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2019 NDSU North Central Research Extension Center Summary

Our goals at the North Central Research Extension Center (NCREC) are to conduct research to find practical answers to crop production problems, conduct educational programs and demonstrations to address these problems, and to increase foundation grade seed of new and popular varieties for this area. New crops, varieties, and production methods are tested as they become introduced to determine their feasibility in our environment.

Agronomy

The North Central Research Extension Center conducts the majority of its agronomic field research trials at the main research facility south of Minot. The agronomy program also utilized off-station locations to strengthen and enhance its research capabilities. Off-station sites have been established at the Dean Schoenberg Farm west of Mohall, at the Dave Teigen Farm west of Rugby, at the Bendickson Farm east of Garrison and at the Wes Doepke Farm north of Wilton. A few individual trials were also conducted at various locations throughout the region and are noted in individual research reports. The NCREC thanks these farmer-cooperators along with county Extension staff, agricultural crop improvement associations and many others for their dedicated support of these research efforts.

Beginning with the 2013 cropping year, agronomic research studies (with a few exceptions) were conducted utilizing no-till methods in a continuous cropping system. In 2016, all crop production research and variety trials were moved to a new permanent location directly west of the Research Center. Broadleaf crops were typically planted into small grain stubble and small grain crops were typically planted into soybean or canola stubble. Soil samples from each research site were collected and analyzed for macro and micro nutrients. Each research site then received fertilizer applications based on those results. Urea (46-0-0) was the primary source of nitrogen and was "planted" prior to seeding or was applied in a mid-row band at seeding time. Monoammonium phosphate (11-52-0) was the primary source of phosphorous and was applied either directly in the seed row or in a mid-row band at planting. Seeding rates were adjusted for seed size and germination to provide a uniform number of pure live seeds (PLS) per acre for each crop and variety. Small plots were seeded with no-till drills equipped with coulter disc openers set at a 7 or 7 ½ -inch row spacing. Row crops were planted with a SRES small plot planter utilizing Great Plains no-till openers and Monosem singulation seed meters. All small grain crops received an early post-emergence herbicide application for weed control. Broadleaf crops typically received a pre-plant herbicide application to control broadleaf weeds followed by a post-emergence herbicide application to control grassy weeds. Other specific pest problems such as flea beetles in canola and leaf rust on sunflower were also treated with appropriate pest control measures when possible.

The fall of 2018 was relatively dry through October. Very little winter wheat was planted in the North Central region of the state. Research plots had good fall growing conditions and had good establishment going into dormancy. Late January through mid-March was bitterly cold. A heavy snow storm during the last week of April provided much needed moisture but delayed planting into May. Canola and other early seeded crops generally had poor and uneven emergence. There was very little precipitation throughout the small grain growing season until the last week of June. Above average precipitation in July provided much needed moisture to finish small grain crops and provided row crops with excellent growing conditions during their reproductive stages. Extended periods of wet weather in most areas prevented farmers from harvesting any crop and caused poor grain quality. These conditions were exacerbated by a snow storm in October with some areas receiving 30" of snow. Most row crops in the North Central region were harvested in December. Plant diseases generally were not an issue this year, however, insect issues like grasshoppers and flea beetles were more prominent. Low commodity prices were precipitated by a trade war with China, Europe and our largest trade partners, Mexico and Canada. This was not a good year for North Dakota's farm economy.

Extension Education

The North Central Research Extension Center provides information and producer education through a number of Extension specialists located at the Center who work with county Extension agents and state specialists. Activities include consultations and presentations delivered through individual contacts and group meetings, workshops, schools, field days and tours on a variety of topics and issues associated with crop production, livestock production, and resource management. Producers and allied industry are welcomed to contact the NCREC at (701) 857-7682 to discuss issues or concerns with available Extension specialists.

Crop Protection: Activities centered on crop protection focused on pest management, beneficial insects, and native pollinators among area crops. During the 2019 season, extension and research activities were focused on pest management and prevention. Research related activities investigated control of wireworm and flea beetle. Additionally, pest and disease pressure were monitored throughout North Dakota and reported with weekly contributed updates released through the publication of NDSU's Crop & Pest Report. Educational activities included producer attended meetings, summer field tours, beneficial insect and native pollinator field day, and agent trainings. Field tours were well attended and focused on a variety of crop protection/cropping system topics. Pollinator conservation topics were popular with programs offered throughout the region. Youth education continues to serve as an on-going mission in the area with several presentations centered on area entomology and their relation to crop protection and cropping systems.

Soil Health: Activities at the NCREC continued to focus on soil pH, salinity, fertility, and cover crops. County based workshops highlighted management of saline areas and soil fertility. Six soil testing clinics were held across North Dakota to teach producers about soil test interpretation and fertility recommendations. Three saline management studies were monitored and evaluated to determine the effectiveness of managing these areas with perennial crops. Two acid soil remediation projects started this year where results will help producers determine lime application amounts as well as the frequency of lime applications. Year four of a shrub salinity tolerance study continued. A pipeline reclamation study was started this year at the NCREC. Soil replacement methods are being evaluated on their impacts on soil characteristics and crop yields. Three Café Talks were held in oil impacted areas. An oil brine spill tour near Mohall was held for regulators, producers, and industry personnel.

Foundation Seed Increase

The NCREC Foundation Seed program works closely with the Foundation Seedstocks program and plant breeders at NDSU's main campus in Fargo. The NCREC's role is to help facilitate the increase of new varieties from Fargo's main campus out to producers in north central North Dakota. The program also maintains inventory of several popular crop varieties grown in the area.

The varieties that will be available for the 2019-2020 cropping season are: ND Genesis barley, Carpio, Divide, Joppa, ND Grano, ND Riveland durum, Gold ND, and Omega flax, Barlow, Bolles, Duclair, Elgin-ND, ND VitPro, Surpass HRSW, Hayden, Jury, Souris oat, and Ashtabula, ND Henson, ND17009GT, ND18008GT soybean.

Pulse Crop Breeding

The pulse crops breeding program conducts research toward the improvement of three pulse crops—chickpea, dry pea, and lentil. Dr. Nonoy Bandillo, NDSU's director of the pulse breeding and genetics program and assistant professor leads the team with assistance from Hannah Worral, NCREC's Research Specialist based in Minot, North Dakota. Efforts for the 2019 season continued to focus on improving yield within the quality standards of the various market classes within these three species, with a special focus on developing varieties for release that have high yield and quality in the presence of several stress factors—namely Ascochyta blight in chickpea; powdery mildew, virus complexes, and root rot species (e.g., Fusarium and Aphanomyces) in pea; and blight caused by Sclerotinia and stemphylium in lentil. The program has also continued to progress on a genetic study aimed at understanding the inheritance of pea protein content. From the hybridization of selected parents with favorable traits to the evaluation of breeding lines, the pulse program generates new crosses every summer in the field and throughout the winter months in the greenhouse in addition to conducting trials across the state to evaluate experimental lines in different environments. Approved for release in 2017, 'ND Eagle' was grown on 933 acres in seven different counties across the state to increase seed to be available to producers in 2019. Breeder seed increases are ongoing in anticipation of the approval of a high-yielding yellow pea, high-yielding medium green lentils, and a more Ascochyta tolerant, high yielding kabuli chickpea.

Weed Science

Weed control studies are conducted in small grains, canola, carinata, faba bean, sunflower, safflower, flax, dry bean, pea, lentil, chickpea, mustard, corn, and soybean. We are evaluating new herbicides/adjuvants or different uses of existing products in various crops. Other experiments involve evaluation of the impact of different cultural practices such as crop rotation and conventional tillage vs. no-till on crop yield, seed quality, weed control, and economic feasibility. We also conduct IR-4 residue trials to collect data for registration of pest control products in minor crops. We have studies that target specific weeds such as Canada thistle, wild oat, foxtails, biennial wormwood, kochia, narrowleaf hawksbeard, horseweed, and others.

Interpreting Statistical Analysis

Field research involves the testing of one or more variables such as crop varieties, fertilizers, weed control methods, etc. Field testing of such variables are conducted in order to determine which variety, fertilizer, herbicide, etc. is best for the particular area of production. The main objectives of crop production research are to determine the best means of producing a crop and how to maximize yield and economic return from farming. Agricultural researchers use statistics as a tool to help differentiate production variables so that real and meaningful conclusions can be drawn from a relatively large amount of data gathered from relatively small research plots.

One of these tools is the Coefficient of Variability (C.V.). This statistic gives an indication of the amount of variation in an experimental trial and is an indication of the precision or effectiveness of the trial and the procedures used in conducting it. Attempts are made to control human error and some environmental conditions such as soil variability by replicating the variable in question. For example, there were three plots (replications) of the variety Faller grown in the Minot HRSW variety trial. The plots are mixed and dispersed throughout the trial to help eliminate differences that might be a result of soil, chaff rows or other variables. The numbers that you see in the tables are an average of all three replications.

The C.V. for yield in the 2019 Minot HRSW variety trial was 13.7 meaning that there was a 13.7 percent average variation between high and low yields among replications. In summation, a trial with a C.V. of 6 is more precise and more can be concluded from it than a trial with a C.V. of 16.

Another important statistical tool is the Least Significant Difference or LSD. If the yield of variety A exceeds variety B by more than the LSD value, you can conclude that under like environmental conditions, variety A is expected to significantly out-yield variety B. The LSD value allows you to separate varieties, fertilizers, herbicides, or any other variable and determine whether or not they are actually different. An LSD of .05 or 5% is always larger and gives you more precision than an LSD of .1 or 10%. Little confidence can be placed in a variety or treatment unless the results differ by more than the LSD value.

Weather Conditions at Minot	2019 Precipitation	113 Year Long Term Average	Departure from Average	2019 Average Degrees	113 Year Long Term Average	Departure from Average
	---------------Inches---------------			---------------Fahrenheit--------------		
January	0.4	0.6	-0.2	8.4	7.5	+0.9
February	1.8	0.5	+1.3	-5.7	12.0	-17.7
March	0	0.7	-0.7	20.8	24.4	-3.6
April	0.9	1.5	-0.6	41.0	40.6	+0.4
May	0.8	2.3	-1.5	50.0	53.4	-3.4
June	3.2	3.3	-0.1	63.5	62.8	+0.7
July	1.7	2.3	-0.6	68.6	68.5	+0.1
August	2.7	2.0	+0.7	65.3	66.7	-1.4
September	7.8	1.6	+6.2	57.1	56.2	+0.9
October	2.1	1.1	+1.0	37.5	43.9	-6.4
November	0.7	0.7	+0.0	25.8	27.3	-1.5
December	*	0.6	*	*	13.4	*
Total	22.8	17.1	+5.7	39.3	39.7	-0.4

Data not available at time of printing.

	2019	Long Term
Coldest Date	Jan 30	Feb 15, 1936
Coldest Temp	-32	-49
Days ≤ 0°	50	39
Days ≥ 90°	2	12
Highest Date	Jul 31	July 11, 1936
Highest Temp	90	109
Last Spring Frost	May 10	May 19
First Fall Frost	Oct 3	Sep 18
Frost Free Days	145	122
GDD for Corn (May 20-Oct 20)	2078	1994
GDD for Wheat (May 2-Aug 12)	3282	4047
GDD for Sunflower (Jun 6-Nov 4)	2682	2764

Staff and Board of Visitors

Administration

Dr. Shana Forster, Center Director, Interim District Director
Cynthia Cross, Administrative Secretary
Phil Koapke, Information Coordinator

Agronomy

Eric Eriksmoen, Research Agronomist
Joseph Effertz, Ag Research Technician
Austin Kraklau, Research Specialist
Dr. Thomas Stefaniak, Assistant Pulse Crop Breeder (resigned Aug 2019)
Hannah Worral, Research Specialist

Foundation Seed Increase

Lee Novak, Seed Production Specialist
Andrew Bertsch, Ag Research Technician

Weed Science

Dr. Brian Jenks, Weed Scientist
Dana Piesik, Ag Research Technician
Tiffany Walter, Research Specialist
Gary Willoughby, Research Specialist

Grape Program

Chris Asmundson, Ag Research Technician

Extension Education

Dr. Chris Augustin, Area Extension Specialist/Soil Health, Interim District Director
John Dhuyvetter, Area Extension Specialist/Livestock Systems (retired May 2019)
Dr. Travis "TJ" Prochaska, Area Extension Specialist/Crop Protection
Vacant, Area Extension Specialist/Cropping Systems

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Pierce: Brad Fritel, Barton & Todd Lysne, Rugby
Renville: Josh Cook, Kenmare & Brady Witteman, Mohall
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Wells: Paul Anderson, Harvey & Glen Keller, Harvey

North Dakota Hard Red Spring Wheat Variety Descriptions, Agronomic Traits, 2019

Variety	Agent or Origin[1]	Year Released	Height (inches)	Straw Strength[2]	Days to Head[3]	Reaction to Disease[4]: Stem Rust[5]	Leaf Rust	Stripe Rust	Tan Spot	Bact.Leaf Streak	Head Scab
Ambush	DynaGro	2016	29	5	58	1	4	3	NA	6	5
Barlow	ND	2009	30	6	58	1	6	4	6	4	4
Bolles	MN	2015	29	4	62	2	3	5	4	7	5
Boost	SD	2016	30	5	62	1	4	3	8	2	5
Commander	**DynaGro**	**2019**	**28**	**6**	**59**	**NA**	**4**	**NA**	**NA**	**4**	**5**
CP3504	Croplan	2015	27	3	61	1	1	6	8	4	6
CP3530	Croplan	2015	31	5	61	1	2	8	6	5	5
CP3616	Croplan	2016	29	4	60	1	5	5	4	6	6
CP3888	Croplan	2017	28	4	60	NA	1	NA	NA	6	6
CP3910	**Croplan**	**2019**	**27**	**5**	**58**	**NA**	**1**	**NA**	**NA**	**8**	**6**
CP3915	**Croplan**	**2019**	**28**	**4**	**59**	**NA**	**1**	**NA**	**NA**	**4**	**5**
CP3939	**Croplan**	**2019**	**29**	**4**	**59**	**NA**	**3**	**NA**	**NA**	**6**	**6**
Elgin-ND	ND	2012	31	5	59	1	6	5	6	6	4
Faller	ND	2007	30	5	61	1	7	8	7	5	4
Glenn	ND	2005	30	4	58	1	6	4	6	4	4
Lang-MN	MN	2017	30	5	61	1	2	1	7	3	4
Lanning	MT	2017	26	3	60	NA	NA	NA	NA	8	6
LCS Breakaway	Limagrain	2011	26	5	58	1	3	6	4	6	6
LCS Cannon	Limagrain	2018	27	4	57	NA	7	NA	NA	7	6
LCS Rebel	Limagrain	2017	30	5	58	1	7	4	8	4	5
LCS Trigger	Limagrain	2016	29	5	64	1	1	2	6	3	4
Linkert	MN	2013	26	2	60	1	3	1	4	6	5
MN-Washburn	**MN**	**2019**	**27**	**3**	**60**	**NA**	**1**	**NA**	**NA**	**5**	**5**
Mott[6]	ND	2009	32	3	60	1	6	6	6	5	6
MS Barracuda	Meridian	2018	27	3	57	NA	2	NA	NA	7	6
MS Camaro	Meridian	2016	26	5	59	1	1	2	8	7	6
MS Chevelle	Meridian	2014	28	5	59	1	4	3	6	7	6
ND VitPro	ND	2016	29	3	59	1	4	3	7	3	4
Shelly	MN	2016	27	5	61	2	6	5	3	7	5
Surpass	SD	2016	28	5	58	1	4	6	8	4	5
SY 611CL2	**Syngenta/AgriPro**	**2019**	**27**	**5**	**59**	**NA**	**NA**	**NA**	**NA**	**6**	**5**
SY Ingmar	Syngenta/AgriPro	2014	28	3	60	1	3	6	6	5	5
SY Longmire[6]	**Syngenta/AgriPro**	**2019**	**28**	**5**	**60**	**NA**	**7**	**NA**	**NA**	**6**	**7**
SY McCloud	**Syngenta/AgriPro**	**2019**	**28**	**4**	**58**	**NA**	**5**	**NA**	**NA**	**6**	**5**
SY Rockford	Syngenta/AgriPro	2017	30	3	61	NA	NA	NA	NA	8	6
SY Soren	Syngenta/AgriPro	2011	27	3	60	1	2	7	2	7	7
SY Valda	Syngenta/AgriPro	2015	27	4	60	1	2	7	6	6	5
TCG-Climax	21st Century Genetics	2017	29	2	64	1	6	3	8	5	5
TCG-Heartland	**21st Century Genetics**	**2019**	**27**	**5**	**58**	**NA**	**2**	**NA**	**NA**	**7**	**6**
TCG-Spitfire	21st Century Genetics	2015	29	4	62	1	5	4	8	4	6
TCG-Stalwart[6]	**21st Century Genetics**	**2019**	**28**	**4**	**59**	**NA**	**8**	**NA**	**NA**	**9**	**7**

