treated Check	Check	...	42	11.5	5.32	2.85	57	56
Prosaro	Feekes 10.5.1 (early anthesis)	6.5	10	2.0	0.23	1.5	59	57
Caramba	Feekes 10.5.1 (early anthesis)	13.5	6	1.7	0.09	1.18	60	57
Miravis Ace	Feekes 10.5.1 (early anthesis)	13.7	6	0.8	0.04	0.9	66	58
Prosaro Pro	Feekes 10.5.1 (early anthesis)	10.3	6	1.6	0.16	0.98	63	58
Sphaerex	Feekes 10.5.1 (early anthesis)	7.3	9	1.3	0.16	0.93	60	57
Miravis Ace fb Prosaro Pro	Early anthesis fb 4-6 days after early anthesis	13.7/10.3	3	0.4	0.01	0.2	68	59
Miravis Ace fb Sphaerex	Early anthesis fb 4-6 days after early anthesis	13.7/7.3	2	0.5	0.03	0.25	70	59
Miravis Ace fb Tebuconazole	Early anthesis fb 4-6 days after early anthesis	13.7/4	6	0.8	0.05	0.68	68	59
Sphaerex	4-6 days after early anthesis	7.3	11	1.9	0.23	0.43	72	59
	Mean		**10**	**2**	**0.63**	**0.99**	**64**	**58**
	LSD		**10**	**3**	**1.7**	**0.95**	**6**	**2**
	P-Value (0.05)		**0.00001***	**0.0001***	**0.0001***	**0.0002***	**0.0001***	**0.003***
**fb: followed by								

***** Indicates treatments are statistically significant.

Note: All treatments were applied with non-ionic surfactant (NIS) @ 0.125 v/v.

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Sudden Death Syndrome on Soybeans in Cavalier County!!

Anitha Chirumamilla and Venkat Chapara

Sudden Death Syndrome (SDS) is one of the leading soybean diseases that is known to cause yield-losses in North America. The disease is caused by the soil borne fungus *Fusarium virguliforme*. SDS was identified in Richland County ND a few years ago. However, the first report of SDS was confirmed in Cavalier County in 2020. Severe SDS can result in yield losses greater than 50 percent.

Symptoms:

Foliar

SDS fungus primarily attacks the roots and releases fungal toxins into the plant system that later reach the above ground parts of the plant. Symptoms on leaves usually appear during late vegetative to flowering and pod development stages of the crop. Leaf symptoms first appear as pale green to yellow spots in between the veins. As the disease progresses, the area between veins turn bright yellow (Fig. 2A&B) and eventually dead/brown with green veins (Fig. 2C). The leaves will detach from the petiole and fall leaving the petioles attached to the stem. In severe infestation, flowers and pods may abort or not fill.

Root

SDS causes root discoloration along with root and crown rot. Diseased plants pull out of the ground easily because of decayed roots. Also, when split lengthwise, the internal tissue will be gray to reddish brown. A blue mold may appear on the outer surface of the roots in advanced stages and during wet conditions.

Figure 1: Soybean field infested with SDS in Cavalier County.
Photo: A. Chirumamilla, NDSU

Figure 2: SDS foliar symptoms: 2A. Pale green to yellow spots in between veins; 2B. Bright yellow spots and green veins; 2C. Dead/brown spots with green veins.
Photos: A. Chirumamilla, NDSU

Figure 3: Dr. Chapara checking for SDS symptoms on soybean roots.
Photo: A. Chirumamilla, NDSU

Similarities with Brown Stem Rot
The foliar symptoms of SDS can be confused with Brown Stem Rot (BSR) as they are very similar. The best way to differentiate is to split the stem of an infected plant and check the color of the pith. The pith stays white in SDS, whereas, it turns brown in a case of BSR.

Figure 4. Brown pith of the stem indicating brown stem rot in soybeans.
Photos: A. Chirumamilla, NDSU

Association with Soybean Cyst Nematode:
There is a high degree of association between the presence of Soybean Cyst Nematode (SCN) in a field and SDS development. If the field is confirmed with SDS it is always beneficial to test for the presence of SCN.

Management:

1. The most important tactic is to plant SDS resistant soybean varieties.
2. Considering the association of SDS with SCN, varieties should also be resistant to SCN.
3. Practice crop rotation with non-host crops such as wheat and canola.
4. Plant into warm soils and reduce excessive soil moisture with drainage.

(Source: Sudden death syndrome on soybeans-University of Minnesota Extension; and Soybean Diseases- Soybean research and information network)

SALT AND SODICITY TOLERANCE OF BARLEY, OAT AND CANOLA

Naeem Kalwar (Extension Soil Health Specialist)
Bryan Hanson (Research Agronomist)
Lawrence Henry (Research Specialist II/Agronomy)
Richard Duerr (Research Specialist/Agronomy)
David Franzen (Extension Soil Specialist)

Barley and oats are some of the most salt and sodicity tolerant annual crops producers can profitably grow in North Dakota. However, at certain salinity and sodicity levels, even barley and oats can result in significant losses. Especially important are the levels of salinity and sodicity in the top six inches of the soils. Sensing the need to determine the economic threshold of soil salinity (Electrical Conductivity or EC) and sodicity (Sodium Adsorption Ratio or SAR) for barley and oats, four barley and four oat varieties were planted at the Langdon REC site in 2022 at three different levels of salinity and sodicity. This trial was a repeat of 2020 and 2021 trials. In addition, four canola varieties were added to the trial in 2022 to compare salinity and sodicity tolerances of the canola crop versus barley and oats.

Soil Analysis Results

Two-foot deep composite soil samples separated into 0-6 and 6-24 inch depths were taken on June 9, 2022 by taking three cores for each sample. The three levels of salinity and sodicity were described as replications 1, 2 and 3 and were sampled separately. Replication 1 was described as having low to moderate levels of salinity and sodicity, replication 2 having moderate to high levels and replication 3 having very high levels. These descriptions were based on the salinity and sodicity tolerance of crops like barley and oats. These levels would be considered high for sensitive crops such as soybean. Soil EC, SAR and pH were analyzed by using the saturated paste extract method (Table 1).

Table 1. The 2020, 2021 and 2022 soil EC, SAR and pH results of the three replications for the 0-6 and 6-24 inch depths.

			EC (dS/m)	EC (dS/m)	EC (dS/m)	SAR	SAR	SAR	pH	pH	pH
Site	**Sample ID**	**Depth (inches)**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**	**2020**	**2021**	**2022**
Rep 1	Low to moderate salinity-sodicity	0-6	3.99	4.63	1.64	7.12	6.20	4.95	7.18	7.54	7.40
		6-24	7.32	7.49	6.70	15.05	14.72	15.50	7.71	7.97	7.80
Rep 2	Moderate to high salinity-sodicity	0-6	7.80	13.20	7.92	18.13	22.88	16.28	7.61	8.17	7.80
		6-24	10.39	12.29	11.03	20.92	21.14	39.54	7.95	8.21	8.00
Rep 3	Very high salinity-sodicity	0-6	10.50	14.90	11.21	27.30	32.74	30.00	7.59	8.14	7.80
		6-24	9.86	12.98	11.10	32.87	32.04	31.83	7.81	8.16	8.00

The main difference in salinity and sodicity levels between the three replications has been the 0-6 inch depth of replication 1 had low to moderate levels, whereas, replication 2 and 3 have had moderate to high levels in 0-6 and 6-24 inch depths. In addition, 6-24 inch depth of replication 1 had moderate to high salinity and sodicity levels. The lower salinity and sodicity levels in replication 1, 0-6 inch depth and corresponding germination, stands, yields and quality in 2020-2022 indicate the levels of salinity and sodicity in the surface layers matter more than the subsurface layers.

Annual snowfall, resulting spring-melt and rainfall in spring and early growing-season also had an impact on salinity and sodicity, especially in the 0-6 inch depths. Weather wise, 2020 was a normal year, 2021 was very dry (spring and early growing-season) and 2022 was very wet (spring and early growing-season). Dry weather in 2021 resulted in a slight increase in EC, whereas, wet weather lowered EC levels in 2022, especially in replication 1, 0-6 inch depth. Lower EC levels combined with high moisture availability in 2022 spring and early growing-season resulted in improved germination, stands and higher yields even at higher salinity and sodicity levels compared to 2020 and 2021.

Trial Design, Plot Sizes, Planting and Harvesting Details

Trial design was randomized split block and plot sizes were 4.7 X 22 feet. Details are in Table 2.

Table 2. 2022 barley, oat and canola varieties, planting dates, seeding rates and fertilizer rates per acre, planting depths, and harvest dates.

Crop	Variety	Planting Date	Seeding Rates (live seeds/acre)	Seeding Depth (inches)	Fertilizer Application (lbs./acre)	Harvest Date
2022 Planting Details						
Barley	AAC Synergy (2-row)	June 10, 2022	1.0 million live seeds per acre	1 to 1.5	Due to a very short growing-season and inability to soil sample early, a uniform rate of 120 pounds of nitrogen and 30 pounds of P2O5 was applied to all three replications the morning of June 10, 2022 by using Urea and MAP.	Straight combined on September 14, 2022 (desiccated on September 8, 2022)
	ND Genesis (2-row)					
	Lacey (6-row)		1.25 million live seeds per acre			
	Tradition (6-row)					
Oats	CS Camden		1.0 million live seeds per acre			
	ND Heart					
	Rockford					
	Souris					
Canola	L345PC		0.4356 million live seeds per acre (10 seeds per square foot)			Straight combined on September 22, 2022 (desiccated on September 14, 2022)
	L340PC					
	DKTFLL21SC					
	LR344PC					

Results and Discussion

Similar to 2020 and 2021, there were differences between the three replications in seedbed, germination, plant growth and vigor, maturity, yield, and quality.

Differences in Seedbed

In 2022 the seedbed turned rough and cloddy with the increase in soil sodicity (replication 2 and 3). This effect was slightly less in 2022 compared to 2021 and 2020. That could be due to the annual tillage that was performed in 2020-2022. See seedbed pictures 1-3 below for comparisons.

Pictures 1-3: Differences in seedbed between replication 1 (low to moderate salinity-sodicity), 2 (moderate to high salinity-sodicity) and 3 (very high salinity-sodicity) on June 9, 2022.