[1] Refers to agent or developer: MN = University of Minnesota; MT = Montana State University; ND = North Dakota State University; SD = South Dakota State University. Bold varieties recently released, data is limited and rating values may change.

[2] Straw Strength = 1 to 9 scale, 1 the strongest, 9 the weakest. Values based on recent data & may change as more data becomes available

[3] Days to Head = number of days from planting to head emergence from boot, averaged based on data from several locations in 2019

[4] Disease reaction scores from 1 to 9, with 1 = resistant and 9 = very susceptible, NA = not available.

[5] Fargo stem rust nursery inoculated with Puccinia graminis f. sp. Tritici races TPMK, TMLK, RTQQ, QFCQ and QTHJ.

[6] Solid stemmed or semisolid stem, imparting resistance to sawfly

-NDSU Publication A574-19 available at www.ag.ndsu.edu.publications

Hard Red Spring Wheat Variety Trial at Minot

Variety	Days to Head	Plant Height	Lodging	Test Weight	Protein	Grain Yield 2017	Grain Yield 2018	Grain Yield 2019	---- Average ---- 2 year	3 year
	DAP[1]	inches	0-9*	lbs/bu	%	---------------------bu/A---------------------				
Faller	63	29	0	61.0	14.2	49.9	101.7	58.0	79.9	69.9
SY Rockford	62	28	0	60.5	15.8	50.6	102.0	50.9	76.4	67.8
LCS Trigger	66	26	0	62.4	13.0	49.2	97.3	54.9	76.1	67.1
TCG Spitfire	64	27	0	62.7	15.1	64.0	85.6	49.8	67.7	66.5
CP3530	62	28	0	61.3	15.6	51.3	92.3	47.0	69.6	63.5
Shelly	63	25	0	61.7	15.8	47.1	97.7	42.4	70.1	62.4
CP3504	62	23	0	61.3	15.4	43.6	93.3	49.7	71.5	62.2
Boost	63	28	0	62.0	15.9	49.3	86.1	50.9	68.5	62.1
Elgin ND	61	29	0	62.2	15.7	50.8	82.8	50.6	66.7	61.4
SY Soren	62	25	0	62.8	16.1	50.8	84.6	48.6	66.6	61.3
DG Ambush	59	27	0	63.6	16.3	48.1	87.7	44.6	66.2	60.1
MS Chevelle	60	26	0	62.2	14.4	45.2	85.1	49.0	67.1	59.8
TCG Climax	65	27	0	62.9	16.6	48.8	84.5	45.5	65.0	59.6
MS Camaro	60	25	0	61.9	16.1	46.9	85.3	44.9	65.1	59.0
SY Valda	62	25	0	63.3	15.0	43.7	88.7	44.6	66.7	59.0
Barlow	59	28	0	63.9	16.1	48.2	82.4	46.2	64.3	58.9
Bolles	63	28	0	61.1	17.9	48.6	81.8	45.6	63.7	58.7
Lang-MN	63	29	0	62.7	15.7	46.9	77.6	50.6	64.1	58.4
CP3616	60	27	0	61.3	16.9	48.3	81.2	45.3	63.3	58.3
Glenn	59	26	0	63.5	16.1	50.6	82.2	39.2	60.7	57.3
LCS Rebel	61	29	0	63.2	15.5	46.8	74.5	48.3	61.4	56.5
Mott**	63	30	0	61.3	15.6	42.9	76.0	49.2	62.6	56.0
SY Ingmar	61	25	0	63.4	17.2	47.7	82.3	37.0	59.6	55.7
Linkert	61	24	0	61.7	17.6	39.2	84.5	42.4	63.4	55.4
Surpass	59	25	0	61.2	15.8	40.7	78.4	39.0	58.7	52.7
LCS Breakaway	59	25	0	63.4	16.8	34.9	76.5	42.5	59.5	51.3
ND VitPro	60	26	0	62.8	16.7	35.2	77.1	39.1	58.1	50.5
MS Barracuda	59	26	0	62.2	15.8		94.6	51.8	73.2	--
Lanning	61	25	0	61.7	16.6	--	94.3	47.9	71.1	--
AAC Penhold	61	25	0	62.3	16.2	--	89.5	48.5	69.0	--
SY611CL2	61	25	0	64.2	16.1	--	90.8	47.1	69.0	--
CP3888	61	26	0	61.4	16.6	--	90.2	43.6	66.9	--
SY McCloud	60	27	0	63.1	17.0	--	90.8	41.0	65.9	--
AAC Brandon	61	28	0	62.0	16.8	--	83.1	46.9	65.0	--
SY Longmire**	61	25	0	62.7	16.4	--	81.0	47.0	64.0	--
MN Washburn	62	24	0	62.1	15.2	--	80.4	47.3	63.8	--
LCS Cannon	59	25	0	63.7	16.2	--	84.5	43.1	63.8	--
AAC Goodwin	62	27	0	63.0	15.8	--	78.0	49.1	63.5	--
DG Commander	61	26	0	63.0	15.3	--	--	55.7	--	--
CP3915	61	26	0	63.2	15.1	--	--	50.3	--	--
TCG Heartland	59	26	0	63.5	16.6	--	--	49.5	--	--
CP3910	60	26	0	63.6	16.0	--	--	48.5	--	--
TCG Stalwart**	61	26	0	60.8	16.2	--	--	48.2	--	--
Duclair**	60	26	0	61.1	15.3	--	--	47.2	--	--
CP3939	61	27	0	61.5	16.3	--	--	44.9	--	--
Trial Mean	61	27	0	62.4	16.0	48.1	86.1	47.0	--	--
C.V.%	1.4	5.2	0	0.6	3.9	12.7	10.2	13.7	--	--
LSD 5%	1	2	NS	0.6	1.0	9.9	14.3	10.4	--	--
LSD 10%	1	2	NS	0.5	0.8	8.3	11.9	8.7	--	--

[1] DAP = Days after planting. **Lodging: 0 = none, 9 = lying flat on the ground.*

*** Wheat Stem Sawfly tolerant.* *NS = no statistical differences between varieties.*

No-till planted on April 23 with a seeding rate of 1.25 million PLS/A and harvested on August 19.

Previous Crop: 2016 = canola, 2017 & 2018 = soybean. *Soil Type: Williams Loam*

Hard Red Spring Wheat Variety Trial at Mohall
Cooperators: Dean Schoenberg and the Renville/Bottineau Ag Improvement Association

	Plant		Test		Grain Yield				
								-- Average --	
Variety	Height	Lodging	Weight	Protein	2017	2018	2019	2 yr	3 yr
	inches	0-9*	lbs/bu	%	---bu/A---				
SY Valda	25	0	63.1	14.5	84.4	67.0	50.6	58.8	67.3
Elgin ND	30	0	62.6	15.1	79.1	67.2	54.3	60.8	66.9
SY Ingmar	26	0	63.7	15.1	80.3	57.4	49.1	53.3	62.3
ND VitPro	29	0	64.8	14.7	75.8	58.0	50.6	54.3	61.5
Glenn	29	0	64.9	15.6	73.8	60.1	50.5	55.3	61.5
Linkert	25	0	62.8	15.7	83.4	52.0	48.2	50.1	61.2
SY Soren	23	0	63.1	15.9	75.6	52.8	46.4	49.6	58.3
Bolles	27	0	62.2	16.9	68.7	54.3	49.1	51.7	57.4
TCG Spitfire	28	0	61.1	14.1	--	75.9	59.7	67.8	--
DG Ambush	27	0	63.7	15.1	--	60.4	52.1	56.3	--
Mott	30	0	62.8	15.3	--	65.0	53.0	59.0	--
LCS Rebel	27	0	64.3	15.0	--	--	56.0	--	--
CP3888	26	0	61.9	15.2	--	--	53.0	--	--
Lanning	25	0	61.4	16.1	--	--	52.1	--	--
MS Barracuda	25	0	63.1	15.0	--	--	51.5	--	--
SY McCloud	27	0	63.4	15.5	--	--	51.2	--	--
LCS Cannon	25	0	63.2	14.7	--	--	50.0	--	--
MN Washburn	25	0	61.0	14.4	--	--	49.3	--	--
Duclair	27	0	60.2	14.3	--	--	55.0	--	--
TCG Stalwart	27	0	60.4	15.5	--	--	54.3	--	--
SY Longmire	27	0	62.3	15.0	--	--	51.9	--	--
Trial Mean	27	0	62.7	15.2	75.3	62.7	52.2	--	--
C.V.%	6.8	0	1.5	2.7	6.5	6.7	8.4	--	--
LSD 5%	3	NS	1.3	0.6	6.9	5.9	6.2	--	--
LSD 10%	2	NS	1.1	0.5	5.7	4.9	5.2	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*
NS = no statistical difference between varieties.
***Bold** = solid stem sawfly tolerant varieties.*

Planted on April 25 with a seeding rate of 1.25 million PLS/A and harvested on August 22.
Previous Crop: 2016 & 2017 = durum, 2018 = canola.
Tillage: minimum till
Soil Type: Barnes loam

Hard Red Spring Wheat Variety Trial at Rugby

Cooperators: Dave Teigen and the Pierce County Crop Improvement Association

Variety	Plant Height	Lodging	Test Weight	Protein	Grain Yield 2017	2018	2019	-- Average -- 2 yr	3 yr
	inches	0-9*	lbs/bu	%	---bu/A---				
Elgin ND	34	0	61.2	14.1	71.4	71.9	67.7	69.8	70.3
SY Soren	28	0	61.5	14.5	59.7	82.7	60.8	71.7	67.7
SY Valda	29	0	60.9	13.4	63.1	73.7	64.8	69.2	67.2
Linkert	29	0	61.3	15.3	71.3	71.0	58.9	65.0	67.1
SY Ingmar	29	0	60.9	14.5	64.6	70.6	59.9	65.2	65.0
Glenn	32	0	62.1	15.3	54.5	73.6	61.7	67.6	63.3
Bolles	31	0	60.5	15.6	45.3	69.8	62.3	66.0	59.1
ND VitPro	31	0	60.7	15.3	49.0	66.1	61.6	63.9	58.9
TCG Spitfire	31	0	58.8	14.3	--	85.4	61.4	73.4	--
DG Ambush	30	0	61.9	15.0	--	77.4	64.8	71.1	--
CP3888	31	0	59.9	14.0	--	--	67.7	--	--
Lanning	29	0	59.1	14.8	--	--	67.2	--	--
LCS Rebel	32	0	62.0	14.4	--	--	65.7	--	--
LCS Cannon	29	0	62.4	14.2	--	--	64.8	--	--
SY McCloud	29	0	62.4	14.6	--	--	64.4	--	--
MN Washburn	30	0	60.5	14.5	--	--	62.5	--	--
MS Barrcuda	28	0	61.3	14.6	--	--	61.7	--	--
SY Longmire	28	0	59.0	14.3	--	--	63.1	--	--
Duclair	31	0	58.3	13.5	--	--	60.7	--	--
TCG Stalwart	29	0	58.7	14.8	--	--	57.7	--	--
Mott	36	0	61.3	15.0	--	--	55.5	--	--
Trial Mean	31	0	60.9	14.5	58.9	76.7	62.9	--	--
C.V.%	4.6	0	1.1	3.5	12.6	6.7	5.7	--	--
LSD 5%	2	NS	1.0	0.7	12.2	7.2	5.1	--	--
LSD 10%	2	NS	0.8	0.6	10.2	6.0	4.2	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*

NS = no statistical difference between varieties.

***Bold** = solid stem sawfly tolerant varieties.*

Planted on April 23 with a seeding rate of 1.25 million PLS/A and harvested on August 22.

Previous Crop: 2016 = field pea, 2017 = barley, 2018 = soybean

Tillage: minimum till

Soil Type: Gardena silt loam

Hard Red Spring Wheat Variety Trial at Garrison
Cooperators: Brian and Roger Bendickson, Garrison

					Grain Yield				
	Plant		Test					-- Average --	
Variety	Height	Lodging	Weight	Protein	2017	2018	2019	2 yr	3 yr
	inches	0-9*	lbs/bu	%	----------------------	---------------------- bu/A	----------------------		
SY Valda	24	0	60.0	13.7	22.8	65.7	61.1	63.4	49.9
Elgin ND	32	0	60.9	14.8	20.3	71.5	57.3	64.4	49.7
ND VitPro	29	0	62.5	15.4	24.2	57.1	59.6	58.3	47.0
Linkert	25	0	60.9	15.3	20.1	60.8	57.6	59.2	46.2
SY Ingmar	26	0	61.3	14.8	17.2	62.5	56.9	59.7	45.5
Glenn	31	0	64.1	15.0	18.9	61.0	54.9	57.9	44.9
Bolles	28	0	60.6	16.7	18.6	62.4	50.9	56.7	44.0
SY Soren	27	0	62.1	14.6	17.1	57.1	55.8	56.4	43.3
TCG Spitfire	26	0	59.9	14.0	--	68.4	61.2	64.8	--
DG Ambush	28	0	62.6	14.8	--	67.5	57.5	62.5	--
LCS Rebel	31	0	62.3	14.3	--	--	64.4	--	--
SY McCloud	27	0	62.3	14.7	--	--	63.0	--	--
MN Washburn	27	0	60.7	14.6	--	--	60.7	--	--
MS Barracuda	27	0	61.3	13.4	--	--	60.0	--	--
CP3888	27	0	59.5	13.9	--	--	59.5	--	--
Lanning	26	0	60.3	15.0	--	--	58.3	--	--
LCS Cannon	28	0	62.2	13.7	--	--	56.8	--	--
SY Longmire	26	0	61.7	14.6	--	--	63.6	--	--
Duclair	28	0	59.0	13.9	--	--	58.8	--	--
TCG Stalwart	26	0	59.5	15.2	--	--	55.5	--	--
Mott	31	0	61.4	15.1	--	--	49.9	--	--
Trial Mean	28	0	61.3	14.6	18.9	65.4	57.9	--	--
C.V.%	6.1	0	0.8	3.3	19.9	6.4	7.9	--	--
LSD 5%	2	NS	0.7	0.7	5.3	5.9	6.5	--	--
LSD 10%	2	NS	0.6	0.6	4.4	5.0	5.4	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*
NS = no statistical difference between varieties.
Bold *= solid stem sawfly tolerant varieties.*

Planted on April 26 with a seeding rate of 1.25 million PLS/A and harvested on August 21.
Previous Crop: 2016 = barley, 2017 = spring wheat, 2018 = soybean.
Tillage: no-till
Soil Type: Williams Bowbells loam
Note: The 2017 trial sustained severe drought and wheat stem sawfly damage.

Hard Red Spring Wheat Variety Trial at Wilton
Cooperator: Wes Doepke, Wilton

					Grain Yield				
	Plant		Test					---- Average ----	
Variety	Height	Lodging	Weight	Protein	2017	2018	2019	2 yr	3 yr
	inches	0-9*	lbs/bu	%	----------------------bu/A----------------------				
SY Soren	25	3	62.2	14.5	39.6	71.6	51.0	61.3	54.1
Linkert	24	1	62.4	15.0	40.4	69.1	52.3	60.7	53.9
ND VitPro	28	4	61.9	15.0	37.8	69.3	53.8	61.5	53.6
Elgin ND	30	6	62.4	14.6	39.6	71.8	47.6	59.7	53.0
SY Ingmar	25	4	62.1	14.9	37.5	72.2	49.2	60.7	53.0
Glenn	30	3	62.0	15.5	36.3	70.3	52.1	61.2	52.9
SY Valda	25	3	62.1	14.5	42.9	64.7	49.0	56.8	52.2
Bolles	25	1	62.4	16.9	37.1	68.3	48.8	58.5	51.4
TCG Spitfire	26	7	62.0	14.5	--	84.1	48.7	66.4	--
DG Ambush	27	4	62.3	15.1	--	74.0	54.6	64.3	--
SY McCloud	26	4	62.3	14.6	--	--	55.4	--	--
LCS Cannon	26	2	62.3	14.2	--	--	53.8	--	--
CP3888	26	4	62.1	14.5		--	53.0	--	--
LCS Rebel	28	5	62.4	15.1	--	--	51.7	--	--
MN Washburn	25	1	61.9	14.7	--	--	50.1	--	--
MS Barracuda	27	3	62.2	15.1	--	--	49.7	--	--
Lanning	25	7	61.8	15.5	--	--	46.0	--	--
Mott	30	3	62.4	15.8	--	--	48.8	--	--
SY Longmire	25	4	61.9	15.3	--	--	47.7	--	--
TCG Stalwart	25	5	61.9	15.8	--	--	45.3	--	--
Duclair	26	5	61.8	15.1	--	--	44.0	--	--
Trial Mean	27	4	62.1	15.1	38.4	72.0	50.1	--	--
C.V.%	4.9	32	0.2	2.0	9.1	5.8	7.9	--	--
LSD 5%	2	2	0.2	0.4	5.0	5.9	5.6	--	--
LSD 10%	2	1	0.2	0.4	4.1	5.0	4.7	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*
Bold *= solid stem sawfly tolerant varieties.*

Planted on April 26 with a seeding rate of 1.25 million PLS/A and harvested on August 21.
Previous Crop: 2016 = wheat, 2017 = soy, 2018 = corn.
Tillage: minimum till
Soil Type: Mandan silt loam
Note: The 2017 trial sustained severe drought and moderate hail damage.

HRSW Yield Results from the North Central Region **Combined Means**

Variety	Lodging	Days to Head	Plant Height	Test Weight	Protein	Grain Yield 2017	2018	2019	2 Year	3 Year
	0-9*	DAP[1]	inches	lbs/bu	%	----------------------bu/A----------------------				
Elgin ND	6	61	31	61.9	14.9	49.9	73.0	55.5	64.3	59.5
SY Valda	3	62	26	61.9	14.2	48.6	72.0	54.0	63.0	58.2
SY Soren	3	62	26	62.3	15.1	45.4	69.8	52.5	61.1	55.9
Glenn	3	59	30	63.3	15.5	45.8	69.4	51.7	60.6	55.6
Linkert	1	61	25	61.8	15.8	47.4	67.5	51.9	59.7	55.6
ND VitPro	4	60	28	62.5	15.4	42.0	65.5	52.9	59.2	53.5
Bolles	1	63	28	61.4	16.8	40.7	67.3	51.3	59.3	53.1
TCG Spitfire	7	64	28	60.9	14.4	--	79.9	56.2	68.0	--
DG Ambush	4	59	28	62.8	15.2	--	73.4	54.7	64.1	--
SY Ingmar	4	61	26	62.3	15.3	45.6	69.0	50.4	59.7	--
LCS Rebel	5	61	29	62.8	14.9	--	--	57.2	--	--
CP3888	4	61	27	61.0	14.8	--	--	55.3	--	--
SY McCloud	4	60	27	62.7	15.3	--	--	55.0	--	--
MS Barracuda	3	59	27	62.0	14.8	--	--	54.9	--	--
SY Longmire	4	61	26	61.5	15.1	--	--	54.7	--	--
Lanning	7	61	26	60.9	15.6	--	--	54.3	--	--
MN Washburn	1	62	26	61.2	14.7	--	--	54.0	--	--
LCS Cannon	2	59	27	62.8	14.6	--	--	53.7	--	--
Duclair	5	60	28	60.1	14.4	--	--	53.2	--	--
TCG Stalwart	5	61	27	60.3	15.5	--	--	52.2	--	--
Mott	3	63	31	61.8	15.4	--	--	51.3	--	--
# of Trials	1	1	5	5	5	6	5	5	10	16

**Lodging: 0 = none, 9 = lying flat on the ground.*

[1] DAP = Days after planting.

Locations: Minot, Garrison, Mohall, Rugby, Wilton

2019 Nitrogen Fertilizer Additives in Spring Wheat at Minot

TRT	Product	Heading Date	Plant Height	Test Weight	Grain Protein	Harvest Moisture	Grain Yield
		DAP[1]	inches	lbs/bu	%	%	bu/A
1	No applied N fertilizer	62	26	63.6	14.5	14.6	43.1
2	124 lbs/A NZONE MAX treated Urea applied mid-row	63	28	63.3	15.1	14.3	56.8
3	124 lbs/A ContaiN MAX treated Urea applied mid-row	62	27	--	--	14.5	61.5
4	124 lbs/A Agrotain Ultra treated Urea applied mid-row	62	27	63.2	15.1	15.7	55.4
5	124 lbs/A Untreated Urea applied mid-row	62	27	63.0	15.7	14.1	54.5
6	93 lbs/A NZONE Max treated Urea applied mid-row	63	28	--	--	14.6	55.9
7	93 lbs/A ContaiN MAX treated Urea applied mid-row	63	27	--	--	15.0	52.7
8	93 lbs/A Agrotain Ultra treated Urea applied mid-row	62	27	63.2	15.4	15.0	57.1
9	93 lbs/A Untreated Urea applied mid-row	62	27	63.2	15.0	14.2	53.1
10	124 lbs/A ContaiN Max treated Urea surface broadcast	63	28	63.6	14.6	15.5	52.9
11	124 lbs/A Untreated Urea surface broadcast	62	28	63.1	14.1	15.5	53.9
12	61 lbs/A ContaiN Max treated urea applied mid-row + 61 lbs/A ContaiN Max treated urea broadcast at flag leaf	62	27	63.0	14.8	14.6	55.0
13	61 lbs/A Untreated Urea applied mid-row + 61 lbs/A ContaiN Max treated urea broadcast at flag leaf	62	28	63.5	15.0	14.6	56.0
Trial Mean		62	27	63.4	14.8	14.8	54.4
C.V. %		1.5	4.4	--	--	7.8	4.4
LSD 0.05		NS	NS	--	--	NS	4.1

[1] *Days After Planting*   *NS = no statistical difference between treatments.*

Tillage = No-till. Previous crop = soybean. Soil type = Williams loam.

Summary: The trial was planted on April 24 with SY Ingmar hard red spring wheat. Fertilizer treatments 2 - 9 were applied in a mid-row band at planting. Fertilizer treatments 10 and 11 were applied to the soil surface at planting. Fertilier treatments 12 and 13 had split applications of fertilizer as stated. Residual soil nitrogen was 28 pounds per acre at 0-24" plus an additional 40 lbs/A soy credit. The trial was harvested on August 20. There were no statistical differences between treatments for heading date, plant height or harvest moisture. Grain proteins and test weights were not statistically analyzed. The 124 lbs/A ContaiN MAX treatment (trt 3) produced a significantly higher yield than other 124 lbs/A treatments (trts 2, 3 and 5). 93 lbs/A treatments (trts 6 -8) produced statistically similar yields to the 93 lbs/A untreated urea check (trt 9). Split applications (trts 12 and 13) did not enhance yields or seed quality compared to the 124 lbs/A untreated check (trt 5). Surface applied ContaiN MAX (trt 10) produced a similar yield and seed quality to the untreated surface application (trt 11) and both of these treatments produced significantly less yield than the soil incorporated ContaiN MAX treatment (trt 3).

2019 AgXplore Foliar Fertilizers in Spring Wheat at Minot

TRT	Product	Heading Date	Plant Height	Test Weight	Grain Protein	Harvest Moisture	Grain Yield
		DAP*	inches	lbs/bu	%	%	bu/A
1	Untreated	63	26	60.4	12.3	13.7	50.5
2	16 oz/A NutriPak[1] at 4 leaf + 16 oz/A NutriPak at flag leaf	63	27	60.3	12.0	13.7	48.5
3	16 oz/A SulPak 17[2] at 4 leaf + 16 oz/A SulPak 17 at flag leaf	63	27	60.6	12.1	13.9	50.7
4	32 oz/A NitroUltra[3] at 4 leaf	63	26	60.4	12.2	13.7	48.2
5	12 oz/A ValuPak[4] at flag leaf	63	27	60.2	12.3	13.7	47.9
Trial Mean		63	27	60.4	12.2	13.8	49.2
C.V. %		1.6	4.8	0.6	4.0	3.0	6.5
LSD 0.05		NS	NS	NS	NS	NS	NS

**Days After Planting*

[1] *AgXplore NutriPak: 8-10-2*

[2] *AgXplore SulPak 17: 8-0-0-17S*

[3] *AgXplore NitroUltra: 10-0-0-0.05B-0.2Cu-0.2Fe-0.1Mn-0.1Mg-0.2Zn*

[4] *AgXplore ValuPak: 7-12-1*

NS = no statistical difference between treatments.

Summary: The primary objective of this trial was to enhance grain protein content and overall plant vitality with various foliar fertilizer treatments. The trial was planted with SY Rockford hard red spring wheat into no-till soybean stubble on April 24 . 50 lbs/A potash (0-0-60) and 50 lbs/A AMS were applied in a mid-row band at planting. 50 lbs/A of MAP (11-52-0) was also applied with the seed at planting. Residual soil fertility levels at 0 - 24" were 25 lbs/A N (+ 40 lbs/A legume crop N crdit), 21 ppm P and 464 ppm K. Soil is a Williams loam with a pH of 6.9. Foliar treatments were applied to 4 leaf wheat on June 4 and to flag leaf wheat on June 17. Fertilizer treatments were mixed with water and applied at a rate of 20 gallons/A with a CO_2 propelled backpack sprayer. The trial was harvested on August 20. None of the foliar fertilizer treatments provided any enhancement to test weight, grain protein or grain yield.

Descriptions and agronomic traits of durum wheat varieties grown in North Dakota, 2019

Variety	Agent or Origin[1]	Year Released	Height (inches)[2]	Straw Strength[3]	Days to Head[4]	Reaction to Disease[5]: Stem Rust[5]	Leaf Rust	Foliar Disease	Bact.Leaf Streak	Head Scab
AC Commander	Can.	2002	31	5	60	1	1	6	NA	NA
Alkabo	ND	2005	33	2	61	1	1	5	7	6
Alzada	WB	2004	28	6	59	1	1	8	NA	9
Ben	ND	1996	35	3	60	1	1	4	7	8
Carpio	ND	2012	34	5	63	1	1	5	6	5
CDC Verona	Can.	2010	32	4	61	1	1	4	NA	8
Divide	ND	2005	35	5	62	1	1	5	7	5
Grenora	ND	2005	32	5	60	1	1	5	7	6
Joppa	ND	2013	33	5	61	1	1	5	7	5
Lebsock	ND	1999	33	3	60	1	1	5	7	6
Maier	ND	1998	32	5	61	1	1	5	NA	8
Mountrail	ND	1998	34	5	62	1	1	5	7	8
ND Grano[6]	ND	2017	34	5	63	1	1	NA	7	6
ND Riveland[6]	ND	2017	34	4	61	1	1	NA	7	5
Pierce	ND	2001	32	5	61	1	1	6	7	8
Rugby	ND	1973	36	5	60	1	1	4	NA	8
Strongfield[6]	Can.	2004	34	6	62	1	1	6	NA	8
Tioga	ND	2010	29	4	61	1	1	5	7	6
VT Peak	Viterra	2010	25	6	61	NA	NA	NA	NA	NA

[1] Refers to agent or developer: Can. = Agriculture Canada, WB = Westbred, ND = North Dakota State University.

[2] Plant height was obtained from the average of six variety trials in 2018.

[3] Straw Strength = 1-9 scale, 1 the strongest & 9 the weakest. Based on recent data. These values may change as more data becomes available.

[4] Days to Heading = the number of days from planting to head emergence from the boot. Averaged from several locations in 2018.