Differences in Germination

Due to the high availability of soil moisture in 2022 spring and early growing-season, the delay in germination between replication 1 versus 2 and 3 was significantly less. In 2020 and 2021, germination in replications 2 and 3 was 8 to 9 days and 22 to 29 days respectively delayed compared to replication 1. However, due to the higher moisture levels and warmer soil temperatures in 2022, germination in replications 2 and 3 was only 2 to 6 days behind replication 1. There were some differences in crops as well. Barley and oats germinated around 6 days earlier than canola. In terms of early growth, barley established slightly earlier than oats, however, oats caught up quickly. Canola took 6 to 8 days longer.

Differences in Growth, Vigor, Stands and Maturity

Similar to germination, barley and oat growth, vigor and stands looked much better in replication 2 and 3 in 2022, which was not the case in 2020 and 2021. That indicates moderate to decent stands and yields can be achieved at high salinity and sodicity levels if soil moisture availability is high (resulting in less competition between water-soluble salts and plant roots for water), which may not be the case at low moisture levels.

Crop maturity was not uniform and was delayed with the increase in salinity and sodicity. When combined, replication 1 was fully mature with no green at all, replication 2 had some green and replication 3 had a lot of green. See pictures 4 to 6 below of replication 1, 2 and 3 to compare the differences in growth and vigor of barley, oat and durum plots.

Picture 4. Canola (left), barley (middle) and oat (right) varieties growing in replication 1 on August 1, 2022.

Picture 5. Two canola (left) and all four barley (middle) and oat (right) varieties growing in replication 2 on August 1, 2022.

Picture 6. No canola (left), all four barley (middle) and oat (right) varieties growing in replication 3 on August 1, 2022.

Differences in Yield and Quality

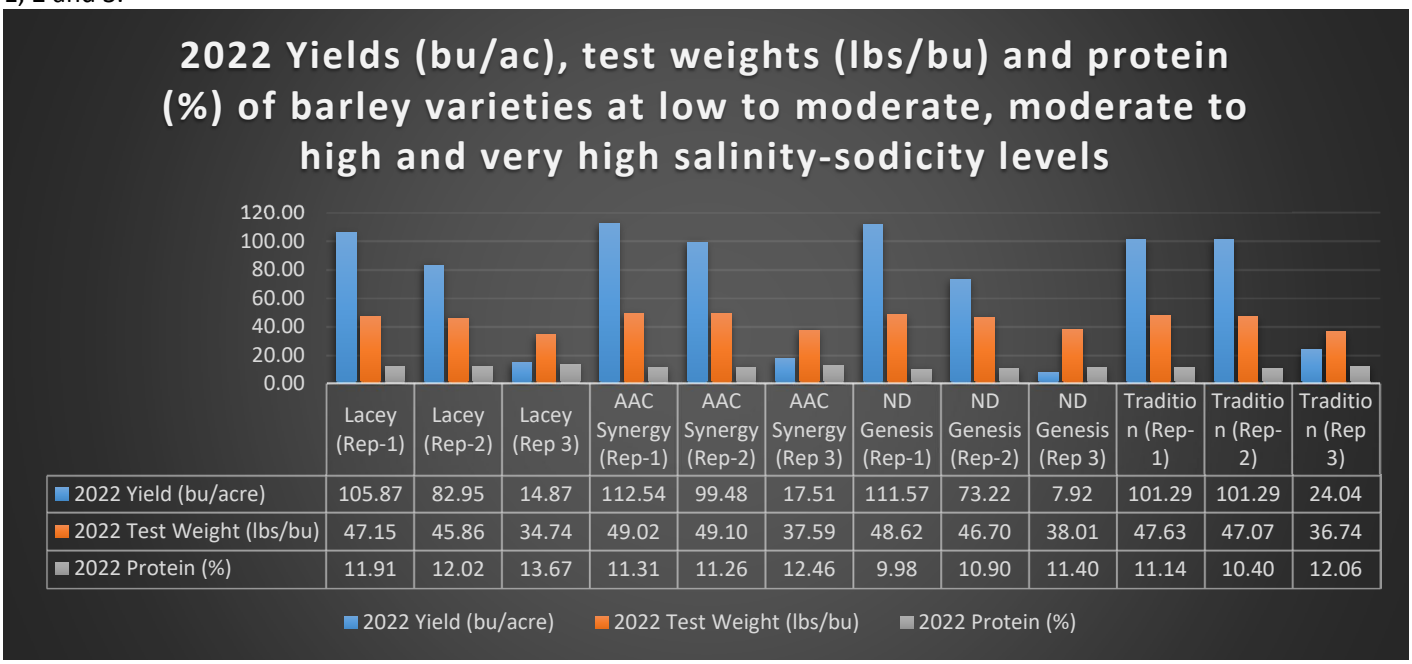
Barley

In 2022, all four barley varieties produced highest yields in replications 1 and 2 compared to 2020 and 2021. In addition, first time in three years, all barley varieties produced some yields in replication 3. In 2020 and 2021, replication 2 yielded 74% and 65% respectively less than replication 1. In 2022 the decrease in yield in replication 2 versus replication 1 ranged between 11-34%. Replication 3 yields ranged between 7.92 to 24.04 bushels per acre in 2022. In 2020 and 2021, replication 3 was a net loss.

The decreased yield gap between replication 1 and 2 and replication 3 produced modest yields despite the increase in salinity and sodicity, can be attributed to the high soil moisture availability during 2022 spring and early growing-season. In addition, Tradition (six-row) again produced highest yields at increased salinity and sodicity levels (replication 2 and 3).

Protein increased in all barley varieties with the increase in salinity and sodicity, whereas, test weight (lbs. per bushel) mostly decreased when salinity and sodicity levels increased. Details are in Figure 1.

Figure 1. 2022 yields (bushels/acre), test weights (lbs./bushel) and protein (%) of the four barley varieties for replications 1, 2 and 3.

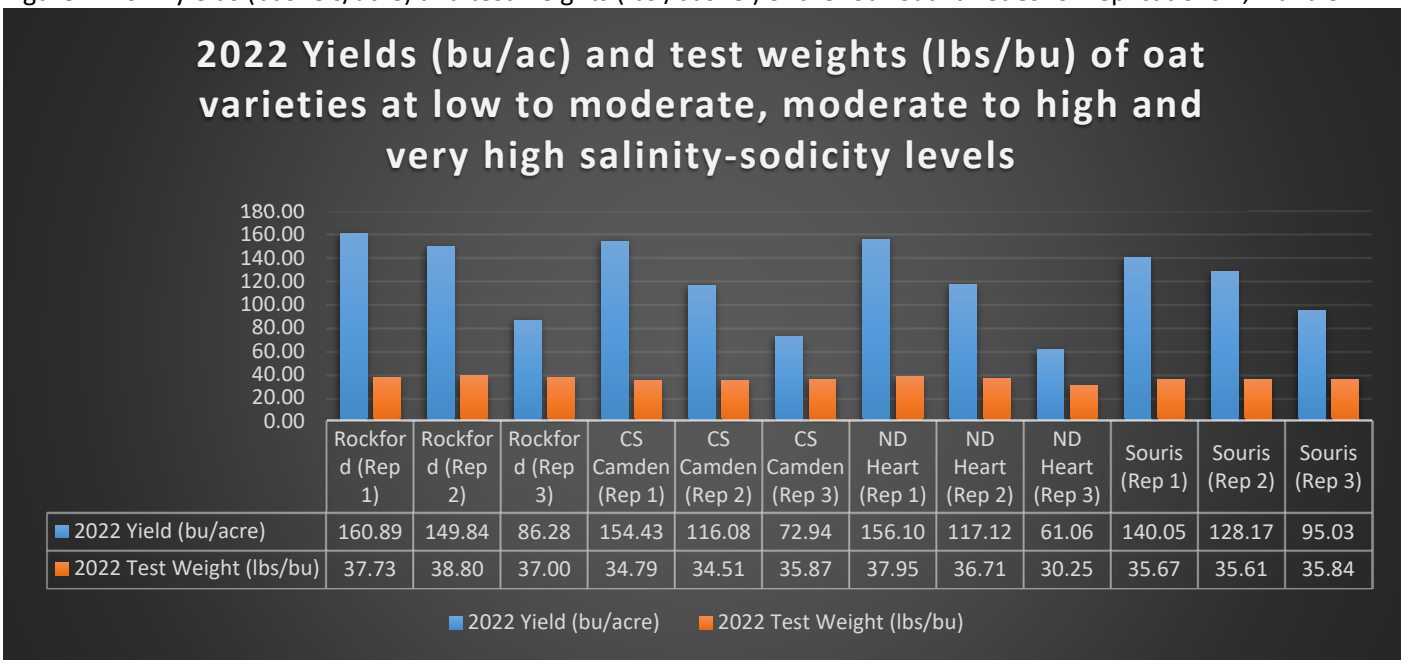


	Lacey (Rep-1)	Lacey (Rep-2)	Lacey (Rep 3)	AAC Synergy (Rep-1)	AAC Synergy (Rep-2)	AAC Synergy (Rep 3)	ND Genesis (Rep-1)	ND Genesis (Rep-2)	ND Genesis (Rep 3)	Tradition (Rep-1)	Tradition (Rep-2)	Tradition (Rep 3)
2022 Yield (bu/acre)	105.87	82.95	14.87	112.54	99.48	17.51	111.57	73.22	7.92	101.29	101.29	24.04
2022 Test Weight (lbs/bu)	47.15	45.86	34.74	49.02	49.10	37.59	48.62	46.70	38.01	47.63	47.07	36.74
2022 Protein (%)	11.91	12.02	13.67	11.31	11.26	12.46	9.98	10.90	11.40	11.14	10.40	12.06

Oats

All four oat varieties produced the best yields in 2022, as did barley.

Figure 2. 2022 yields (bushels/acre) and test weights (lbs./bushel) of the four oat varieties for replications 1, 2 and 3.



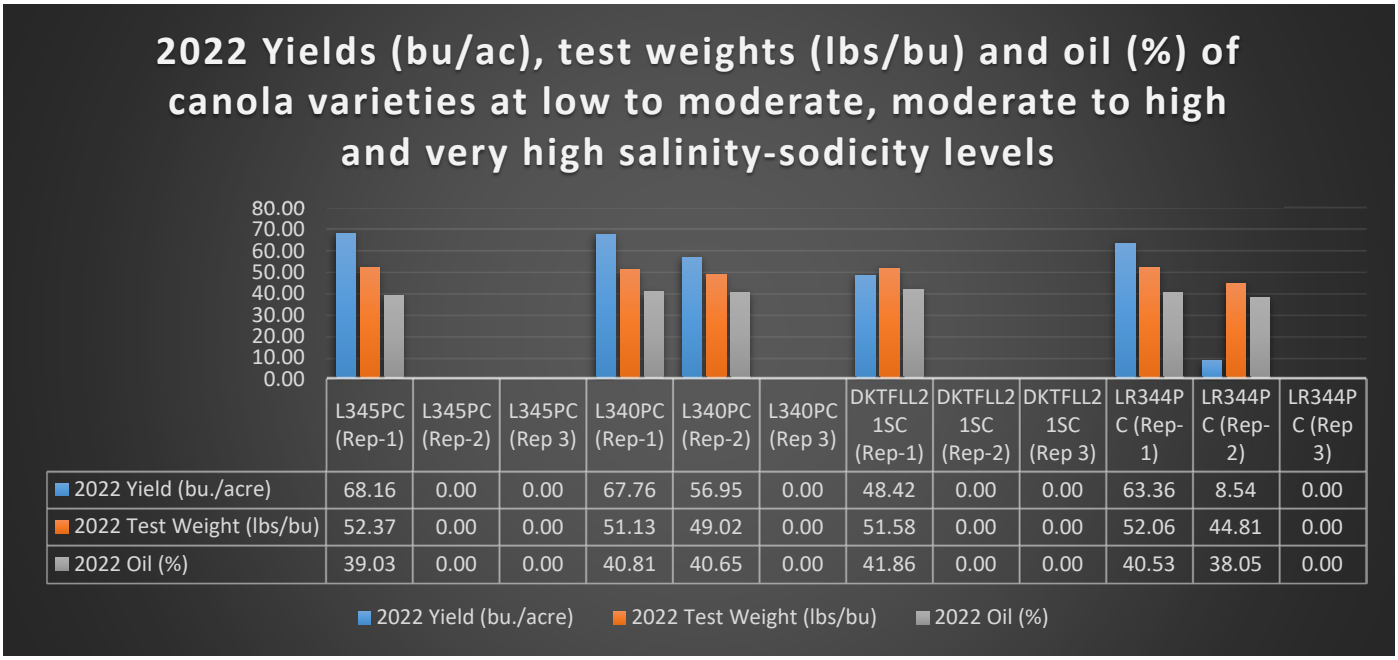
	Rockford (Rep 1)	Rockford (Rep 2)	Rockford (Rep 3)	CS Camden (Rep 1)	CS Camden (Rep 2)	CS Camden (Rep 3)	ND Heart (Rep 1)	ND Heart (Rep 2)	ND Heart (Rep 3)	Souris (Rep 1)	Souris (Rep 2)	Souris (Rep 3)
2022 Yield (bu/acre)	160.89	149.84	86.28	154.43	116.08	72.94	156.10	117.12	61.06	140.05	128.17	95.03
2022 Test Weight (lbs/bu)	37.73	38.80	37.00	34.79	34.51	35.87	37.95	36.71	30.25	35.67	35.61	35.84

The yield gap between replication 2 in 2022 ranged between 8 to 25 percent, whereas, it ranged from 55 to 76 percent in 2020 and 2021. Replication 3 yielded 32 to 60 percent less in 2022 versus replication 1. In 2020 and 2021 the yield decrease ranged between 65.15 to 99.65 percent. Test weights were generally lower due to reduced growth and vigor at high salinity and sodicity. Details are in Figure 2.

Canola

In replication 1, canola yields ranged between 48.42 to 68.16 bushels per acre (2421 to 3408 pounds per acre). In replication 2, only L340PC and LR344PC varieties produced modest yields. Replication 3 was a net loss. This was an indication that despite the high availability of soil moisture in 2022 spring and early growing-season, canola varieties performed poorly in replication 2 and 3, compared to barley and oats. Details are in Figure 3.

Figure 3. 2022 yields (bushels/acre), test weights (lbs./bushel) and oil (%) of the four canola varieties for replications 1, 2 and 3.



	L345PC (Rep-1)	L345PC (Rep-2)	L345PC (Rep 3)	L340PC (Rep-1)	L340PC (Rep-2)	L340PC (Rep 3)	DKTFLL21SC (Rep-1)	DKTFLL21SC (Rep-2)	DKTFLL21SC (Rep 3)	LR344PC (Rep-1)	LR344PC (Rep-2)	LR344PC (Rep 3)
2022 Yield (bu./acre)	68.16	0.00	0.00	67.76	56.95	0.00	48.42	0.00	0.00	63.36	8.54	0.00
2022 Test Weight (lbs/bu)	52.37	0.00	0.00	51.13	49.02	0.00	51.58	0.00	0.00	52.06	44.81	0.00
2022 Oil (%)	39.03	0.00	0.00	40.81	40.65	0.00	41.86	0.00	0.00	40.53	38.05	0.00

Summary:

- Increased sodicity resulted in poor seedbed as sodicity destroys soil structure.
- Increased salinity and sodicity resulted in delayed and uneven germination, poor growth and vigor, delayed maturity, yield and quality.
- Surface salinity and sodicity (0-6” depths) had more impact on stands and yields than subsurface salinity and sodicity (6-24” depths).
- Spring and early growing-season soil moisture levels had a significant impact on germination, growth, yields and quality even at higher salinity and sodicity levels. When crops receive optimum rain at crucial growth stages, especially during the early growing-season, there is less competition for water between plants and salts, and the effects from drought can be significantly less.
- Oats turned out to be slightly more salt-tolerant than barley (ND Heart).
- Six-row (Tradition) barley yielded higher than two-row varieties with the increase in salinity and sodicity.
- Canola was significantly less salt and sodicity tolerant than barley and oats.

COMPARING CONVENTIONAL-TILL VERSUS NO-TILL IN NE NORTH DAKOTA

Naeem Kalwar (Extension Soil Health Specialist)
Travis Hakanson (Research Specialist/Foundation Seed)
Carmen Ewert (Research Technician/Foundation Seed)

Figure 1. The Langdon Research Extension Center conventional-till versus no-till demonstration site on October 6, 2021.

Conventional tillage practices and the soil disturbance and loss they cause are well documented, especially in western North Dakota. Early adopters of no-till in western ND stopped using tillage for planting several decades ago. The main reasons were to conserve soil moisture and protect topsoil. However, in the northeast, producers mostly kept tilling their soils in fall and then again in spring. The common reason was and still is to dry the soils for timely planting as northeast ND has a slightly shorter growing-season compared to the other parts of the state. Recent wet weather cycle that started in 1993 also made switching to no-till difficult as producers became wary about wet field conditions in the spring resulting in late planting. A shorter growing season resulting in late planting can not only cause significant yield losses but there could be difficulties during harvest due to a wet-fall or early frost. Depending upon soil type and landscape and agronomic practices, it can take several years for the no-till practices to improve soil structure and water infiltration to help overcome challenges posed by a wet spring or fall. Several producers in the NE in the past tried no-till. Due to the wet weather, they faced numerous challenges such as muddy and saturated fields, cooler soil temperatures, poor seedbed, late planting, soil crusting, poor germination and stands during spring and muddy fields during harvest in the fall. Most of them gave up no-till and went back to conventional-till.

If we compare the weather and accumulated growing degree days of major crops grown around Langdon (NE) versus other parts of the state, Langdon weather is slightly cooler and wet. It has the lowest number of accumulated growing degree days for growing most crops.

For comprehensive comparisons, weather data from the Langdon North Dakota Agricultural Weather Network (NDAWN) station was compared with the stations in Carrington, Dickinson, Fargo, Hettinger, Minot and Williston (Figure 2 and 3). Based on the 2018-2022 average data (Figure 2), Langdon area had the lowest average maximum temperature versus all other NDAWN stations. In terms of lowest average minimum temperatures, only the Hettinger station recorded slightly

lower temperature versus Langdon (42.60° versus 43.00°). For average rainfall during 2018-2022, the Langdon area received more rain than Minot and Williston.

Figure 2. Average maximum and minimum temperatures (°F) and total rainfall (inches) from April 1 to October 31 for 2018-2022.