[5] Disease reaction scores from 1-9, with 1 = resistant and 9 = very susceptible. NA = Not adequately tested. Foliar Disease = reaction to tan spot and septoria leaf spot complex.

[6] Low cadmium accumulating variety

-NDSU Publication A1067-19 available at www.ag.ndsu.edu.publications

Durum Variety Trial at Minot

Variety	Days to Head	Plant Height	Lodging	Test Weight	Protein	Grain Yield 2016	2018	2019	Average 2 year	3 year
	DAP[1]	inches	0-9*	lbs/bu	%	bu/A				
ND Grano	65	29	0	61.2	15.1	78.1	86.7	50.9	68.8	71.9
Joppa	62	25	0	61.8	15.1	78.3	86.0	46.0	66.0	70.1
VT Peak	62	25	0	62.3	15.4	77.4	81.9	47.9	64.9	69.1
Carpio	65	26	0	62.3	13.8	72.5	82.2	52.4	67.3	69.0
Mountrail	65	27	0	61.8	14.2	72.5	78.8	55.3	67.1	68.9
TCG Bright	63	26	0	61.4	14.0	81.4	70.0	50.2	60.1	67.2
Divide	65	28	0	62.3	15.2	64.2	75.9	56.7	66.3	65.6
Lebsock	62	25	0	63.1	15.2	66.7	82.0	41.6	61.8	63.4
ND Riveland	64	26	0	61.3	16.0	71.0	80.5	36.5	58.5	62.7
Ben	62	28	0	60.9	15.8	61.8	74.9	49.1	62.0	61.9
Alkabo	63	25	0	61.1	14.9	72.3	70.3	40.3	55.3	61.0
Grenora	61	24	0	59.4	15.3	69.1	67.0	44.2	55.6	60.1
Maier	62	25	0	60.4	16.7	66.1	70.7	43.0	56.8	59.9
Tioga	64	29	0	59.2	15.9	51.7	77.1	47.3	62.2	58.7
Pierce	63	25	0	60.5	15.2	61.3	72.6	41.7	57.2	58.5
CDC Verona	63	23	0	60.3	16.5	59.7	67.9	44.5	56.2	57.4
Rugby	62	27	0	59.6	17.6	59.1	78.0	30.4	54.2	55.8
AC Commander	62	23	0	60.0	15.1	61.1	58.9	45.7	52.3	55.2
Strongfield	64	28	0	61.2	16.6	45.7	65.7	48.5	57.1	53.3
Normanno	62	19	0	58.7	15.4	61.3	59.9	35.7	47.8	52.3
Alzada	62	21	0	59.6	15.4	60.9	58.3	35.3	46.8	51.5
TCG Webster	61	20	0	60.0	15.0		71.3	37.0	54.1	
Trial Mean	63	26	0	60.6	15.6	70.9	74.9	44.6	--	--
C.V.%	1.6	8.0	0	2.1	5.0	6.7	4.8	13.2	--	--
LSD 5%	2	3	NS	2.1	1.3	7.7	5.9	9.5	--	--
LSD 10%	1	3	NS	1.7	1.1	6.4	4.9	8.0	--	--

[1] DAP = Days after planting. **Lodging: 0 = none, 9 = lying flat on the ground.*

NS = no statistical difference between varieties.

No-till planted on April 23 with a seeding rate of 1.5 million PLS/A and harvested on August 20.

Previous Crop: 2015, 2017 & 2018= soybean. *Soil Type: Williams Loam*

Note: There is no data from 2017.

Durum Variety Trial at Mohall

Cooperators: Dean Schoenberg and the Renville/Bottineau Ag Improvement Association

					Grain Yield				
	Plant		Test					-- Average --	
Variety	Height	Lodging	Weight	Protein	2017	2018	2019	2 yr	3 yr
	inches	0-9*	lbs/bu	%	bu/A				
Grenora	25	0	60.2	14.0	72.4	54.2	47.5	50.8	58.0
Joppa	26	0	62.3	14.0	74.0	50.5	48.0	49.2	57.5
Carpio	25	0	62.0	13.2	67.0	55.1	48.0	51.5	56.7
Alkabo	25	0	61.4	13.6	63.8	56.5	45.6	51.0	55.3
Mountrail	26	0	60.8	13.7	68.1	47.0	48.6	47.8	54.6
ND Riveland	29	0	61.9	14.0	69.0	48.6	45.8	47.2	54.5
ND Grano	26	0	61.9	14.0	61.3	48.8	46.2	47.5	52.1
Divide	25	0	60.9	14.9	56.5	43.3	44.0	43.6	47.9
Tioga	28	0	61.0	15.2	--	52.2	42.8	47.5	--
Lebsock	24	0	61.2	14.5	--	49.0	43.5	46.3	--
Trial Mean	26	0	61.4	14.1	67.5	50.8	46.0	--	--
C.V.%	5.1	0	1.0	3.3	7.8	11.5	10.3	--	--
LSD 5%	2	NS	0.8	0.7	7.7	8.4	NS	--	--
LSD 10%	2	NS	0.7	0.6	6.4	7.0	NS	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*
NS = no statistical difference between varieties.

Planted on April 25 with a seeding rate of 1.5 million PLS/A and harvested on August 22.
Previous Crop: 2016 & 2017 = durum, 2018 = canola.
Tillage: minimum till
Soil Type: Barnes loam

Durum Variety Trial at Rugby

Cooperators: Dave Teigen and the Pierce County Crop Improvement Association

					Grain Yield				
	Plant		Test					-- Average --	
Variety	Height	Lodging	Weight	Protein	2017	2018	2019	2 yr	3 yr
	inches	0-9*	lbs/bu	%	bu/A				
ND Riveland	32	0	62.1	14.0	70.8	69.6	60.1	64.8	66.8
ND Grano	30	0	62.1	14.4	63.4	70.1	58.4	64.2	64.0
Carpio	31	0	61.6	14.0	64.9	67.9	55.2	61.5	62.7
Joppa	30	0	61.3	14.1	48.4	79.1	53.2	66.2	60.2
Alkabo	30	0	61.7	14.2	45.7	71.0	56.3	63.7	57.7
Divide	30	0	60.6	15.0	41.6	74.8	53.2	64.0	56.5
Mountrail	30	0	60.9	13.8	41.2	72.5	55.6	64.1	56.4
Grenora	29	0	59.4	14.6	45.8	59.9	57.6	58.7	54.4
Tioga	33	0	61.0	14.6	--	68.5	58.4	63.4	--
Lebsock	28	0	61.3	14.2	--	63.7	51.6	57.6	--
Trial Mean	30	0	61.2	14.3	52.0	70.1	56.0	--	--
C.V.%	4.5	0	0.9	1.9	12.7	6.3	6.4	--	--
LSD 5%	2	NS	0.8	0.4	11.3	6.4	5.2	--	--
LSD 10%	2	NS	0.7	0.3	9.4	5.3	4.3	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*
NS = no statistical difference between varieties.

Planted on April 23 with a seeding rate of 1.5 million PLS/A and harvested on August 22.
Previous Crop: 2016 = field pea, 2017 = barley, 2018 = soybean
Tillage: minimum till
Soil Type: Gardena silt loam

Durum Variety Trial at Garrison
Cooperators: Brian and Roger Bendickson, Garrison

Variety	Plant Height	Lodging	Test Weight	Protein	Grain Yield 2017	2018	2019	-- Average -- 2 yr	3 yr
	inches	0-9*	lbs/bu	%	bu/A				
Mountrail	29	0	60.9	12.7	20.7	63.2	59.8	61.5	47.9
ND Grano	31	0	61.7	13.9	18.8	62.4	61.3	61.8	47.5
Grenora	29	0	58.8	13.5	18.3	65.7	54.7	60.2	46.2
Alkabo	29	0	60.8	13.7	19.6	59.8	57.3	58.5	45.6
ND Riveland	32	0	61.3	14.2	21.4	57.9	57.0	57.4	45.4
Joppa	30	0	60.9	13.3	16.7	62.8	56.4	59.6	45.3
Carpio	30	0	61.4	13.5	18.3	61.3	53.8	57.6	44.5
Divide	31	0	61.4	13.9	19.1	58.3	52.4	55.4	43.3
Tioga	32	0	60.5	13.5	--	63.6	54.6	59.1	--
Lebsock	28	0	60.6	13.3	--	62.9	52.9	57.9	--
Trial Mean	30	0	60.8	13.5	19.0	61.8	56.0	--	--
C.V.%	6.4	0	1.0	2.8	21.6	11.3	6.0	--	--
LSD 5%	3	NS	0.8	0.5	NS	NS	4.9	--	--
LSD 10%	2	NS	0.7	0.4	NS	NS	4.1	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*
NS = no statistical difference between varieties.

Planted on April 26 with a seeding rate of 1.5 million PLS/A and harvested on August 21.
Previous Crop: 2016 = barley, 2017 = spring wheat, 2018 = soybean.
Tillage: no-till
Soil Type: Williams Bowbells loam
Note: The 2017 trial sustained severe drought and wheat stem sawfly damage.

Durum Variety Trial at Wilton
Cooperator: Wes Doepke, Wilton

Variety	Plant Height	Lodging	Test Weight	Protein	Grain Yield 2017	2018	2019	-- Average -- 2 yr	3 yr
	inches	0-9*	lbs/bu	%	bu/A				
Grenora	25	2	54.0	15.5	41.8	75.0	40.5	57.8	52.4
ND Grano	26	1	56.3	15.9	42.0	67.2	41.1	54.2	50.1
ND Riveland	27	1	58.9	15.6	43.3	66.3	39.6	52.9	49.7
Mountrail	25	2	56.5	15.3	39.6	57.9	42.1	50.0	46.5
Carpio	25	2	57.9	15.7	43.6	53.5	41.8	47.6	46.3
Joppa	25	3	57.1	15.3	44.0	55.5	38.9	47.2	46.1
Alkabo	25	1	57.6	15.3	38.4	57.1	39.9	48.5	45.1
Divide	25	4	57.5	16.1	33.0	62.2	36.2	49.2	43.8
Tioga	27	2	57.0	16.2	--	55.6	39.9	47.8	--
Lebsock	25	2	56.9	15.5	--	53.0	36.4	44.7	--
Trial Mean	26	2	57.0	15.6	41.0	60.6	39.6	--	--
C.V.%	4.9	35	1.3	1.7	10.9	6.5	8.1	--	--
LSD 5%	2	1	1.1	0.4	6.5	5.7	4.7	--	--
LSD 10%	1	1	0.9	0.3	5.4	4.7	3.9	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*

Planted on April 26 with a seeding rate of 1.5 million PLS/A and harvested on August 21.
Previous Crop: 2016 = wheat, 2017 = soy, 2018 = corn.
Tillage: minimum till
Soil Type: Mandan silt loam

2019 Durum Yield Results from the North Central Region **Combined Means**

Variety	Plant Height	Lodging	Test Weight	Protein	Grain Yield 2017	2018	2019	Average 2 Year	3 Year
	inches	0-9*	lbs/bu	%	----------------------	-----------bu/A	-----------	----------------------	
ND Grano	28	1	60.6	14.6	46.4	67.0	51.6	59	55
ND Riveland	29	1	61.1	14.7	51.1	64.6	47.8	56	54
Carpio	27	2	61.1	14.0	48.5	64.0	50.2	57	54
Joppa	27	3	60.7	14.4	45.8	66.8	48.5	58	54
Mountrail	28	2	60.2	13.9	42.4	63.9	52.3	58	53
Grenora	26	2	58.3	14.6	44.6	64.4	48.9	57	53
Alkabo	27	1	60.5	14.3	41.9	62.9	47.9	55	51
Divide	28	4	60.5	15.0	37.6	62.9	48.5	56	50
Tioga	30	2	59.7	15.1	--	63.4	48.6	56	--
Lebsock	26	2	60.6	14.5	--	62.1	45.2	54	--
# of Trials	5	1	5	5	4	5	5	10	14

**Lodging: 0 = none, 9 = lying flat on the ground.*

Locations: 2017: Garrison, Mohall, Rugby, Wilton
Locations: 2018 & 2019: Minot, Garrison, Mohall, Rugby, Wilton

2019 North Dakota Barley Variety Descriptions

Variety	Use[1]	Origin[2]	Year Released	Awn Type[3]	Rachilla Hair Length[4]	Aleurone Color	Height (inch)	Days to Head	Straw Stength[5]	Reaction toi Disease[6] Stem Rust	Spot form Blotch	Spot Blotch	Net Blotch
2 Row Types													
AAC Connect	M/F	Meridian	2017	R	L	White	27	62	3	4	5	4	5
AAC Synergy	M/F	Syngenta	2015	R	L	White	27	63	5	4	3	4	4
ABI Balster	M/F	BARI	2015	R	L	White	27	64	6	NA	4	8	NA
Conlon[7]	M/F	ND	1996	S	L	White	27	57	7	8	4	6	3
Explorer	M	Secobra	NA	R	L	White	25	61	4	NA	NA	8	4
ND Genesis	M/F	ND	2015	S	L	White	29	61	5	8	4	4	6
Pinnacle	M/F	ND	2006	S	L	White	29	60	6	8	8	4	6
6 Row Types													
Lacey	M/F	MN	2000	S	S	White	30	58	4	8	4	3	7
Tradition	M/F	BARI	2003	S	L	White	30	58	3	8	6	3	7

[1] M = malting; F = feed.
[2] BARI = Busch Agricultural Resources Inc.; MN = University of Minnesota; ND = North Dakota State University.
[3] R = rough; S = smooth.
[4] S = short; L = long.
[5] Straw Strength scores from 1-9, with 1 = strongest and 9 = weakest.
[6] Disease reaction scores from 1-9, with 1 = resistant and 9 = very susceptible, NA – not available.
[7] Lower DON accumulations than other varieties tested.

-NDSU Publication A1049-19 at https://www.ag.ndsu.edu/publication

Barley Variety Trial at Minot

Variety	Days to Head	Plant Height	Lodging	% Plump	% Thin	Test Weight	Protein	Grain Yield 2017	2018	2019	2 Year	3 Year
	DAP[1]	inches	0-9[2]	>6/64	<5/64	lbs/bu	%	-bu/A-				
2 Row Types												
Explorer	69	25	0	97	0	48.3	10.8	72.6	103.1	110.1	106.6	95.3
Pinnacle	66	32	0	98	0	47.5	9.3	72.4	102.1	110.8	106.5	95.1
ND Genesis	68	29	0	97	0	46.8	10.3	77.6	98.0	109.6	103.8	95.1
ABI Balster	69	29	0	98	0	49.1	10.2	79.6	93.8	108.3	101.1	93.9
AAC Synergy	70	33	0	98	0	47.7	10.1	69.2	103.8	106.6	105.2	93.2
Conlon	65	29	0	98	0	49.5	11.6	72.0	82.2	105.5	93.9	86.6
AAC Connect	69	32	0	97	0	48.5	10.9			114.7		
6 Row Types												
Tradition	64	31	0	98	0	49.5	12.2	68.6	106.2	98.6	102.4	91.1
Lacey	64	32	0	98	0	48.7	11.6	64.0	98.2	96.8	97.5	86.3
Trial Mean	66	30	0	98	0	48.0	10.5	70.8	98.1	105.6		
C.V.%	1.1	2.7	0	0.5	80	1.6	6.1	7.6	5.5	5.5	--	--
LSD 5%	2	2	NS	1	NS	1.3	1.1	8.8	8.9	9.8	--	--
LSD 10%	2	2	NS	1	NS	1.1	0.9	7.4	7.4	8.1	--	--

[1] DAP = Days after planting. *[2] Lodging: 0 = none, 9 = lying flat on the ground.*
NS = no statistical difference between varieties.