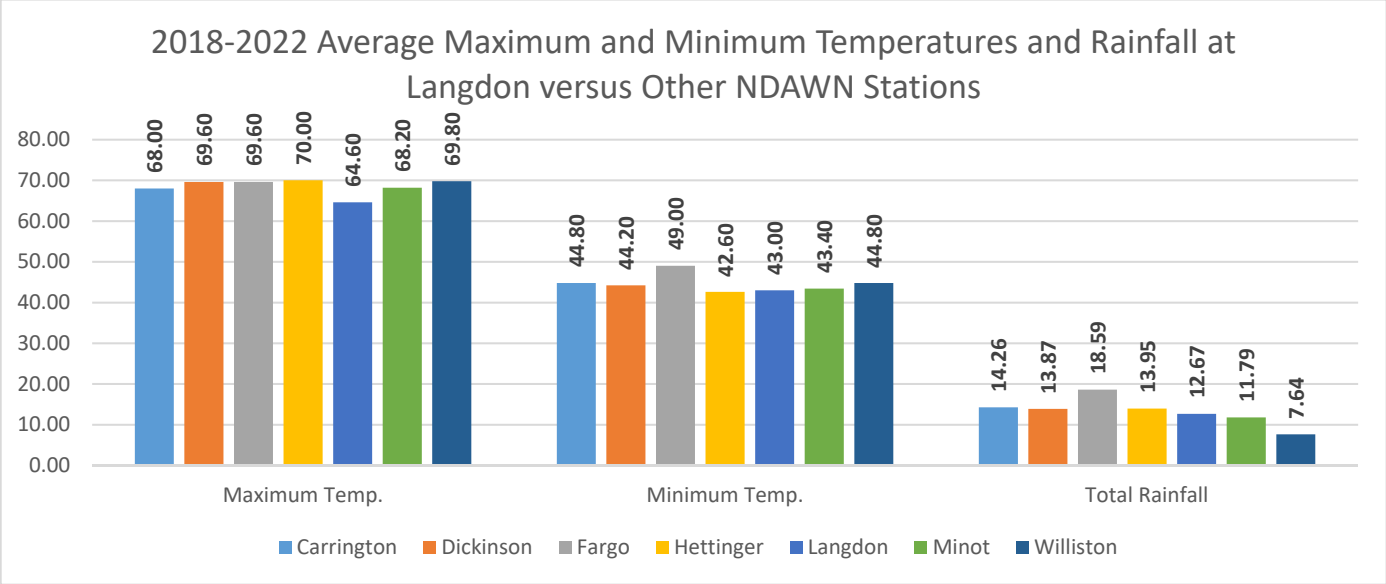
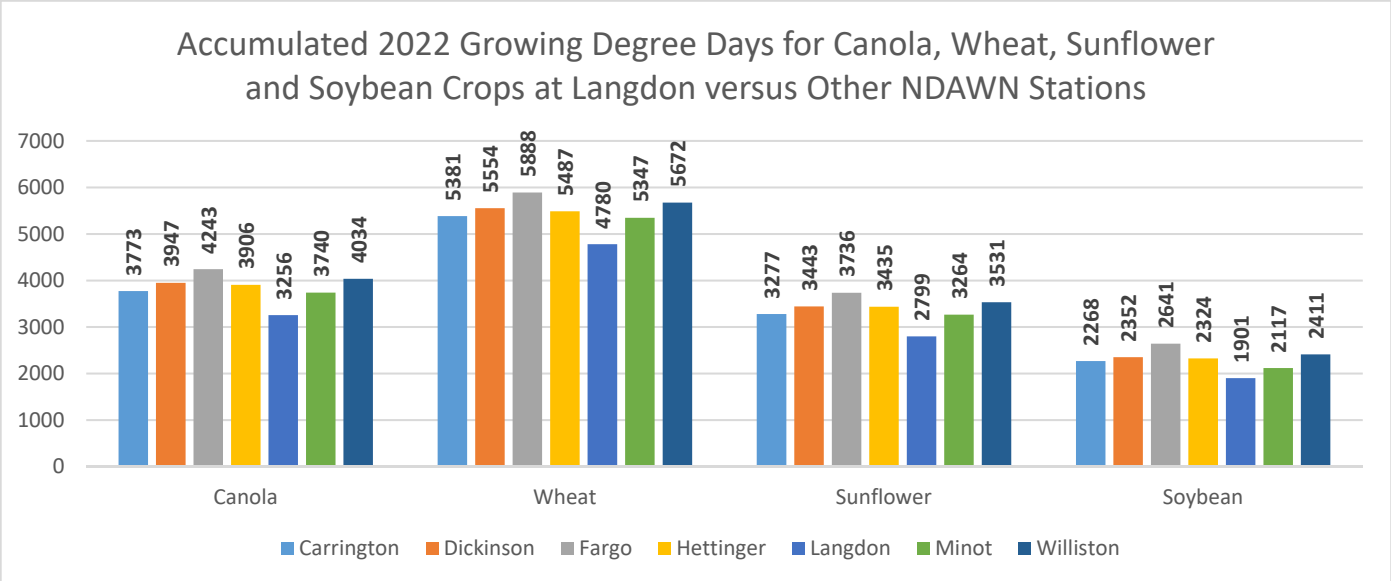


Figure 3 shows the NDAWN Station accumulated growing degree days for growing canola, wheat, sunflower and soybean around Carrington, Dickinson, Fargo, Hettinger, Langdon, Minot and Williston in 2022. The selected dates for canola, wheat and sunflower are from April 1 to October 31. For soybean, accumulated growing degree days are shown at 00.1 relative humidity. The starting time period for all stations is April 1, but the times for the end of the growing season are slightly different. For the Minot station, it is October 3, for Carrington, Hettinger and Langdon it is October 6 and for Dickinson, Fargo and Williston stations, it is October 7.

Figure 3. 2022 accumulated growing degree days for canola, wheat, sunflower and soybean at Langdon and other NDAWN Stations.



Based on the data in Figure 3, Langdon area had the lowest number of accumulated growing degree days for growing canola, wheat, sunflower and soybean versus the rest of the NDAWN stations in 2022. Given the benefits of no-till and the differences in Langdon area weather versus the rest of the state, a ten-year field scale conventional-till versus no-till

demonstration was initiated in the fall of 2021 at the NDSU Langdon Research Extension Center in Langdon, ND. The plan is to keep everything the same except the differences in tillage practices.

Objectives

Short-term objectives of this study are, how early each field can be planted, differences in the input costs, germination, stands and yields. Long-term objectives include effects on soil erosion, aggregation, structure, pore space and water infiltration (movement through soil layers).

Site Distribution and Details

An approximately 35-acre field was divided into two from north to south to create conventional-till and no-till sites. The no-till site is on the west and measured around 13.74 acres. The conventional-till site is on the east and measured 20.67 acres. There was a 15-feet border between them. Both sites included productive, marginal and unproductive areas in order to be truly representative of the farmer fields.

Field Work Details

Fall-2021

- After harvesting soybeans, the conventional-till site was chiseled once on October 6. The no-till site was left as is.
- Separate composite four-foot deep soil samples for 0-12", 12-24", 24-36" and 36-48" depths were taken from conventional-till productive ground (CT-PG), conventional-till unproductive ground (CT-UG), no-till productive ground (NT-PG) and no-till unproductive ground (NT-UG) for textural and chemical analysis.
- Separate soil bulk density samples were taken from CT-PG, CT-UG, NT-PG and NT-UG for 0-5" and 5-10" depths.
- Soil water infiltration rates were measured on CT-PG, CT-UG, NT-PG and NT-UG sites by simulating one inch of rain followed by the second inch.

Spring-2022

- On the conventional-till site, a uniform rate of 125 pounds of N through Urea per acre was spread on May 29 followed by one-pass of a cultivator for incorporation. Then Fargo and Treflon (PPI) were sprayed on June 6 followed by two-passes of a cultivator. On June 7, Prosper (HRSW) was planted at the seeding rate of 1.66 bushels per acre.
- No-till site was planted with Prosper (HRSW) on the afternoon of June 13 using the John Deere 1895 disc no-till drill. Seeding rate was 1.66 bushels per acre. Due to the issue of the no-till drill not able to flow high fertilizer rates, only 62.5 pounds per acre of N (135.86 pounds of Urea per acre) was applied at the time of planting. The rest of the 62.5 pounds of N per acre was top dressed later in order to make no-till fertilizer rate comparable to the conventional-till site. No-till site was sprayed with Roundup PowerMax 3 at 20 ounces per acre with Kicker (active ingredient ammonium sulfate) mixed in at 2.5 gallons of Kicker per 100 gallons of water (0.27 gallons of Kicker per acre).

Fall-2022

- Conventional-till site was disked once on October 5.
- Separate composite four-foot deep soil samples for 0-12", 12-24", 24-36" and 36-48" depths were taken from conventional-till productive ground (CT-PG), conventional-till unproductive ground (CT-UG), no-till productive ground (NT-PG) and no-till unproductive ground (NT-UG) for chemical analysis.
- Separate soil bulk density samples were taken from CT-PG, CT-UG, NT-PG and NT-UG for 0-5" and 5-10" depths.
- Soil water infiltration rates were measured on CT-PG, CT-UG, NT-PG and NT-UG sites by simulating one inch of rain followed by the second inch.

Soil Water Infiltration

Soil water infiltration rates were measured by pounding a six-inch diameter ring into the surface soil. After the ring was in place, 444 ml of deionized water was used to simulate one inch of rain. Once there was no standing water while soil was still saturated, second inch of rain was simulated by pouring 444 ml of additional deionized water. Both simulations were

timed for water absorption into the soil. The fall-2021 infiltration rates are in Table 1. There were a few key observations based on fall-2021 soil water infiltration rates:

- Soil water infiltration rates of conventional-till productive and unproductive grounds were much faster than the no-till productive and unproductive grounds.
- On the no-till site, water infiltration was much faster on productive ground versus unproductive ground. That was mainly an effect of higher sodicity level, which caused soil dispersion resulting in dense soil layers.

Table 1. Soil water infiltration rates of conventional-till and no-till in fall-2021.

Site	Time for infiltrating First-inch	Time for infiltrating Second-inch
Fall-2021		
Conventionally-Tilled Productive Ground (CT-PG)	53.18 seconds	3 minutes and 3.29 seconds
Conventionally-Tilled Unproductive Ground (CT-UG)	36.45 seconds	3 minutes and 33.87 seconds
No-Tilled Productive Ground (NT-PG)	2 minutes and 5.74 seconds	8 minutes and 21.19 seconds
No-Tilled Unproductive Ground (NT-UG)	23 minutes and 1.88 seconds	1 hour, 16 minutes and 20.97 seconds

Soil Analysis Results

Based on the 2021 soil analysis results, conventional-till productive ground had low levels of salinity and no issue of sodicity in the 0-12 inch depth. The levels of salinity were high with moderately high sodicity in the same depth of unproductive ground. In the no-till area, salinity level was moderately high with very low sodicity in the 0-12 inch depth of productive ground. In the unproductive area of no-till, salinity and sodicity levels were very high in the 0-12 inch soil depth. Details are in Table 2.

Soil nitrogen (N) and phosphorous (P) levels in the unproductive areas of conventional-till and no-till were very high and high compared to the productive areas of both sites (Table 2). These results are quite representative of the saline and sodic areas versus areas that do not have these issues as there are hardly any plants growing on saline and sodic areas to take up nutrients from the soil.

Table 2. The 2021 soil EC, SAR, pH, N, P and K results of the conventional-till and no-till productive and unproductive areas for 0-12, 12-24, 24-36 and 36-48 inch soil depths.

	Depth	EC	SAR	pH	NO3-N	P	K	O.M.
Sample ID	**(inches)**	**(dS/m)**			**(lbs./ac.)**	**(ppm)**	**(ppm)**	**(%)**
Conventional-till Productive Ground	0-12	2.44	2.06	7.60	16.0	5.0	190	3.20
	12-24	4.90	3.99	7.76	6.0	3.0	130	1.50
	24-36	5.25	5.89	7.77	8.0	2.0	180	1.00
	36-48	2.09	7.67	7.86	10.0	3.0	280	1.10
Conventional-till Unproductive Ground	0-12	10.43	10.88	7.65	66.0	10.0	180	5.20
	12-24	11.28	11.27	7.51	74.0	6.0	105	4.50
	24-36	10.39	11.36	7.3	32.0	4.0	125	2.10
	36-48	8.47	10.19	7.28	20.0	3.0	205	1.60
No-till Productive Ground	0-12	4.18	4.45	7.35	6.0	13.0	170	4.40
	12-24	7.10	10.74	7.82	4.0	2.0	100	3.10
	24-36	8.16	18.11	7.92	2.0	2.0	200	1.20
	36-48	8.19	17.47	7.87	4.0	1.0	195	0.80
No-till Unproductive Ground	0-12	13.52	24.15	7.77	52.0	16.0	120	4.70
	12-24	13.34	23.02	7.87	24.0	2.0	110	2.40
	24-36	11.82	23.50	7.85	32.0	2.0	100	1.20
	36-48	10.86	18.14	7.76	28.0	2.0	140	0.80

Harvest Details

- Both conventional-till and no-till sites were swathed on September 19 and combined on September 28.