Planted on April 24 with a seeding rate of 1 million PLS/A and harvested on August 8.
Previous Crop: 2016 = canola, 2017 & 2018 = soybean.
Tillage: No-till
Soil Type: Williams Loam

2019 Barley Hay Variety Trial at Minot

Variety	Days to Head	Plant Height	Harvest Moisture	Yield 0% moist
	DAP[1]	inches	%	tons/A
Haymaker	68	28	56	3.20
Stockford	68	27	57	2.91
Hays	69	25	52	2.62
Lavina	68	25	51	2.39
Tradition	62	27	51	2.19
Bestford	64	29	65	1.88
Trial Mean	66	27	55	2.53
C.V.%	0.9	7.1	5.6	7.5
LSD 5%	1	NS	1	0.35
LSD 10%	1	NS	1	0.28

[1]DAP = days after planting

Planting Date: April 24
Harvest Date: July 24 (soft dough)
Seeding Rate: 90 lbs/A
Tillage: Transitional No-till (year 2)
Previous Crop: Soybean
Soil Type: Williams Loam

2019 North Dakota Oat Variety Descriptions

							Reaction to Diseases				
Variety	Origin[1]	Year Released	Grain Color	Height	Straw Strength	Maturity[2]	Stem Rust[3]	Crown Rust[3]	Barley Y.Dwf[4]	Test Weight	Protein[5]
AC Pinnacle	AAFC	1999	White	39	Med.	63	8	8	8	V.good	L
Beach	ND	2004	White	35	M.strg.	63	8	4	6	V.good	M
CDC Dancer	Sask.	2000	White	35	Strong	63	8	6	8	V.good	M
CDC Minstrel	Sask.	2006	White	34	M.strg.	64	8	8	8	Good	M
CS Camden	Meridian	2016	White	33	Strong	64	8	6	NA	Good	NA
Deon	MN	2013	Yellow	37	Strong	65	8	1	2	V.good	NA
Hayden	SD	2014	White	36	Med.	62	8	7	NA	V.good	NA
HiFi	ND	2001	White	35	Strong	63	4	8	2	Good	M
Hytest	SD	1986	White	38	M.strg.	62	8	6	8	V.good	H
Jury	ND	2012	White	34	M.strg.	64	1	8	4	V.good	M
Killdeer	ND	2000	White	32	Strong	63	8	6	4	Good	M
Leggett	AAFC	2005	White	33	Strong	63	3	1	8	Good	M
Newburg	ND	2011	White	38	Med.	62	1	8	4	Good	M
Otana	MT	1977	White	36	M.weak	63	8	8	8	V.good	M/L
Paul6	ND	1994	Hull-less	37	Strong	68	1	4	2	Good	H
Rockford	ND	2008	White	38	Strong	65	8	8	4	V.good	M
Souris	ND	2006	White	33	Strong	63	6	8	6	V.good	M
Stallion	SD	2006	White	34	Med.	64	8	3	NA	V.good	M
Warrior	SD	2018	White	32	Strong	62	NA	1	NA	V.good	M

[1] *AAFC = Agriculture & Agri-Food Canada; MN = University of Minnesota; ND = North Dakota State University; SD = South Dakota State University; Sask. = University of Saskatchewan; MT = Montana State University.*

[2] *Days after planting.*

[3] *Disease reaction scores from 1-9, with 1 = resistant and 9 = very susceptible.*

[4] *Disease reaction scores from 1-9, with 1 = resistant and 9 = very susceptible, NA – not available.*

[5] *H = high; M = medium; L = low; NA = not available.*

[6] *Hull-less variety.*

-NDSU Publication A1049-19 at https://www.ag.ndsu.edu/publications

Oat Variety Trial at Minot

Variety	Days to Head	Plant Height	Lodging	Test Weight	Grain Yield 2017	2018	2019	Average 2 year	3 year
	[1]DAP	inches	[2]0-9	lb/bu	bu/A				
Hayden	62	31	0	38.1	151.0	143.7	123.9	133.8	139.5
Beach	63	31	0	39.7	140.1	150.8	118.7	134.8	136.5
AC Pinnacle	65	34	0	37.3	144.7	136.1	128.0	132.1	136.3
CS Camden	64	28	0	34.5	144.0	137.7	126.4	132.1	136.0
Leggett	68	33	0	36.2	132.8	142.1	122.3	132.2	132.4
Stallion	63	29	0	36.6	139.5	130.9	125.7	128.3	132.0
CDC Minstrel	67	32	0	36.2	143.3	120.3	123.8	122.1	129.1
HiFi	63	33	0	36.6	147.7	117.6	117.6	117.6	127.6
Deon	66	32	0	37.3	136.3	125.6	117.9	121.8	126.6
CDC Dancer	63	32	0	36.5	126.6	134.6	115.1	124.8	125.4
Hytest	62	32	0	37.9	122.9	133.3	119.4	126.3	125.2
Rockford	66	36	0	38.4	119.0	132.4	121.6	127.0	124.3
Killdeer	62	34	0	38.3	130.9	115.3	113.1	114.2	119.8
Souris	64	30	0	38.0	141.4	112.3	102.9	107.6	118.9
Jury	62	31	0	38.2	127.8	111.3	114.5	112.9	117.9
Otana	62	31	0	38.5	136.3	113.4	99.7	106.6	116.5
Newburg	63	32	0	38.6	119.7	92.7	116.5	104.6	109.6
Paul	68	34	0	42.7	99.9	103.3	82.4	92.9	95.2
Warrior	62	29	0	36.5			120.5		
Trial Mean	64	32	0	37.8	139.7	125.4	114.3	--	--
C.V.%	1.1	4.0	0	2.3	7.9	11.9	8.0	--	--
LSD 5%	1	2	NS	1.4	18.0	24.1	14.8	--	--
LSD 10%	1	2	NS	1.2	15.0	20.4	12.4	--	--

[1] DAP = Days after planting. *[2] Lodging: 0 = none, 9 = lying flat on the ground.*

Planted on April 24 with a seeding rate of 1 million PLS/A and harvested on August 8.

Previous Crop: 2016, 2017 & 2018 = soy.

Soil Type: Williams Loam

Tillage: No-till

2019 North Dakota Hard Red Winter Wheat Variety Description and Agronomic Traits

Variety	Agent or Origin[2]	Year	Reaction to Disease[1] Stripe Rust	Leaf Rust	Stem Rust	Scab	Tan Spot	Days to Head	Straw Strength[4]	Height[5] (inches)	Winter[6] Hardiness
Emerson	A.Can.	2011	1	6	1	3	5	1	2	32	3
Ideal	SD	2011	4	1	3	8	4	-1	4	28	5
Jerry	ND	2001	8	3	1	8	8	0	5	34	3
Keldin	WB	2011	2	3	3	5	3	0	3	29	3
Loma	MT	2016	1	NA	1	8	NA	3	4	26	3
Northern	MT	2015	1	8	1	8	6	2	4	29	6
Oahe	SD	2016	2	3	6	NA	NA	-2	5	29	3
Peregrine	CDC	2008	1	3	1	6	6	1	5	34	2
SY Monument	Agripro	2014	3	3	NA	6	NA	-2	3	27	4
SY Sunrise	Agripro	2015	3	NA	NA	6	NA	-2	3	23	5
SY Wolf	Agripro	2010	3	3	1	6	1	-2	3	27	6
SY Wolverine	**Agripro**	**2019**	**NA**	**NA**	**NA**	**NA**	**NA**	**-5**	**3**	**25**	**NA**
TCG-Boomlock	**TCG**	**2019**	**NA**	**NA**	**NA**	**NA**	**NA**	**-1**	**5**	**29**	**NA**
Thompson	SD	2017	5	3	3	3	NA	-1	3	30	NA
WB4462	WB	2016	7	3	NA	8	6	-5	4	28	3
WB4595	**WB**	**2019**	**4**	**4**	**NA**	**6**	**6**	**-1**	**3**	**28**	**3**

[1] Disease reaction scores from 1-9, with 1 = resistant and 9 = very susceptible, NA = not available.

[2] A.Can. = Agriculture and Agri-Food Canada; CDC = Crop Development Centre, University of Saskatchewan; MT = Montana State University; ND = North Dakota State University; SD = South Dakota State University; TCG = Twenty-first Century Genetics; WB = WestBred.

[3] Days to heading relative to Jerry.

[4] Straw strength: 1 = strongest, 9 = weakest. Based on field observations in 2018 only.

[5] Based on the average of several environments, and should be used for comparing varieties. The environment can impact the height of varieties. 6Relative winter hardiness rating: 1 = excellent, 10 = very poor. These values are subject to change as additional information becomes available. Bold varieties are those recently released, so data are limited and rating values may change.

-NDSU Publication A1196-19 at https://www.ag.ndsu.edu/publications

Hard Red Winter Wheat Variety Trial at Minot

Variety	Spring Stand	Heading Date	Plant Height	Lodging	Test Weight	Grain Protein	Grain Yield 2017	2018	2019	2 yr avg	3 yr avg
	%	June	inches	0 - 9*	lbs/bu	%	bushels per acre				
Peregrine	98	15	31	1	62.4	11.7	89.8	35.4	60.6	48.0	61.9
SY Monument	99	12	24	0	60.0	11.8	84.1	30.4	65.6	48.0	60.0
Oahe	99	10	26	0	62.0	12.3	77.3	31.5	66.1	48.8	58.3
Ideal	99	13	25	0	60.8	12.3	74.9	31.8	61.5	46.7	56.1
Keldin	88	13	27	1	62.0	12.3	79.7	26.4	61.4	43.9	55.8
SY Wolf	98	11	24	0	62.5	13.7	87.3	21.6	49.0	35.3	52.6
Jerry	98	13	29	2	60.3	12.6	57.9	25.7	54.3	40.0	46.0
Overland-Fhb1	98	10	25	1	59.3	13.2	60.3	28.9	46.6	37.7	45.3
AC Emerson	98	14	29	0	62.1	14.1	53.9	25.0	56.0	40.5	45.0
Loma	92	15	23	1	61.7	14.0	62.8	18.1	48.8	33.4	43.2
Northern	96	14	25	1	62.6	13.5	54.6	21.6	52.5	37.1	42.9
SY Sunrise	99	9	21	0	61.3	11.9	55.0	18.8	45.3	32.0	39.7
Thompson	99	10	27	0	60.8	13.0	--	33.1	57.7	45.4	--
WB4462	99	7	23	2	61.5	12.5	--	18.2	49.0	33.6	--
WB4595	99	11	25	0	64.4	11.2	--	--	65.1	--	--
Decade-Fhb1	99	11	24	0	61.5	13.5	--	--	58.8	--	--
LCS Mint	98	10	24	1	63.2	12.6		--	54.2	--	--
LCS Link	94	10	24	0	62.2	12.9	--	--	54.1	--	--
TCG-Boomlock	98	12	25	1	61.5	13.2	--	--	52.3	--	--
LCS Chrome	99	11	25	1	61.2	13.4	--	--	52.1	--	--
LCS Fusion AX	80	13	25	1	61.0	12.4	--	--	51.8	--	--
SY Wolverine	99	7	21	0	62.3	13.2	--	--	46.5	--	--
Trial Mean	97	11	25	1	61.6	12.8	68.7	26.7	54.6	--	--
C.V. %	6.7	8.4	4.9	92	0.9	2.5	7.9	22.0	9.1	--	--
LSD 0.05	NS	2	2	1	0.9	0.5	8.9	9.6	8.1	--	--
LSD 0.10	NS	1	2	1	0.7	0.4	7.4	8.0	6.8	--	--

*Lodging: 0 = none, 9 = lying flat on the ground.

NS = no statistical difference between varieties.

Planting Date: September 18, 2018

Harvest Date: August 6, 2019

Seeding Rate: 1.3 million live seeds / acre

Previous Crop: 2016 = canola, 2017 = spring wheat, 2018 = soy

Tillage: Transitional No-till (year 3)

Soil Type: Williams loam

Note: The 2018 trial sustained dry growing conditions resulting in relatively low yields.

2019 North Dakota Winter Rye Variety Descriptions

Variety	Origin[1]	Year Released	Height (inches)	Straw Strength	Days to Flowering	Seed Color	Seed Size	Winter Hardiness
AC Hazlet	Canada	2006	43	Good	152	Bl-grn.	Small	Good
Aroostok	USDA	1981	45	Fair	145	Tan	Small	V.good
Bono[3]	KWS Germany	2013	37	Good	151	Green	Med.	Good
Brasetto[3]	KWS Germany	2008	36	V.good	151	Bl-grn.	Large	Good
Dacold	ND	1989	42	Good	154	Bl-grn.	Med.	Good
Hancock	WI	1979	43	Good	149	Tan	Large	Fair[4]
ND Dylan	ND	2016	45	Good	150	Blue	Med.	V.good
ND Gardner	ND	2019	44	Fair	144	Bl-grn.	Small	V.good
Rymin	MN	1973	42	V.good	150	Grn-gray	Large	Fair[4]
Spooner	WI	1993	44	V.good	149	Tan	Large	Good
Wheeler	MI	1971	47	Fair	152	Tan	Large	Fair

[1] ND = North Dakota State University; WI = University of Wisconsin; MN = University of Minnesota; MI = Michigan State University.

[2] NA = not available.

[3] Hybrid.

[4] Varieties with fair winter hardiness should not be seeded in bare soil.