Key Takeaways Based on Year One

- The conventional-till productive ground site appeared ready for planting at the surface four to five days earlier than the no-till productive ground.
- The conventional-till productive ground site was wet right underneath the tillage depth compared to the no-till productive ground site. That resulted in marginal seedbed, uneven germination and stand.
- The no-till unproductive ground looked much better and ready for planting compared to conventional-till unproductive ground. That indicates tillage may be less forgiving on areas with high salinity and sodicity levels.
- Once ready for planting, the no-till productive ground site had a better seedbed, even germination and uniform stands.
- Conventional-till unproductive ground had spotty germination and stand, whereas, no-till unproductive ground had zero germination and remained barren. That could be due to the higher salinity and sodicity levels in no-till unproductive ground site compared to conventional-till unproductive ground site.
- Despite planted six days later, the no-till productive site caught up in growth and maturity with the conventional-till productive site.
- Both sites were swathed on September 19 and combined on September 28.
- No-till site yielded three bushels per acre more than the conventional-till site.

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

Naeem Kalwar (Extension Soil Health Specialist)

Figure 1. The NDSU Langdon Research Extension Center Groundwater Management Research Project Lift Station.

This research report is an extension of an ongoing long-term research trial on a tiled saline and sodic site. The main objectives of the trial are:

- Does soil sodicity negatively affect tile drainage performance?
- Will tiling lower soil salinity under wet and dry weather conditions?
- Does the drained water from a tiled field increase salinity and sodicity levels of the surface water resources?

This abbreviated report only summarizes annual soil electrical conductivity (EC), sodium adsorption ratio (SAR), pH and bulk density results. If information about the trial background, objectives, location, site, description, design, methodology and complete set of data collected annually is needed, please contact the NDSU Langdon Research Extension Center:

Mail: 9280 107th Avenue NE, Langdon, ND 58249
Phone: (701) 256-2582
Email: ndsu.langdon.rec@ndsu.edu

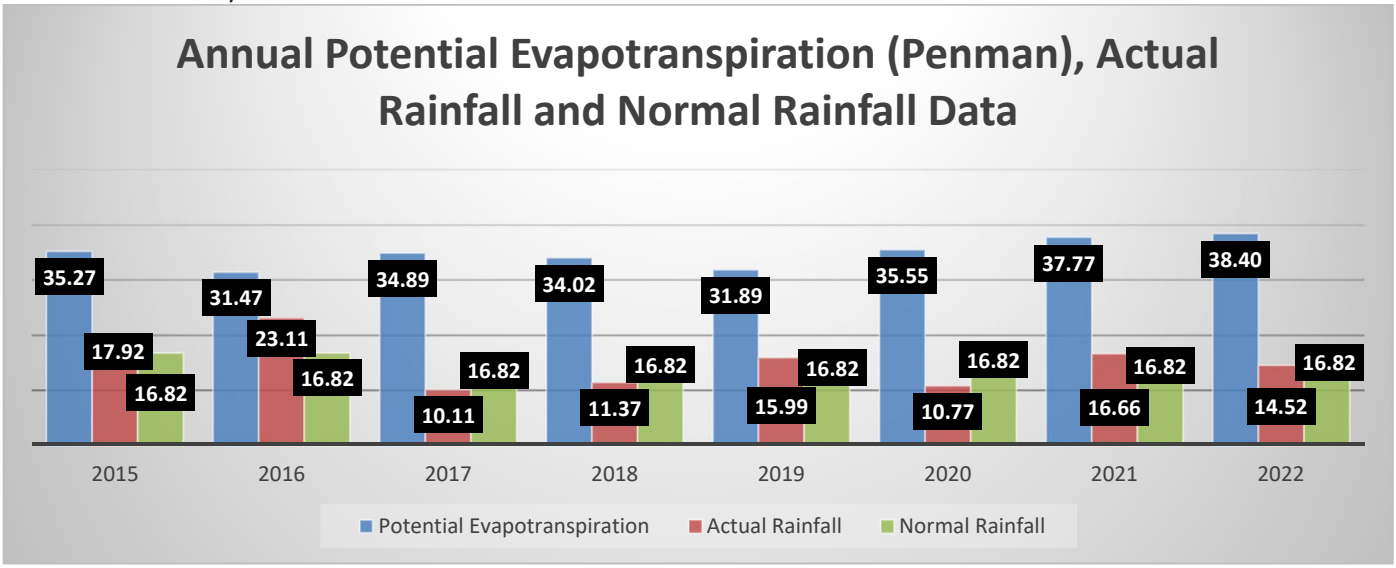
RESULTS AND DISCUSSION

The findings below are based on the statistical analysis of soil electrical conductivity (EC dS/m), sodium adsorption ratio (SAR), pH and bulk density (g/cm^3) and its corresponding gravimetric water content (GW in %). This was done to measure the differences in these properties at the time of tiling compared to after applying the soil amendments (treatments). The effects of annual growing-season rainfall and potential evapotranspiration (Penman) were noted on the resulting average annual growing-season groundwater depths measured from May 1 to October 31. The treatment means of EC, SAR and pH represent 2014 and 2016-2022 results of three replications for the zero to four-foot soil depths. The treatment means of groundwater depths and bulk density and its corresponding GW represent 2015 to 2022 results of three replications measured for zero to seven and a half-foot and zero to ten-inch soil depths respectively. Due to the dry weather during summer and fall, it was not possible to take water quality samples in 2022 from the tile drainage lift station as well as upstream and downstream of the lift station from the surface water drainage ditch in which tile drainage water drains. For previous annual water quality results, please contact the Langdon Research Extension Center.

Annual Changes in Weather and Soil Groundwater Depths

Changes in soil chemical properties are greatly influenced by the fluctuations in the weather such as annual evapotranspiration and rainfall (Figure 2) and resulting groundwater depths and capillary rise of soil water.

Figure 2. Annual growing-season potential evapotranspiration (Penman), actual rainfall and normal rainfall in inches measured from May 1 to October 31.

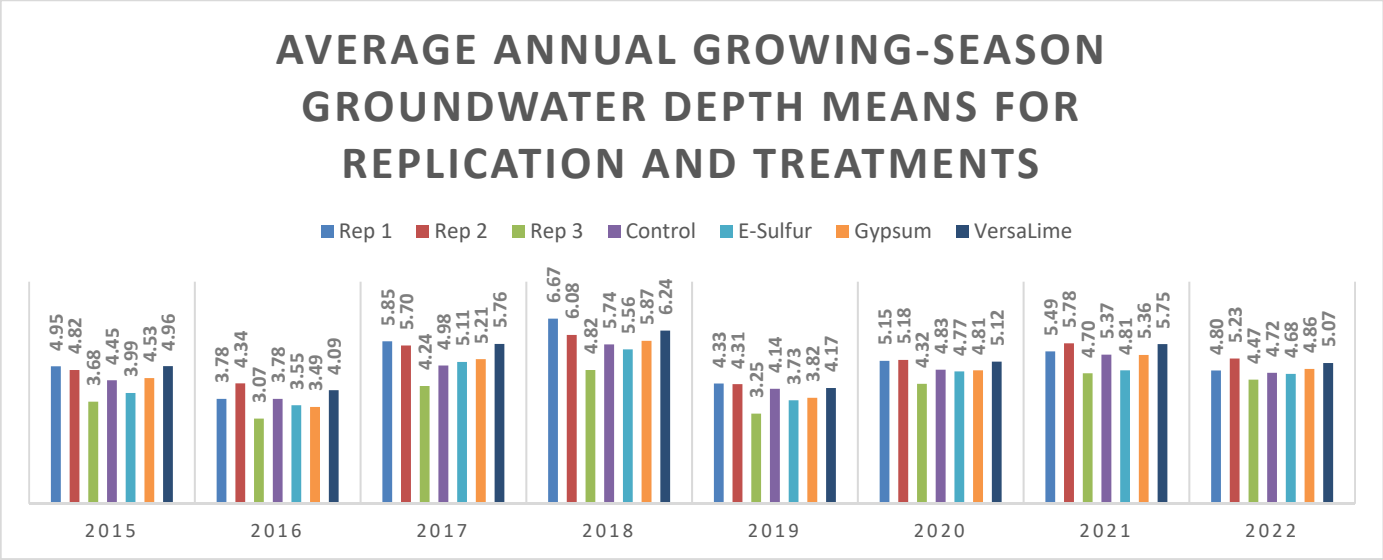


Increased evapotranspiration versus rainfall generally results in lower groundwater depths, however, can cause less leaching of soluble salts, increased capillary rise of soil water and slower dissolution of soil amendments. A smaller gap between these two could result in shallower groundwater depths, however, under good soil water infiltration and improved drainage, not only excess salts can be moved out of the fields but soil amendments can also produce favorable results. A smaller gap between evapotranspiration and rainfall will result in reduced capillary rise of soil water (wicking up) as capillary water moves from higher to lower moisture levels. In 2016, the gap between evapotranspiration and rainfall was smallest of the eight-years and the infiltration was still good as higher levels of soluble salts were neutralizing the dispersion caused by sodicity. This resulted in the highest decrease in soil salt levels in 2016 since the site was tiled in 2014. In 2017, there was a significant increase in soil salt levels compared to 2016, which could be due to an increase in the capillary rise of soil water due to the greater differences between annual evapotranspiration and rainfall. That trend continued in 2018-2022 due to the drier weather.