-NDSU Publication A1049-19 at https://www.ag.ndsu.edu/publications

Winter Rye Variety Trial at Minot

Variety	Winter Survival	Heading Date	Plant Height	Lodging	Test Weight	Grain Yield 2017	2018	2019	2 yr avg	3 yr avg
	%	June	inches	0-9*	lbs/bu	bushels per acre				
Hazlet	99	7	43	1	57.4	76.7	57.1	75.1	66.1	69.6
Rymin	99	5	42	1	57.2	76.9	55.5	75.7	65.6	69.4
ND Dylan	99	5	45	2	57.2	72.6	45.5	77.3	61.4	65.1
Dacold	99	7	42	1	57.5	58.8	42.6	76.9	59.8	59.4
Hancock	99	4	43	1	57.1	69.6	45.4	62.5	53.9	59.2
DREB15	99	1	45	1	56.3	56.9	40.0	65.0	52.5	54.0
Spooner	99	4	44	2	56.1	57.5	35.7	60.5	48.1	51.2
Aroostook	99	3	45	2	56.4	40.9	27.9	59.1	43.5	42.6
Wheeler	99	8	47	1	52.7	41.0	23.1	30.0	26.5	31.4
Brasetto	99	6	36	1	56.1	--	59.1	101.5	80.3	--
Bono	99	7	37	1	57.5	--	--	105.6	--	--
Trial Mean	99	5	43	1	56.5	63.9	43.2	71.7	--	--
C.V. %	0.0	16	5.7	56.0	1.8	8.4	7.8	6.4	--	--
LSD 5%	NS	1	4	NS	1.8	9.1	5.8	7.8	--	--
LSD 10%	NS	1	3	NS	1.5	7.5	4.8	6.5	--	--

**Lodging: 0 = none, 9 = lying flat on the ground.*

NS = no statistical difference between varieties.

Planting Date: September 18, 2018
Harvest Date: August 7, 2019
Seeding Rate: 1 million live seeds / acre
Previous Crop: 2016 = canola, 2017 = spring wheat, 2018 = soy
Tillage System: Transitional No-till (year 3)
Soil Type: Williams loam
Note: The 2018 trial sustained severe spring moisture stress.

Grain Corn Variety Trial at Minot

Company / Brand	Hybrid	Relative Maturity	Days to Silk	Ear Height	Harvest Moisture	Test Weight	Grain Yield 2017[a]	2018[b]	2019[c]	2 yr	3 yr
		days	DAP*	inches	%	lbs/bu	------- bushels per acre --------				
Rea Hybrids	1B720	72	70	37	25	60.0	--	--	104	--	--
Rea Hybrids	1B780	79	76	38	27	58.1	--	68	112	90	--
Rea Hybrids	2B862	86	78	36	30	58.9	--	--	117	--	--
Integra	2803 VT2P	78	79	43	28	60.6	135	58	83	70	92
Integra	3009 VT2P	80	74	34	25	59.3	--	--	104	--	--
Integra	3282 VT2P	82	81	39	27	58.2	--	64	101	82	--
Integra	3325-3010A	83	82	36	30	59.4	--	74	90	82	--
Integra	3537 VT2P	85	81	41	29	59.1	143	75	102	88	107
Dyna-Gro	D22QH42	82	78	38	25	59.3	--	--	107	--	--
Thunder Seed	6074 VT2P	74	76	37	25	57.0	--		91	--	--
Thunder Seed	6079 VT2P	79	74	37	25	60.6	--	--	101	--	--
Thunder Seed	6081 3220	81	79	39	29	62.2	--	--	92	--	--
Thunder Seed	6782 VT2P	82	80	42	26	57.8	--	75	94	84	--
Proseed	1980	80	73	39	23	58.3	--	--	92	--	--
Hefty	H2532	75	73	35	26	59.2	--	--	88	--	--
Hefty	H2802	78	78	45	24	58.9	121	56	97	77	91
Hefty	H2922	79	73	39	27	62.4	--	77	122	99	--
Hefty	H3022	80	77	40	27	59.7	--	58	97	77	--
Hefty	H3122	81	80	42	27	59.1	--	66	110	88	--
Hefty	H3322	83	78	42	26	58.6	--	64	142	103	--
Hefty	H3302	83	78	42	26	56.3	146	62	120	91	109
Hefty	H3432	84	78	38	27	57.8	--	--	126	--	--
Legacy Seeds	L-1818 VT2P	79	74	38	26	60.3	--	--	87	--	--
Legacy Seeds	L-2213 VT2P	80	77	39	25	59.8	139	68	86	77	98
Legacy Seeds	L-2019 VT2P	80	75	40	27	59.9	--	--	108	--	--
Legacy Seeds	L-2347 VT2P	83	80	40	28	59.8	--	--	118	--	--
Legacy Seeds	L-2314 VT2P	83	81	43	30	58.9	164	82	111	96	119
Peterson Farms Seed	71V81	81	79	39	27	58.2	--	78	98	88	--
Peterson Farms Seed	78A82	82	81	43	29	59.1	136	59	104	82	100
Peterson Farms Seed	73S84	84	80	43	29	61.0	--	--	118	--	--
Trial Mean			77	39	27	59.2	134	68	104	--	--
C.V.%			2.3	6.8	9.9	3.1	8.1	10.7	10.6	--	--
LSD 5%			3	4	NS	3.0	18	12	18	--	--
LSD 10%			2	4	NS	2.5	15	10	15	--	--

**DAP = Days after planting.*

[a] 2017 Minimum till twin rows planted on May 12 into barley stubble and harvested on October 21.

[b] 2018 Strip till planted on May 15 into spring wheat stubble and harvested on October 11.

[c] 2019 Strip till planted on May 9 into spring wheat stubble and harvested on October 28.

Planting Rate: 30,000 seeds/A *Row Spacing: 30"*

Soil Type: Williams Loam

Note: Test weights and yields are adjusted to 15.5% moisture. The 2018 trial sustained severe drought.

Silage Corn Variety Trial at Minot

Company	Hybrid	Relative Maturity	Days to Silk	Harvest Moisture	Crude Protein	TDN	------------ Yield ------------ 2018	2019	2 yr avg
			DAP[1]	%	%	%	tons/A @65% moisture		
Integra	STP4128R	91	82	61	6.1	68	10.45	20.22	15.33
Integra	STP4759R	98	91	68	6.8	69	9.53	23.13	16.33
Proseed	STS 103	103	88	66	6.8	75	--	19.46	--
Thunder Seed	4900 HDRR	100	89	66	8.1	69	--	23.52	--
Thunder Seed	6098 VT2P	98	86	66	5.8	71	--	21.57	--
Thunder Seed	6999 VT2P	99	84	66	8.2	71	--	25.30	--
Dairyland Seed	HiDF-3407RA	107	92	73	7.4	68	--	22.40	--
Dairyland Seed	HiDF-3290-9	90	86	66	7.1	72	--	18.67	--
Dairyland Seed	HiDF-3099RA	99	86	65	6.1	70	12.86	20.52	16.69
Dairyland Seed	HiDF-3197RA	97	88	67	5.4	71	13.55	22.57	18.06
Dairyland Seed	HiDF-3802AMXT	102	88	69	4.4	67	--	20.31	--
Legacy Seeds	L-5467 RRLFY	101	88	66	6.7	67	12.40	21.26	16.83
Legacy Seeds	L-3567 RRLFY	95	89	66	5.8	70	10.96	20.88	15.92
Legacy Seeds	L-4567 RRLFY	100	91	70	7.1	68	12.58	20.50	16.54
Legacy Seeds	L-4545 RRLFY	100	84	66	4.3	69	14.29	20.71	17.50
	Grain ck	80	76	58	8.1	74	--	17.98	--
	Grain ck	86	78	56	7.4	70	--	21.55	--
Trial Mean			87	66	6.5	70	11.94	21.08	--
C.V.%			2.5	4.7	--	--	16.40	14.10	--
LSD 5%			4	5	--	--	3.25	NS	--
LSD 10%			3	4	--	--	2.71	4.10	--

[1] DAP = days after planting

NS = no statistical dfference between hybrids.

Planting Date: May 10
Harvest Date: October 7
Planting Rate: 30,000 seeds/A
Row Spacing: 30"
Tillage: No-till
Previous Crop: 2017 and 2018 = hrsw
Soil Type: Williams Loam
Note: The 2018 trial sustained severe drought.

2018 Silage Corn Row Spacing and Seeding Rate Trial at Minot

The primary objective of this trial was to compare seeding rate and row spacing combinations to achieve maximum silage yields. A secondary objective was to observe agronomic and silage quality characteristics associated with these seeding rate and row spacing combinations. The trial was comprised of two hybrids with relative maturities of 91 and 100 days that were planted into 15 inch and 30 inch rows with seeding rates of 20k, 25k, 30k and 35k seeds per acre. Data was tabulated and analyzed for statistically significant differences between these factors.

The trial was planted on May 14 into soybean stubble that was minimally tilled and harvested on September 11. The soil type was a Williams Loam.

Table 1 shows individual treatment means and statistically significant differences between these treatments.

Table 1. Individual Means

Hybrid	Row Spacing	Seeding Rate	Harvest Stand	Days to Silk	Ear Height	Harvest Moisture	Protein	TDN	Silage Yield
RM		seeds/A	plants/A	DAP[1]	inches	%	%	%	tons/A[2]
91 day	15"	20k	21,672	77	35	62.8	7.8	70.0	18.6
		25k	26,006	74	33	59.9	7.6	70.9	19.6
		30k	27,451	74	34	60.1	8.4	69.6	17.3
		35k	34,675	75	35	55.0	7.2	71.1	28.3
	30"	20k	13,725	76	33	63.3	8.4	70.3	13.4
		25k	18,782	76	31	61.7	8.5	71.6	14.6
		30k	20,227	77	33	63.0	8.8	69.9	15.3
		35k	23,839	75	33	61.6	8.2	69.9	16.7
100 day	15"	20k	23,116	82	37	69.0	8.3	68.0	18.7
		25k	26,006	81	40	67.8	8.3	68.1	16.3
		30k	34,675	81	37	67.6	8.0	67.5	24.7
		35k	33,230	82	36	70.3	9.2	66.6	19.8
	30"	20k	14,448	82	40	68.2	8.9	68.6	12.3
		25k	24,561	84	37	71.6	9.3	68.3	16.0
		30k	20,227	86	34	72.6	9.7	68.4	12.0
		35k	25,284	84	31	70.7	9.1	68.2	12.1
C.V.%			16.9	2.3	8.2	3.5	7.0	1.8	9.0
LSD 5%			6,830	3	5	3.8	1.0	2.1	2.6

Table 2 shows the combined means for row spacing. 15 inch row spacing produced 40% more harvested plants which corresponded to a 44% higher silage yield compared to 30 inch row spacing. A 15 inch row spacing allows for more plant-to-plant spacing within each row compared to 30 inch rows, thus providing for more uniform plant distribution and efficiency in resource utilization such as sunlight, soil moisture and plant nutrient. In addition to higher silage yield, the 15 inch row spacing also initiated silking earlier, produced taller plants (ear ht), had a lower harvest moisture and produced slightly less protein than 30 inch rows.

Table 2. Row Spacing Combined Means

Row Spacing	Harvest Stand	Days to Silk	Ear Height	Harvest Moisture	Protein	TDN	Silage Yield
	plants/A	DAP[1]	inches	%	%	%	tons/A[2]
15"	28,353 a	78 a	36 a	64.1 a	8.1 a	69.0 a	20.4 a
30"	20,137 b	80 b	34 b	66.6 b	8.8 b	69.4 a	14.1 b

Continued on next page

2018 Silage Corn Row Spacing and Seeding Rate Trial at Minot Continued

Table 3 shows the combined means for seeding rates. As would be expected, there was a trend for increasing silage yields with increasing seeding rates with the highest rate producing significantly more silage than that produced with lower seeding rates.

Table 3. Seeding Rate Combined Means

Seeding Rate	Harvest Stand	Days to Silk	Ear Height	Harvest Moisture	Protein	TDN	Silage Yield
seeds/A	plants/A	DAP[1]	inches	%	%	%	tons/A[2]
20k	18,240 a	79 a	36 a	65.8 a	8.3 a	69.2 a	15.7 a
25k	23,839 b	79 a	35 ab	65.3 a	8.4 a	69.8 a	16.7 ab
30k	25,645 b	79 a	34 b	65.8 a	8.7 a	68.8 a	17.3 b
35k	29,257 c	79 a	34 b	64.4 a	8.4 a	68.9 a	19.2 c

Table 4 shows combined means for hybrids. Again, as would be expected, each hybrid expressed differences between agronomic, silage quality and silage yields. An unexpected difference was for the 100 day hybrid producing significantly less silage yield than the 91 day hybrid. A possible explanation for this may be from the 100 day hybrid sustaining severe stalk lodging.

Table 4. Hybrid Combined Means

Hybrid	Harvest Stand	Days to Silk	Ear Height	Harvest Moisture	Protein	TDN	Silage Yield
RM	plants/A	DAP[1]	inches	%	%	%	tons/A[2]
91 day	23,297 a	75 a	33 a	60.9 a	8.1 a	70.4 a	18.0 a
100 day	25,193 a	83 b	36 b	69.7 b	8.8 b	67.9 b	16.5 b

[1]DAP = Days After Planting [2]Silage Yields are adjusted to 65% moisture

Values followed by different letters are statistically significant ($p < 0.05$)

Although this was a single year trial, it shows the potential impact that row spacing and seeding rates can have on silage corn production. Silage yields were significantly higher when 15 inch rows were utilized compared to 30 inch rows. Higher seeding rates translated into higher established plant densities and higher yields while maintaining silage quality. Hybrid selection is critical and should be based on unbiased testing in environmentally similar growing regions.

Safflower Variety Descriptions

Variety	Origin[1]	PVP[2]	Hull Type[3]	Oil Type[4]	Irrigated Yield[5]	Dryland Yield[5]	Test Weight[5]	Oil[5]	Maturity	Tolerance[6] Alt	BB
Cardinal	MSU/NDSU	yes	N	high lino	v good	v good	high	fair	med	T	MT
Finch	MSU/NDSU	no	N	lino	good	v good	v high	fair	m early	MS	T
Hybrid 1601	STI	yes	STP	high oleic	v good	v good	med	good	m late	MT	MT
Hybrid 9049	STI	yes	N	high oleic	v good	v good	v high	fair	med	MT	MT
MonDak	MSU/NDSU	yes	N	high oleic	good	v good	high	fair	m early	T	MT
Montola 2000	MSU/NDSU	yes	N	high oleic	m good	good	med	good	early	MS	MS
Montola 2001	MSU/NDSU	yes	STP	high oleic	good	fair	med	good	med	MT	MT
Montola 2003	MSU/NDSU	yes	N	high oleic	v good	v good	m high	good	m early	MT	MT
Montola 2004	MSU/NDSU	yes	N	high oleic	good	good	m high	good	m early	MS	MT
Morlin	MSU/NDSU	yes	STP	high lino	v good	good	med	good	m late	T	T
Nutrasaff	MSU/NDSU	yes	RED	lino	good	good	med	high	med	T	MT

[1] MSU = Montana State University, NDSU = North Dakota State University, STI = Safflower Technologies International
[2] PVP = Plant Variety Protection. "yes" indicates the variety is protected and the seed may be sold for planting purposes only as a class of certified seed (Title V option).
[3] STP = striped, N = normal, RED = reduced.
[4] Lino = linoleic.
[5] Relative ratings of yield, test weight and oil will vary under conditions of moderate-severe disease infestation.
[6] Alt = Alternaria leaf spot disease, BB = bacterial blight, S = susceptible, MS = moderately susceptible, MT = moderately tolerant, T = tolerant.

Safflower Variety Trial at Minot

Variety	Days to Bloom	Plant Height	Seed Yield 2017	2018	2019	2 yr Avg.	3 yr Avg.
	DAP[1]	inches	pounds per acre				
Linoleic Types							
Cardinal	78	30	2165	1671	2277	1974	2038
NutraSaff	78	28	2257	1541	2055	1798	1951
Finch	77	29	2074	1391	2111	1751	1859
Chickadee	78	29	--	1706	2310	2008	1339
Rubis Red	77	28	--	1518	2117	1818	1212
Oleic Types							
Hybrid 1601	78	28	3020	1894	2144	2019	2353
MonDak	79	28	2582	1622	2016	1819	2073
Montola 2003	80	26	2120	1544	2075	1809	1913
Hybrid 200	79	29	--	2054	2083	2068	--
Hybrid 446	77	29	--	1480	2162	1821	--
Trial Mean	78	28	2435	1642	2135	--	--
C.V.%	1.0	5.0	12.4	11.6	5.8	--	--
LSD 5%	1	2	528	326	214	--	--
LSD 10%	1	2	433	269	177	--	--

[1] Days after Planting

Planting Date: May 6
Harvest Date: September 19
Tillage System: Minimum till
Seeding Rate: Hybrids = 18 lbs/A, non-hybrids = 25 lbs/A
Previous Crop: 2016 = soybean, 2017 & 2018 = hrsw
Soil Type: Williams Loam
Note: The 2019 trial had severe sprout damage which affected test weights and oil contents (data not shown).

Oil Type Sunflower Variety Trial at Minot

Company	Hybrid	Days to Bloom	Days to Mature	Plant Height	Oil	Test Weight	------- Yield ------- 2017	2018	2019	Average 2 yr	3 yr
		DAP*	DAP*	inches	%	lbs/bu	--------------- lbs/A ---------------				
Proseed	E-31 CL	69	119	54	39.7	28.7	2723	2319	1345	1832	2129
Proseed	E-362436	69	123	50	41.7	31.9	2387	1990	1575	1782	1984
Proseed	E-21 CL	72	124	51	39.0	28.2	2034	1769	1536	1653	1780
Proseed	E-91 E	68	118	58	41.2	30.6		--	1767	--	--
Proseed	E-92 E	72	124	65	43.3	28.4	--	--	1339	--	--
Dyna-Gro	H48HO15CL	72	124	44	48.7	29.6	--	2879	1581	2230	--
Dyna-Gro	H49HO19CL	69	120	42	48.2	31.7	--	2547	1601	2074	--
Dyna-Gro	H44HO12CL	65	119	47	46.4	31.5	--	2246	1764	2005	--
Dyna-Gro	H45NS16CL	65	118	47	45.3	33.4	--	2507	1499	2003	--
Dyna-Gro	H42HO18CL	65	120	46	46.9	31.9	--	2015	1625	1820	--
Dyna-Gro	H49NS14CL	69	123	49	48.9	32.5	--	--	2311	--	--
Dyna-Gro	H45HO10EX	66	121	50	46.1	30.2	--	--	2128	--	--
SunOpta	4425CL	67	121	54	39.9	30.4	2467	2249	1874	2061	2197
SunOpta	4415 HO/CLP/DM	68	123	46	42.8	31.7	2519	2185	1647	1916	2117
CROPLAN	CP455E	67	125	50	44.6	31.5	2744	3124	2965	3045	2944
CROPLAN	CP545CL	70	124	50	46.6	30.9	3144	2270	2088	2179	2501
CROPLAN	CP432E	65	120	52	40.2	30.4	2247	2096	1993	2044	2112
CROPLAN	CP450E	69	124	52	40.5	28.8	--	2371	1895	2133	--
CROPLAN	CP4909E	68	124	48	44.7	31.0	--	--	2033	--	--
Nuseed	Camaro II	68	122	52	48.8	33.6	3000	2322	2283	2302	2535
Nuseed	Hornet	70	124	56	48.2	30.4	2651	2649	2215	2432	2505
Nuseed	Falcon	68	120	48	47.7	31.6	2792	2387	1752	2069	2310
Nuseed	N4HM354	65	123	48	46.1	32.6	2567	1883	1916	1900	2122
Nuseed	N4H470 CL Plus	70	124	50	49.8	31.2	--	3106	2518	2812	--
Nuseed	N4H302 E	67	124	45	46.8	29.6	--	2642	2012	2327	--
Nuseed	N5LM307	65	120	52	40.6	28.7	--	1650	2004	1827	--
Long term ck	Hybrid 894	65	120	47	43.9	31.4	1818	1995	1640	1818	1818
Late matur ck	559CL	68	125	59	46.7	32.3	1782	2219	2072	2146	2024
Trial Mean		68	122	52	44.7	30.8	2582	2178	1889	--	--
C.V.%		1.1	1.6	5.3	1.6	2.9	16.5	11.8	14.4	--	--
LSD 5%		1	3	5	1.2	1.5	693	308	442	--	--
LSD 10%		1	3	4	1.0	1.2	580	258	370	--	--

**DAP = Days after planting.*

Planting Date: May 22 *Harvest Date: November 5* *Row Spacing: 30"*

Planting Population: 21,000 plants/A *Tillage: Minimum Till* *Soil Type: Williams loam*

Previous Crop: 2016 = barley, 2017 = soybean, 2018 = spring wheat

Note: Yield, test weight and oil content are adjusted to 10% moisture.

Non-Oil Type Sunflower Variety Trial at Minot

Company/Brand	Hybrid	Date of 50% Bloom	Maturity Date	Plant Height	Test Weight	Seed Over Screen >22/64	>20/64	>18/64	Yield
		July	Sept	inches	lbs/bu	------------	%	------------	lbs/A
SunOpta	9583CLP	31	25	52	24.7	66	69	73	1790
Long Term Check	Hybrid 924	30	27	51	26.1	51	63	71	1057
Trial Mean		30	26	52	25.4	59	66	72	1424
C.V.%		1.3	4.7	8.3	2.3	33	30	22	7.2
LSD 5%		NS	NS	NS	NS	NS	NS	NS	362

Planting Date: May 20
Planting Rate: 21,000 seeds/A
Row Spacing: 30"
Harvest Date: November 5
Previous Crop: spring wheat
Tillage: Minimum till
Soil Type: Williams Loam
Note: Test weight and yield are adjusted to 10% moisture.

Conventional Soybean Variety Trial at Minot

Variety	Maturity Group	IDC Rating	Maturity Date	Plant Height	Protein	Oil	Test Weight	Yield 2017	Yield 2018	Yield 2019	Yield 2 yr	Yield 3 yr
		1-5[a]	Sept	inches	%	%	lbs/bu	bushels / acre				
ND Stutsman	0.7	1.9	17	22	34.1	15.5	56.8	37.2	24.1	48.5	36.3	36.6
ND Benson	0.4	1.9	18	24	36.1	15.8	57.2	31.4	19.5	48.6	34.1	33.2
ND Henson	0.0	2.1	10	20	34.6	16.4	57.3	22.0	23.1	51.7	37.4	32.3
RR check	00.6	--	3	22	35.1	15.0	57.1	27.4	19.9	38.4	29.1	28.6
RR check	00.9	2.4	6	20	34.8	15.2	57.2	28.2	16.9	39.8	28.3	28.3
ND Rolette	00.9	1.3	13	21	34.6	16.4	57.7	--	28.6	45.3	37.0	--
MN0810CN	0.8	--	17	27	36.3	15.2	57.6	--	19.2	43.0	31.1	--
RR check	00.8	--	5	20	34.1	15.4	57.3	--	17.7	44.2	31.0	--
RR check	0.8	2.0	21	23	33.8	15.2	54.0	--	--	47.8	--	--
MN0083	00.8		4	21	35.8	15.4	57.5	--	--	30.0	--	--
Trial Mean		2.1	14	22	34.7	15.8	56.8	28.5	22.0	45.8	--	--
C.V.%		20.0	12.8	8.3	1.4	2.2	0.9	19.0	17.1	8.3	--	--
LSD 5%		0.3	3	3	0.8	0.6	0.8	9.0	6.3	6.2	--	--
LSD 10%		0.3	2	2	0.7	0.5	0.7	7.5	5.2	5.2	--	--

[a] IDC rating = Iron deficiency chlorosis rating: 1 - green, 3 - yellow, 5 - dead

Planting Date: May 17
Planting Rate: 150,000 PLS/A
Row Spacing: 15"
Tillage: Minimum Till
Previous Crop: 2016 = barley, 2017 = corn, 2018 = wheat
Harvest Date: October 8
Soil Type: Williams Loam
Note: Oil, protein and yield are adjusted to 13% moisture. The 2018 trial sustained moderate drought.

RR, GT, Extend and Enlist Soybean Variety Trial at Minot

Company/Brand	Variety	Herbicide System	Maturity Group	IDC Rating	Maturity Date	Plant Height	Protein	Oil	Test Weight	Yield 2017	Yield 2018	Yield 2019	Yield 2 yr	Yield 3 yr
				1-5[a]	Sept	inches	%	%	lbs/bu	bushels / acre				
REA Hybrids	RX00749	XT	00.7	1.8	6	25	32.2	15.9	56.1	--	26.4	50.1	38.3	--
REA Hybrids	RX00810	XT	00.8	2.4	6	22	33.2	16.0	56.1	--	--	46.1	--	--
REA Hybrids	RX0228	XT	0.2	1.6	15	29	33.4	15.9	56.7	34.9	26.6	44.5	35.5	35.3
REA Hybrids	RX0330	XT	0.3	1.9	18	25	32.5	15.3	56.6	--	--	50.8	--	--
LG Seeds	LGS00663RX	XT	00.6	2.1	6	24	32.7	15.5	57.3	--	29.5	46.8	38.1	--
LG Seeds	LGS00899RX	XT	00.8	2.3	14	26	32.1	16.3	56.9	--	--	47.9	--	--
LG Seeds	LGS0111RX	XT	0.1	2.6	16	28	32.2	16.2	56.2	--	43.1	52.8	48.0	--
Integra	50001 R2X	XT	00.1	2.5	16	25	33.5	15.7	56.4	--	--	52.6	--	--
Integra	20215 R2Y	RR	0.2	2.2	15	25	33.7	15.2	57.0	29.4	43.8	51.2	47.5	41.5
Integra	50309N R2X	XT	0.3	1.5	17	23	32.2	15.4	56.8	--	28.2	48.6	38.4	--
Integra	40350E3	EN	0.3	--	20	22	33.7	15.3	56.8	--	--	61.0	--	--
Proseed	XT 60-09	XT	00.9	2.2	14	23	32.3	16.3	56.9	34.1	30.7	52.7	41.7	39.2
Proseed	EL 80-093	EN	00.9	2.2	17	26	31.8	16.0	56.9	--	--	57.0	--	--
Proseed	50-10	RR	0.1	2.9	13	21	33.2	16.4	56.8	--	--	53.3	--	--
Proseed	XT 80-20	XT	0.2	1.6	14	22	32.3	15.6	56.4	--	36.5	41.9	39.2	--
Peterson Farms Seed	18X008	XT	00.8	2.3	7	25	33.0	16.0	56.9	38.8	32.3	46.5	39.4	39.2
Peterson Farms Seed	19EN008	EN	00.8	1.6	17	25	31.3	16.4	56.9	--	--	54.7	--	--
Peterson Farms Seed	20X01	XT	0.1	3.2	15	22	33.1	16.0	56.2	--	--	43.4	--	--
P3 Genetics	2002E	EN	0.2	--	17	22	32.5	15.4	56.4	--	--	47.4	--	--
NorthStar	NS 90094E3	EN	00.9	1.4	17	24	32.5	16.0	56.9	--	--	45.9	--	--
NorthStar	NS 60092XR2	XT	00.9	2.0	14	23	33.1	15.5	57.2	29.4	32.0	46.9	39.4	36.1
NorthStar	NS 90214E3	EN	0.2	2.5	17	22	32.3	15.6	55.9	--	--	46.6	--	--
Legacy Seeds	LS-00639N RR2X	XT	00.6	2.3	4	23	31.9	15.9	56.9	--	--	43.2	--	--
Legacy Seeds	LS-00930 RR2X	XT	00.9	2.6	17	21	34.0	15.7	56.1	--	--	46.9	--	--
Legacy Seeds	LS-0239N RR2X	XT	0.2	1.7	11	23	32.4	15.6	56.7	--	--	48.2	--	--
Legacy Seeds	LS-0438 RR2X	XT	0.4	2.6	18	23	32.7	16.1	56.2	--	--	50.5	--	--
Norcan	NOR004	GT	00.4	--	6	19	34.6	16.6	56.0	--	29.3	41.1	35.2	--
Norcan	NOR005	GT	00.5	--	6	21	33.7	16.7	56.8	--	33.1	44.2	38.7	--
Norcan	NOR04	GT	0.4	--	11	22	33.9	16.8	56.5	--	--	38.2	--	--
Hefty	H006x0	XT	00.6	--	3	22	31.9	16.2	56.6	--	--	41.4	--	--
Hefty	H007x7	XT	00.7	--	6	19	32.3	16.2	57.1	--	--	41.4	--	--
Hefty	H008x8	XT	00.8	--	8	29	31.7	16.2	56.7	39.1	29.3	49.3	39.3	39.2
Hefty	H009x7	XT	00.9	--	10	26	33.1	15.2	57.1	34.6	36.6	41.1	38.8	37.4
Hefty	H01E9	EN	0.1	2.2	17	22	33.5	15.4	55.8	--	--	51.9	--	--