It is important to note that while the total annual evapotranspiration and rainfall numbers are important, they do not reflect the weather trends for the entire growing-season. For example, from May 1 to October 31, 2021, Langdon Research Extension Center NDAWN station recorded 37.77 inches of total potential evapotranspiration and 16.66 inches of actual rainfall versus a normal of 16.82 inches. That means Langdon area received close to its normal rain in 2021. During the early part of the 2021 growing-season from May 1 to August 8, Langdon NDAWN recorded 25.62 inches of total potential evapotranspiration and only 6.43 inches of actual rainfall versus a normal of 11.42 inches. The gap of 19.19 inches between total annual evapotranspiration and actual rainfall and 43.69 percent less rainfall versus normal for that period created moderate to severe drought. On August 9, the Langdon area received 3.68 inches of rain and kept getting significant showers afterwards. Overall, Langdon NDAWN recorded 12.16 inches of total annual evapotranspiration and 10.22 inches of rain versus a normal of 5.40 inches from August 9 to October 31. So, during the latter part of the growing-season, the gap between total annual evapotranspiration and rainfall was only 1.94 inches with 189.25 percent actual rain compared to normal. It was important to receive the much-needed moisture during that time, but most of the growing-season was over by then.

Figure 3 has the average annual growing-season groundwater depth means for replications and treatments for 2015-2022. These means of groundwater depths represent actual annual measurements of groundwater depths measured from May 1 to October 31 on a weekly basis.

Figure 3. Annual means of average growing-season groundwater depths for replications and treatments in feet measured from May 1 to October 31 on a weekly basis.



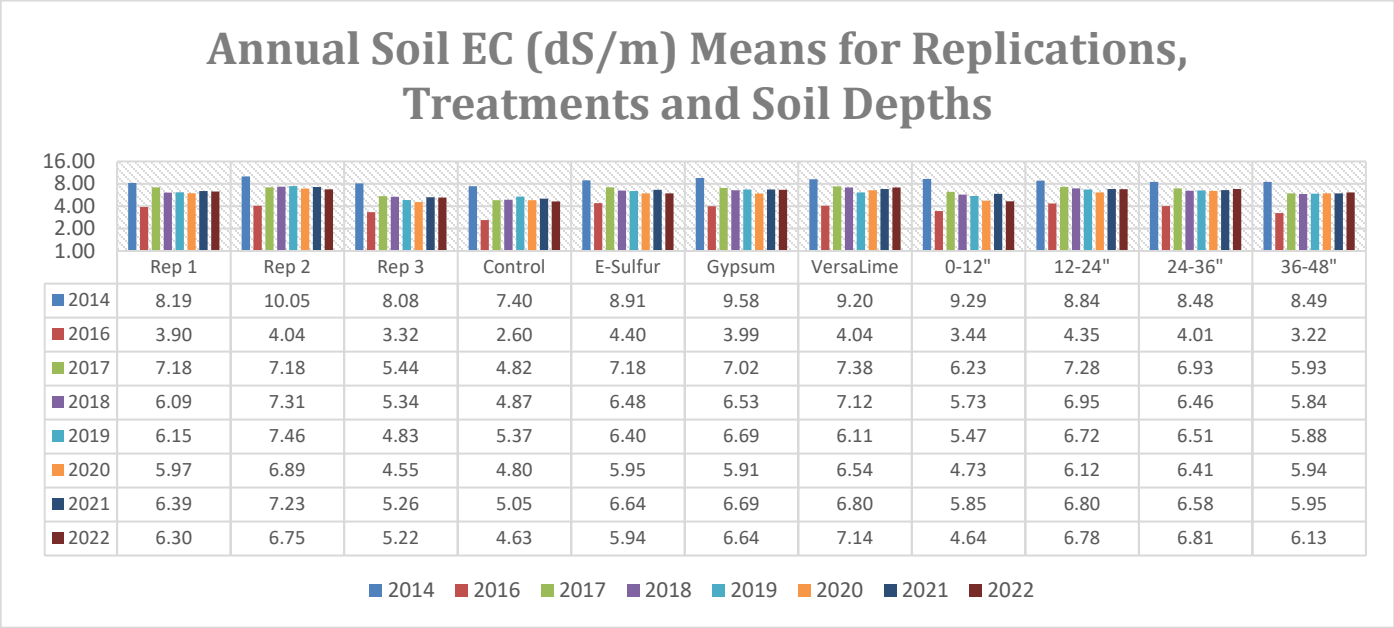
Note: In 2015, groundwater depths were only measured from mid-June to the end of October.

The 2016 average growing-season groundwater depths for treatments and replications were the shallowest (3.07 to 4.34 feet deep). Groundwater depths in 2018 were the deepest (4.82 to 6.67 feet deep). Replication 3 had the shallowest average annual growing-season groundwater depths compared to replications 1 and 2 in all years. VersaLime treatment had the deepest depths during most years.

Differences in Soil Electrical Conductivity (Salinity) Levels

Soil EC levels have been directly related to the annual growing-season rainfall and resulting moisture levels in the topsoil.

Figure 4. Annual soil EC (dS/m) means for replications, treatments and soil depths.



	Rep 1	Rep 2	Rep 3	Control	E-Sulfur	Gypsum	VersaLime	0-12"	12-24"	24-36"	36-48"
2014	8.19	10.05	8.08	7.40	8.91	9.58	9.20	9.29	8.84	8.48	8.49
2016	3.90	4.04	3.32	2.60	4.40	3.99	4.04	3.44	4.35	4.01	3.22
2017	7.18	7.18	5.44	4.82	7.18	7.02	7.38	6.23	7.28	6.93	5.93
2018	6.09	7.31	5.34	4.87	6.48	6.53	7.12	5.73	6.95	6.46	5.84
2019	6.15	7.46	4.83	5.37	6.40	6.69	6.11	5.47	6.72	6.51	5.88
2020	5.97	6.89	4.55	4.80	5.95	5.91	6.54	4.73	6.12	6.41	5.94
2021	6.39	7.23	5.26	5.05	6.64	6.69	6.80	5.85	6.80	6.58	5.95
2022	6.30	6.75	5.22	4.63	5.94	6.64	7.14	4.64	6.78	6.81	6.13

Soil EC levels in 2016, were significantly lower despite shallow average annual growing-season groundwater depths due to excess rainfall and improved drainage under tiling. EC levels increased again in 2017 and that trend continued in 2018-2022 despite the land being tiled and the average annual growing-season groundwater depths being deeper than the depth of the tiles. That was a result of increased capillary rise of soil water due to low rainfall and higher evapotranspiration. This defies the common belief that only lowering the groundwater depths will cause excess salts to

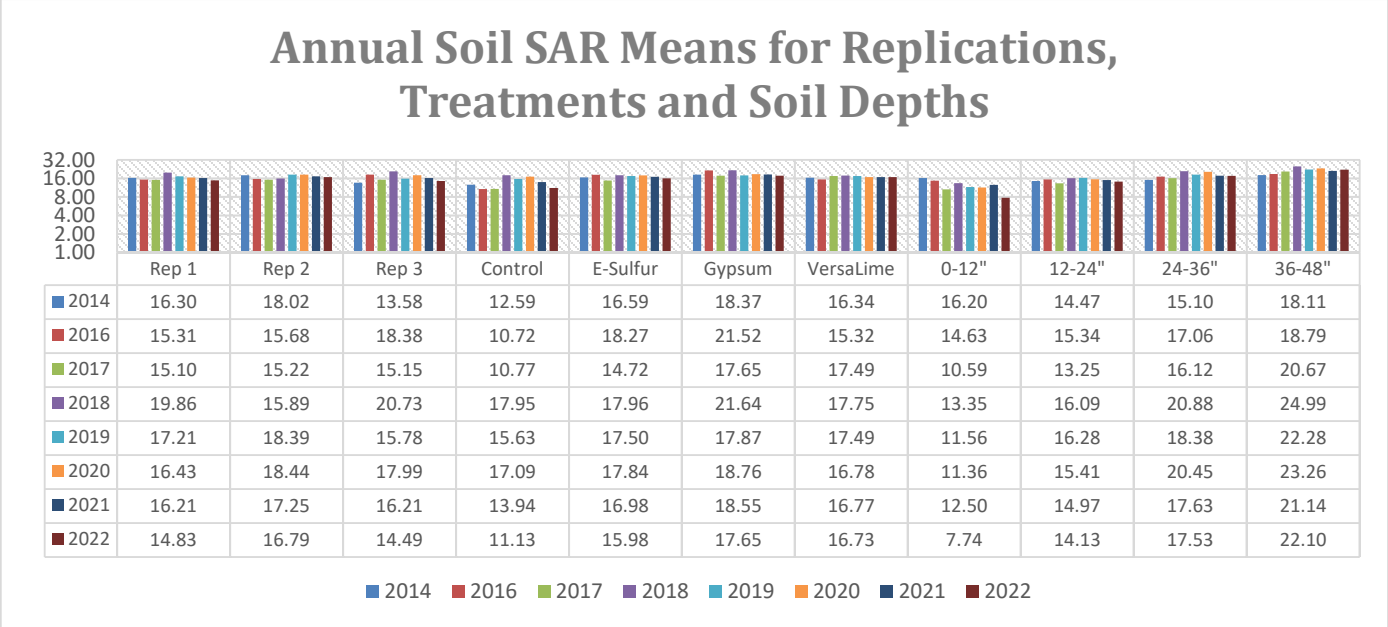
leach out. Lowering soil EC levels will need an optimum combination of low enough groundwater depths combined with sufficient rain and good soil water infiltration to push the salts into deeper depths. The importance of good soil water infiltration is also evident from the fact that the highest EC levels were observed in 12-24 and 24-36-inch soil depths. This could be an indication of decent infiltration through the first foot (especially under lower sodicity levels) with much slower water movement through the second and third feet of soil resulting in higher levels of salts. Sufficient rain will also result in improved moisture levels in the topsoil resulting in decreased capillary rise. Based on soil test EC levels, establishing a salt-tolerant annual crop (barley, oat) or perennial salt-tolerant grass mix is also very important as that will reduce evaporation and consequently capillary rise.

EC levels in 2014 were the highest followed by the levels in 2021 and 2017-2019, 2022, 2020 and 2016. Replication 2 had the highest EC levels followed by replications 1 and 3. VersaLime treatments had the highest levels followed by gypsum, E-sulfur and control treatments. The highest EC levels were found in the 12-24-inch soil depths followed by 24-36-inch, 36-48 inch and 0-12-inch depths. Details of soil EC (dS/m) levels are shown in Figure 4.

Differences in Soil Sodium Adsorption Ratio SAR (Sodicity) Levels

The major change in 2022 was that the SAR levels in the 0-12-inch depth significantly decreased versus 2014-2021. Soil SAR levels in the 12-24, 24-36 and 36-48-inch depths remained unchanged (Figure 5). This could be due to the high precipitation during 2022 spring and early growing-season. Apart from this change, soil SAR levels have been inconsistent.

Figure 5. Annual soil SAR means for replications, treatments and soil depths.



	Rep 1	Rep 2	Rep 3	Control	E-Sulfur	Gypsum	VersaLime	0-12"	12-24"	24-36"	36-48"
2014	16.30	18.02	13.58	12.59	16.59	18.37	16.34	16.20	14.47	15.10	18.11
2016	15.31	15.68	18.38	10.72	18.27	21.52	15.32	14.63	15.34	17.06	18.79
2017	15.10	15.22	15.15	10.77	14.72	17.65	17.49	10.59	13.25	16.12	20.67
2018	19.86	15.89	20.73	17.95	17.96	21.64	17.75	13.35	16.09	20.88	24.99
2019	17.21	18.39	15.78	15.63	17.50	17.87	17.49	11.56	16.28	18.38	22.28
2020	16.43	18.44	17.99	17.09	17.84	18.76	16.78	11.36	15.41	20.45	23.26
2021	16.21	17.25	16.21	13.94	16.98	18.55	16.77	12.50	14.97	17.63	21.14
2022	14.83	16.79	14.49	11.13	15.98	17.65	16.73	7.74	14.13	17.53	22.10

Overall, SAR remained the highest in 2018 followed by 2020, 2019, 2016, 2014, 2022, 2017 and 2021. Replication 2 had the highest SAR levels followed by replications 1 and 3. Gypsum treatment had the highest levels followed by E-sulfur, VersaLime and control treatments. In addition, soil SAR levels increased with soil depth with 0-12-inch depths having the lowest SAR levels and 36-48-inch depths having the highest SAR levels. Details of soil SAR levels are shown in Figure 5.

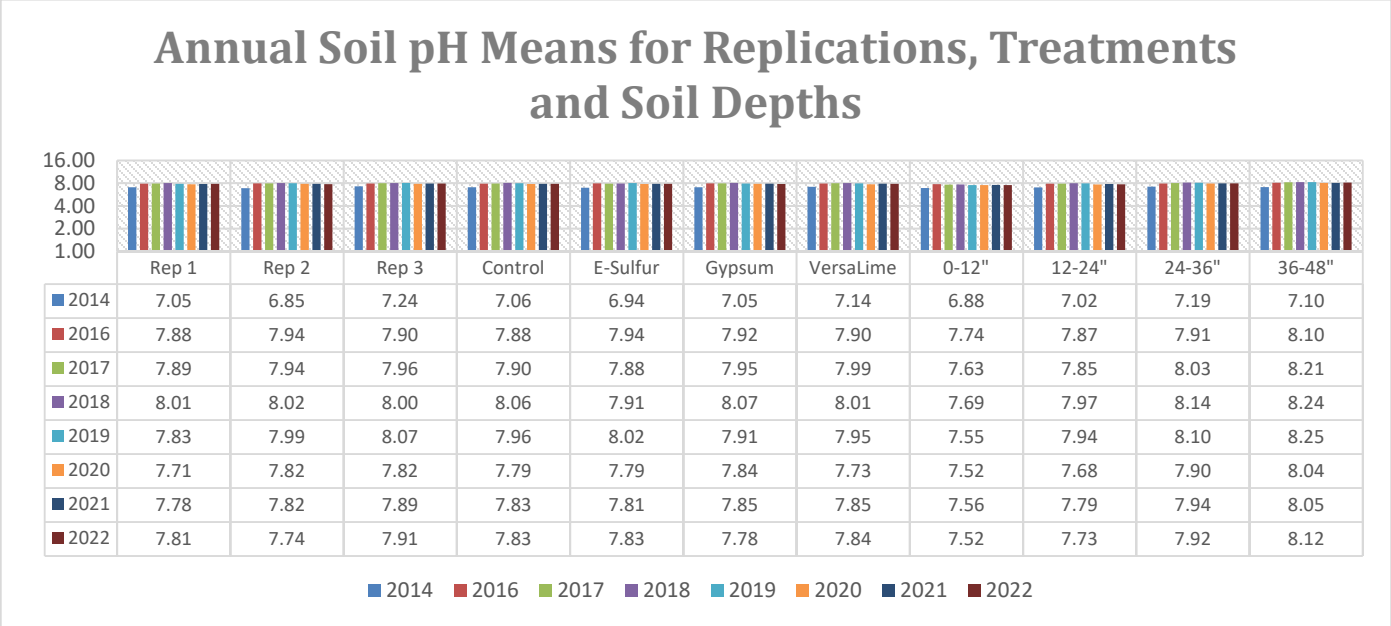
Differences in Soil pH Levels

Soil pH levels were generally consistent with the soil moisture levels at the time of sampling and have had no impact so far related to the application of soil amendments (Figure 6).

Overall, soil pH levels remained the highest in 2021 followed by 2018, 2019, 2017, 2016, 2022, 2020 and 2014. Replication 3 had the highest pH levels followed by replications 2 and 1. That is interesting as generally replication 3 has the shallowest average annual growing-season groundwater depths followed by replications 2 and 1 in most years. VersaLime treatment had the highest levels followed by gypsum, control and E-sulfur treatments. Like SAR, soil pH significantly increased with

soil depth and 0-12-inch depths had the lowest pH levels, whereas, 36-48-inch depths had the highest pH levels. That is another indication of soil pH increasing with moisture as soil moisture generally increases with increase in depth. Details of soil pH levels are shown in Figure 6.

Figure 6. Annual soil pH means for replications, treatments and soil depths.

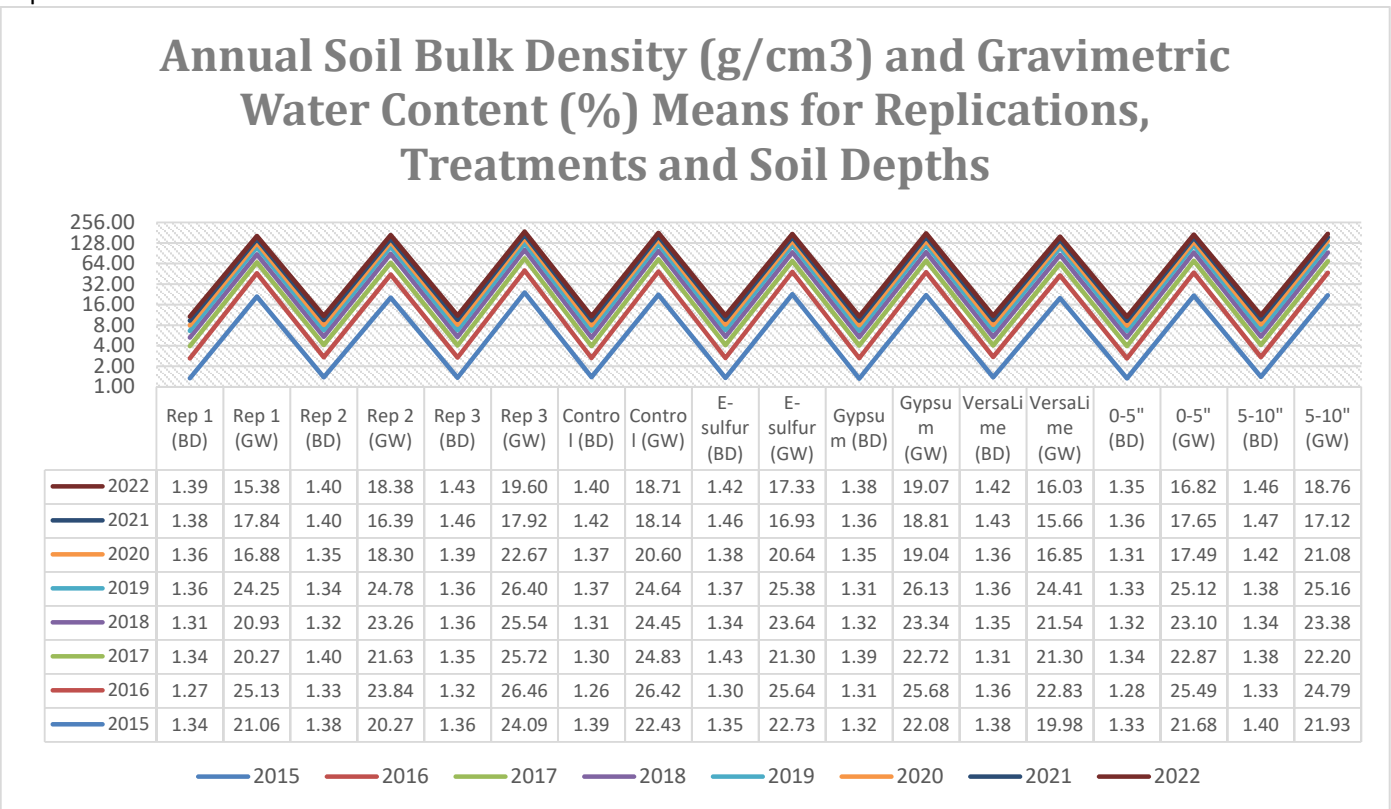


	Rep 1	Rep 2	Rep 3	Control	E-Sulfur	Gypsum	VersaLime	0-12"	12-24"	24-36"	36-48"
2014	7.05	6.85	7.24	7.06	6.94	7.05	7.14	6.88	7.02	7.19	7.10
2016	7.88	7.94	7.90	7.88	7.94	7.92	7.90	7.74	7.87	7.91	8.10
2017	7.89	7.94	7.96	7.90	7.88	7.95	7.99	7.63	7.85	8.03	8.21
2018	8.01	8.02	8.00	8.06	7.91	8.07	8.01	7.69	7.97	8.14	8.24
2019	7.83	7.99	8.07	7.96	8.02	7.91	7.95	7.55	7.94	8.10	8.25
2020	7.71	7.82	7.82	7.79	7.79	7.84	7.73	7.52	7.68	7.90	8.04
2021	7.78	7.82	7.89	7.83	7.81	7.85	7.85	7.56	7.79	7.94	8.05
2022	7.81	7.74	7.91	7.83	7.83	7.78	7.84	7.52	7.73	7.92	8.12

Differences in Soil Bulk Density Levels

Soil bulk density increased with soil depths. Despite not being a clear trend, bulk density increased as the gravimetric soil water content decreased (Figure 7).

Figure 7. Annual means of soil bulk density (g/cm^3) and gravimetric water (%) levels for replications, treatments and soil depths.



	Rep 1 (BD)	Rep 1 (GW)	Rep 2 (BD)	Rep 2 (GW)	Rep 3 (BD)	Rep 3 (GW)	Control (BD)	Control (GW)	E-sulfur (BD)	E-sulfur (GW)	Gypsum (BD)	Gypsum (GW)	VersaLime (BD)	VersaLime (GW)	0-5" (BD)	0-5" (GW)	5-10" (BD)	5-10" (GW)
2022	1.39	15.38	1.40	18.38	1.43	19.60	1.40	18.71	1.42	17.33	1.38	19.07	1.42	16.03	1.35	16.82	1.46	18.76
2021	1.38	17.84	1.40	16.39	1.46	17.92	1.42	18.14	1.46	16.93	1.36	18.81	1.43	15.66	1.36	17.65	1.47	17.12
2020	1.36	16.88	1.35	18.30	1.39	22.67	1.37	20.60	1.38	20.64	1.35	19.04	1.36	16.85	1.31	17.49	1.42	21.08
2019	1.36	24.25	1.34	24.78	1.36	26.40	1.37	24.64	1.37	25.38	1.31	26.13	1.36	24.41	1.33	25.12	1.38	25.16
2018	1.31	20.93	1.32	23.26	1.36	25.54	1.31	24.45	1.34	23.64	1.32	23.34	1.35	21.54	1.32	23.10	1.34	23.38
2017	1.34	20.27	1.40	21.63	1.35	25.72	1.30	24.83	1.43	21.30	1.39	22.72	1.31	21.30	1.34	22.87	1.38	22.20
2016	1.27	25.13	1.33	23.84	1.32	26.46	1.26	26.42	1.30	25.64	1.31	25.68	1.36	22.83	1.28	25.49	1.33	24.79
2015	1.34	21.06	1.38	20.27	1.36	24.09	1.39	22.43	1.35	22.73	1.32	22.08	1.38	19.98	1.33	21.68	1.40	21.93

Bulk density levels in 2021 and 2022 were the highest followed by 2020, 2015 and 2017, 2019, 2018 and 2016 at 17.38 and 17.79, 19.28, 21.81, 22.54, 25.14, 23.24 and 25.14 percent gravimetric water levels respectively. Replication 3 had the highest bulk density levels followed by replications 2 and 1 at 23.55, 20.86 and 20.22 percent gravimetric water levels. E-sulfur treatments had the highest levels followed by VersaLime, control and gypsum treatments at 21.70, 19.83, 22.53 and 22.11 percent gravimetric water levels. The 0-12-inch soil depth had lower bulk density levels compared to 5-10-inch depth at 21.28 and 21.80 percent gravimetric water levels. Soil bulk density (g/cm^3) and corresponding gravimetric water content (%) levels are shown in Figure 7.

SUMMARY

Research data and observations are not conclusive at this point. Since most soils in North Dakota are clayey, the general belief is that these soils will infiltrate water slower and nothing can be done about it. That is true if we only compare the texture of clayey soils with silty or sandy soils. However, a clayey soil with high to very high dispersion or swelling will infiltrate water much slower than the same clay type not having these issues. Reducing soil dispersion and/or swelling combined with no or minimum-till practices and practices that help increase organic matter will improve soil particle aggregation, structure, pore space and water infiltration.

Based on the observations eight years after tiling and seven years after applying the soil amendments, below are answers for the three main objectives of this long-term research trial:

Does soil sodicity negatively affect tile drainage performance?

Yes, soil sodicity has negatively affected the performance of tile drainage at this site and despite heavy rains and standing water at the soil surface, sometimes it takes days for the lift station pump to start draining excess water. It eventually happens, but it takes time. Another evidence of slower water infiltration is roughly no change in groundwater depths for three to five days even after a heavy rain. Two specific examples are:

- Despite receiving 3.68 inches on August 9, 2021, it took the lift station pump four to seven days to start pumping the excess water into the drainage ditch.
- In 2019, the Langdon NDAWN recorded 1.52 inches from September 9 to 13 and there was visible standing water at the soil surface in low areas, however, the lift station pump was not running. It took the lift station pump three to four days to start running and drain the excess soil water.

Will tiling lower soil salinity under wet and dry weather conditions?

Tiling has lowered soil salinity (EC) levels under wet weather in 2016. With drier weather, salinity levels have actually increased in 2017-2022 despite land being tiled. That is due to the lack of rain water to force excess water-soluble salts into deeper depths and increased rise of capillary water due to increased evapotranspiration.

Does the drained water from a tiled field increase salinity and sodicity levels of the surface water resources?

Based on the 2015-2021 water quality analysis results, tile-drained water has added conductivity, total dissolved solids and SAR to the drainage ditch or the surface water resource. Over time depending upon the site-specific soil chemistry, tile drainage water can add salts and sodicity to the surface water resources.

2022 LREC Extension Cropping Systems Specialist Report

Anitha Chirumamilla

IPM Trapping and Scouting: The NE IPM survey team consisted of a scout and a trapper. During the crop growing season, the scout conducted weekly surveys from each of the nine (Grand Forks, Pembina, Cavalier, Walsh, Ramsey, Nelson, Benson, Rolette and Towner) counties for insects and diseases of crops such as wheat, barley, soybean and sunflower. The trapper conducted pheromone trapping (for insect pests such as wheat midge, wheat army worm and black cut worm in wheat; swede midge, canola flower midge, diamondback moth and bertha army worm in canola; banded sunflower moth, sunflower moth and *Arthuri* moth in sunflower ***(Figure 1)***. Results of scouting and trapping were tracked from various regions of ND and updated weekly on the IPM website: https://www.ndsu.edu/agriculture/ag-hub/ag-topics/crop-production/diseases-insects-and-weeds/integrated-pest-management.

Figure 1. IPM trapper setting up a pheromone trap for canola Swede midge

Hessian Fly in Wheat: Hessian fly (*Mayetiola destructor* (Say)) was observed infesting several spring wheat fields in Cavalier County. Hessian fly is one of the most serious insect pests of wheat in the United States. Infestations are sporadic in North Dakota with outbreaks being reported in 1991, 2003 and 2015 (Glogoza 2004, Knodel 2015). Hessian fly belongs to the midge family (Cecidomyiidae) of which another important insect pest orange blossom wheat midge belongs to. Hessian fly larvae cause damage by injecting salivary toxins into the plant cells while feeding which interferes with the growth of the plant thereby weakening or killing the plant. Adult Hessian flies are small (1/8th inch) mosquito like with smoky gray wings.

In the spring, females lay eggs on the upper surfaces of wheat leaves. Upon hatching, the larvae move to the base of the leaf and remain feeding beneath the leaf sheath.

Damage

The stage of the wheat plant and the degree of infestation determines the severity of hessian fly damage. Larval feeding at an early seedling stage might kill the plant. However, infestation in later stages of the crop might result in severe stunting with bluish colored leaves or weakening of the stem which usually breaks just above the first or second node ***(Figure 2)*** leading to lodging.

The infested fields in Cavalier County had stems broken with 1-2 flaxseed-like maggots (***Figure 2***). The fields appeared to have a significant infestation, almost 5% of heads were lodged or not harvestable. Northwest Minnesota also reported high pressures of Hessian fly near the Beltrami area and the least amount of pressure in the fields closest to Crookston (Source: Dr. Jochum Wiersma, UMN).

Management

Insecticides are not recommended for Hessian fly problems considering the sporadic nature of the pest and the difficulty in optimizing the timing of adult emergence. Best management practices include:

1) Controlling volunteer wheat in late summer
2) Using resistant varieties

Figure 2: Hessian fly larva in flaxseed stage. Hessian fly feeding damage with wheat stem bent above the first node.

Waterhemp and Palmer are spreading in NE North Dakota:

Waterhemp and Palmer are the two most important pigweed species posing a challenge to crop production in ND. Both are tough weeds to control as they have developed resistance to nearly every herbicide mode of action that is being used in crop production. These weeds share some similar characteristics that makes them troublesome and challenging:

1)They are dioecious which means male and female plants are separate

2) Produce extreme amounts of seed (1-5 million seeds per plant)

3) Emerge throughout the crop season until August

In 2022, waterhemp had been identified in a field (field pea) near Milton in Cavalier County. Although waterhemp has been reported in this county before (around 2015) in the Vang area, it has not spread and appeared to be contained. The distribution of waterhemp plants throughout the field and in headland area shows the infestation appeared to have been spread by the combine. The source of seed was not identified.

Figure 3: Palmer amaranth; palmer (left) and waterhemp (right) plants next to each other in a soybean field in Traill County

In addition, palmer amaranth was also identified in a soybean field along with waterhemp in Traill County. Palmer has been spreading in ND since its first report in 2018. Farmers are encouraged to pay attention to the weed species and their management practices to help prevent the spread of these troublesome weeds. Farmers are strictly advised to seek the help of county Extension agents and weed officers in case of a palmer or waterhemp suspicion. It is very important to correctly identify the weed to make sound management decisions.

Langdon REC Foundation Seed Stocks Program

The Langdon REC supports a Foundation Seed Stocks (FSS) Program to help increase and distribute the newest NDSU varieties of HRSW, durum, barley, soybean 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 2022 growing season are listed below:

HRSW – Faller, ND Frohberg, MN-Torgy, Prosper, ND VitPro, Glenn, MN-Washburn, Bolles
Barley – Lacey
Soybeans – ND17009GT
Flax – ND-Hammond, CDC Rowland

Growers who have grown seed for certification in one of the last four years who request seed prior to December 1 will be guaranteed an allocation. Any seed inventories available after December 1 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.

DISCLAIMER. The information given herein is for educational purposes only. Any reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement is implied by the NDSU Langdon Research Extension Center faculty and staff.

NDSU Langdon Research Extension Center

9280 107th Ave. N.E., Langdon, ND 58249
(701) 256-2582 • fax (701) 256-2580






Website: **www.ag.ndsu.edu/langdonrec**
Email: **NDSU.Langdon.REC@ndsu.edu**
Facebook: **www.facebook.com/langdonrec**

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