Continued on next page

RR, GT & Extend Soybean Variety Trial at Minot Continued

Company/Brand	Variety	Herbicide System	Maturity Group	IDC Rating	Maturity Date	Plant Height	Protein	Oil	Test Weight	Yield 2017	Yield 2018	Yield 2019	Yield 2 yr	Yield 3 yr
				1-5[a]	Sept	inches	%	%	lbs/bu	bushels / acre				
Hefty	H01x0	XT	0.1	2.8	15	24	33.8	15.9	56.4	--	--	52.2	--	--
Hefty	H02E0	EN	0.2	1.9	16	19	31.6	16.0	56.5	--	--	50.3	--	--
Hefty	H02x7	XT	0.2	--	17	33	32.3	16.0	56.2	--	28.1	62.3	45.2	--
Hefty	H03x7	XT	0.3	--	17	19	33.9	15.6	56.6	33.4	32.8	51.8	42.3	39.3
Hefty	H04E8	EN	0.4	--	18	23	32.8	16.2	56.8	--	--	40.6	--	--
Dairyland Seed	DSR-C999/R2y	RR	00.9	2.8	10	26	33.3	16.0	56.3	40.7	30.4	52.3	41.3	41.1
Dairyland Seed	DSR-0200/R2Y	RR	0.2	1.7	16	26	34.1	15.1	57.0	--	32.1	47.8	40.0	--
Thunder Seed	SB89006N	XT	00.6	--	7	24	31.8	16.0	56.8	--	25.7	50.7	38.2	--
Thunder Seed	SB88007N	XT	00.7	2.2	6	28	32.5	16.2	56.8	36.3	23.1	50.4	36.7	36.6
Thunder Seed	ASTRO R2Y	RR	00.8	1.8	12	30	33.6	15.3	56.9	40.5	22.2	45.6	33.9	36.1
Thunder Seed	TE79009	EN	00.9	--	17	20	33.6	15.3	56.6	--	--	48.4	--	--
Dyna-Gro	S009XT68	XT	00.9	2.3	14	28	33.2	15.0	57.3	34.0	32.8	50.3	41.5	39.0
Dyna-Gro	S03XT29	XT	0.3	1.7	16	25	32.8	15.2	57.1	--	30.6	52.9	41.7	--
NDSU	ND18008GT	GT	00.7	2.8	4	23	33.6	16.4	56.7	27.7	32.8	36.0	34.4	32.2
NDSU	ND17009GT	GT	00.9	3.1	14	25	34.0	16.4	58.3	27.4	36.1	49.6	42.8	37.7
U of M	M06R-614008GT	GT	00.8	2.6	8	21	33.0	15.7	57.2	--	--	44.3	--	--
Trial Mean				2.4	12	24	32.9	15.9	56.7	34.3	30.5	48.1	--	--
C.V.%				22.6	10.4	7.1	2.2	2.2	0.8	11.0	12.1	7.0	--	--
LSD 5%				0.4	2	3	1.2	0.6	0.7	6.1	5.9	5.5	--	--
LSD 10%				0.3	2	2	1.0	0.5	0.6	5.1	5.0	4.6	--	--

[a] *IDC rating = Iron deficiency chlorosis rating: 1 - green, 3 - yellow, 5 - dead*

Planting Date: May 22
Planting Rate: 150,000 PLS/A
Row Spacing: 15"
Tillage: Minimum Till
Previous Crop: 2016 = barley, 2017 = corn, 2018 = wheat
Harvest Date: October 25
Soil Type: Williams Loam
Note: Oil, protein and yield are adjusted to 13% moisture.

Soybean Variety Trial at Mohall

Cooperators: Dean Schoenberg and the Renville/Bottineau Ag Improvement Assoc.

Company/Brand	Variety	Herbicide System	Maturity Group	IDC Rating	Plant Height	Protein	Oil	Test Weight	Yield 2017	Yield 2018	Yield 2019	Yield 2 yr	Yield 3 yr
				1-5[a]	inches	%	%	lbs/bu	------------------ bushels/acre ------------------				
REA Hybrids	RX00749	XT	00.7	1.8	23	32.4	15.1	57.6	--	22.9	39.5	31.2	--
REA Hybrids	RX00810	XT	00.8	2.4	21	32.9	15.6	56.8	--	--	52.3	--	--
REA Hybrids	RX0330	XT	0.3	1.9	26	34.2	15.6	51.5	--	--	38.6	--	--
LG Seeds	LGS00663RX	XT	00.6	2.1	20	32.3	15.1	58.9	--	26.3	36.8	31.6	--
LG Seeds	LGS00899RX	XT	00.8	2.3	25	32.7	15.8	57.0	--	--	45.3	--	--
LG Seeds	LGS0111RX	XT	0.1	2.6	26	32.4	15.7	55.5	--	31.4	56.7	44.1	--
Integra	50060N	XT	00.6	--	27	32.6	14.9	56.7	--	--	47.4	--	--
Integra	40089 E3	EN	00.8	1.9	25	31.7	14.3	57.0	--	--	39.1	--	--
Integra	20097 R2Y	RR	00.9	2.7	25	33.2	14.7	57.1	39.8	28.7	43.7	36.2	37.4
Integra	40129 E3	EN	0.1	1.4	23	31.0	15.2	54.0	--	--	35.7	--	--
Integra	50001 R2X	XT	00.1	2.5	24	32.4	15.8	54.5	--	--	40.9	--	--
Integra	40209 E3	EN	0.2	2.3	25	33.2	13.2	55.8	--	--	37.3	--	--
Proseed	XT 60-09	XT	00.9	2.2	27	31.9	15.7	57.7	--	--	44.1	--	--
Proseed	EL 80-093	EN	00.9	2.2	25	31.7	14.7	56.4	--	--	45.7	--	--
Proseed	50-10	RR	0.1	2.9	26	32.8	15.0	58.0	--	--	42.1	--	--
Proseed	XT 80-20	XT	0.2	1.6	23	31.4	15.1	57.1	--	--	37.7	--	--
Peterson Farms	18X008	XT	00.8	2.3	25	32.5	15.8	57.6	--	--	40.9	--	--
Peterson Farms	19EN008	EN	00.8	1.6	25	32.7	14.3	55.7	--	--	38.8	--	--
Peterson Farms	20X01	XT	0.1	3.2	23	32.1	15.7	56.1	--	--	38.9	--	--
P3 Genetics	2002E	EN	0.2	--	25	33.2	13.7	55.3	--	--	38.7	--	--
NorthStar	NS 60065NXR2	XT	00.6	2.2	24	32.0	15.3	57.7	--	--	35.9	--	--
NorthStar	NS 90084NE3	EN	00.7	1.8	23	32.1	14.4	56.2	--	--	36.7	--	--
NorthStar	NS 90094E3	EN	00.9	1.4	22	32.1	14.5	54.8	--	--	41.5	--	--
Legacy Seeds	LS-00639N RR2X	XT	00.6	2.3	24	32.5	15.3	57.9	--	--	41.6	--	--
Legacy Seeds	LS-00930 RR2X	XT	00.9	2.6	22	32.4	15.7	57.1	--	--	41.6	--	--
Legacy Seeds	LS-0239N RR2X	XT	0.2	1.7	25	32.1	14.9	56.6	--	--	42.5	--	--
Dyna-Gro	S005XT38	XT	00.5	2.1	25	31.5	15.5	58.0	39.8	29.3	39.8	34.6	36.3
Dyna-Gro	S007XT27	XT	00.7	2.2	23	32.5	14.9	58.9	--	29.7	39.5	34.6	--
Dyna-Gro	S009XT68	XT	00.9	2.3	25	32.2	14.9	58.0	--	--	32.4	--	--
Thunder Seed	SB89006N	XT	00.6	--	23	31.9	15.1	56.9	--	29.3	33.0	31.1	--
Thunder Seed	SB88007N	XT	00.7	2.2	25	32.3	16.0	57.8	42.4	28.6	41.4	35.0	37.5
Thunder Seed	ASTRO R2Y	RR	00.8	1.8	25	33.7	13.8	57.9	39.7	35.9	37.3	36.6	37.6

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Soybean Variety Trial at Mohall Continued

Company/Brand	Variety	Herbicide System	Maturity Group	IDC Rating	Plant Height	Protein	Oil	Test Weight	Yield 2017	Yield 2018	Yield 2019	Yield 2 yr	Yield 3 yr
				1-5[a]	inches	%	%	lbs/bu	bushels/acre				
Hefty	H006x0	XT	00.6	--	22	32.5	14.9	57.7	--	--	37.8	--	--
Hefty	H007x7	XT	00.7	--	21	32.7	15.1	59.0	--	--	37.5	--	--
Hefty	H008x8	XT	00.8	--	25	32.1	15.9	56.4	--	23.2	36.4	29.8	--
Hefty	H009x7	XT	00.9	--	28	32.7	14.8	56.8	--	--	42.0	--	--
Hefty	H01x0	XT	0.1	2.8	25	33.5	15.7	56.3	--	--	48.1	--	--
Hefty	H01E9	EN	0.1	2.2	23	33.6	13.3	55.9	--	--	35.7	--	--
Hefty	H02x7	XT	0.2	--	29	30.6	16.2	55.3	--	28.3	40.1	34.2	--
Hefty	H02E0	EN	0.2	1.9	24	32.1	13.1	54.9	--	--	42.6	--	--
Hefty	H03x7	XT	0.3	--	25	32.1	15.4	55.7	54.1	33.1	40.5	36.8	42.6
NDSU	ND18008GT	GT	00.7	2.8	24	32.8	15.5	58.0	29.3	25.3	31.8	28.6	28.8
NDSU	ND17009GT	GT	00.9	3.1	25	34.7	15.2	58.7	39.2	25.8	33.7	29.7	32.9
Trial Mean				2.4	24	32.5	15.0	56.8	38.9	27.5	40.1	--	--
C.V.%				22.6	5.3	2.8	3.3	1.4	8.5	11.4	14.0	--	--
LSD 5%				0.4	2	1.3	0.7	1.1	4.6	4.4	7.9	--	--
LSD 10%				0.3	2	1.1	0.6	0.9	3.8	3.7	6.6	--	--

[a] *IDC rating = Iron deficiency chlorosis rating: 1 - green, 3 - yellow, 5 - dead*

Planting Date: May 23
Harvest Date: October 18
Planting Rate: 150,000 PLS/A
Row Spacing: Solid Seeded (7" rows)
Soil Type: Barnes loam
Tillage: Minimum Till
Previous Crop: 2016 & 2017 = durum, 2018 = canola
Note: Protein, oil, test weight and yield are adjusted to 13% moisture.

Soybean Variety Trial at Rugby
Cooperators: Dave Teigen and the Pierce County Crop Improvement Assoc.

Company/Brand	Variety	Herbicide System	Maturity Group	IDC Rating	Plant Height	Protein	Oil	Test Weight	---------- Yield --------- 2018	2019	Avg.
				1-5[a]	inches	%	%	lbs/bu	-bushels per acre-		
REA Hybrids	RX00749	XT	00.7	1.8	23	33.7	15.8	56.6	55.9	33.2	44.6
REA Hybrids	RX00810	XT	00.8	2.4	21	33.2	16.3	56.1	--	38.6	--
REA Hybrids	RX0228	XT	0.2	1.6	26	33.7	15.9	56.3	60.1	39.6	49.9
REA Hybrids	RX0330	XT	0.3	1.9	24	33.3	15.2	55.9	--	41.7	--
LG Seeds	LGS00663RX	XT	00.6	2.1	21	33.6	15.7	57.5		33.5	--
LG Seeds	LGS00899RX	XT	00.8	2.3	24	33.0	16.4	56.4	--	38.6	--
LG Seeds	LGS0111RX	XT	0.1	2.6	27	33.8	16.1	56.0	--	45.7	--
Integra	50001 R2X	XT	00.1	2.5	23	33.7	15.8	56.0	--	41.8	--
Integra	40129 E3	EN	0.1	1.4	22	32.2	16.2	56.0	--	34.6	--
Integra	40209 E3	EN	0.2	2.3	22	33.3	15.6	55.8	--	35.9	--
Integra	20215 R2Y	RR	0.2	2.2	24	33.7	15.5	56.6	54.8	41.9	48.4
Integra	50309N R2X	XT	0.3	1.5	24	32.8	15.3	56.7	66.3	40.7	53.5
Proseed	XT 60-09	XT	00.9	2.2	26	32.7	16.6	56.7	--	37.5	--
Proseed	EL 80-093	EN	00.9	2.2	24	32.8	16.3	56.5	--	38.9	--
Proseed	50-10	RR	0.1	2.9	29	33.1	16.4	56.7	--	42.5	--
Proseed	XT 80-20	XT	0.2	1.6	25	32.6	15.4	56.4	--	44.0	--
Peterson Farms	18X008	XT	00.8	2.3	27	32.8	16.6	56.5	--	35.2	--
Peterson Farms	19EN008	EN	00.8	1.6	25	32.7	16.1	56.5	--	40.5	--
Peterson Farms	20X01	XT	0.1	3.2	22	33.3	16.1	56.3	--	35.6	--
P3 Genetics	2002E	EN	0.2	--	21	33.2	15.8	56.0	--	37.7	--
NorthStar	NS 90214E3	EN	0.2	2.5	21	33.6	15.5	55.7	--	42.0	--
NorthStar	NS 60264NXR2	XT	0.2	1.8	23	33.0	15.5	56.3	57.3	46.5	51.9
NorthStar	NS 90334E3	EN	0.3	2.4	22	33.2	15.5	56.5	--	46.3	--
Legacy Seeds	LS-00930 RR2X	XT	00.9	2.6	23	33.3	15.9	56.5	--	43.4	--
Legacy Seeds	LS-0239N RR2X	XT	0.2	1.7	25	33.1	15.2	56.7	53.8	40.5	47.1
Legacy Seeds	LS-0429 E3	EN	0.4	1.8	24	34.0	15.9	55.6	--	40.9	--
Legacy Seeds	LS-0438 RR2X	XT	0.4	2.6	23	34.0	15.9	55.7	--	41.0	--
NDSU	ND18008GT	GT	00.7	2.8	21	33.7	16.7	56.5	56.2	36.8	46.5
NDSU	ND17009GT	GT	00.9	3.1	24	35.0	16.6	58.6	57.4	35.3	46.3
Trial Mean				2.4	24	33.3	15.9	56.4	58.6	39.4	--
C.V.%				22.6	7.6	1.3	1.7	0.7	6.4	9.1	--
LSD 5%				0.4	3	0.6	0.4	0.5	5.2	5.0	--
LSD 10%				0.3	2	0.5	0.3	0.4	4.4	4.2	--

[a] IDC rating = Iron deficiency chlorosis rating: 1 - green, 3 - yellow, 5 - dead

Planting Date: May 23
Harvest Date: October 21
Planting Rate: 150,000 PLS/A
Row Spacing: Solid Seeded (7" rows)
Soil Type: Gardena silt loam
Tillage: Minimum Till
Previous Crop: 2017 = Barley, 2018 = soybean
Note: Protein, oil, test weight and yield are adjusted to 13% moisture.

Soybean Variety Trial at Garrison

Cooperators: Brian and Roger Bendickson, Garrison

Company/Brand	Variety	Herbicide System	Maturity Group	IDC Rating	Plant Height	Protein	Oil	Test Weight	Yield 2018	Yield 2019	Yield 2 yr
				1-5[a]	inches	%	%	lbs/bu	bushels/acre		
Rea Hybrids	RX00810	XT	00.8	2.4	22	34.7	15.0	56.9	--	43.4	--
Rea Hybrids	RX0330	XT	0.3	1.9	27	33.3	14.6	54.8	--	42.1	--
Rea Hybrids	RX0520	XT	0.5	2.1	22	35.2	14.5	52.5	--	41.1	--
LG Seeds	LGS00899RX	XT	00.8	2.3	25	34.0	15.4	56.9	--	47.7	--
LG Seeds	LGS0111RX	XT	0.1	2.6	26	34.7	14.8	54.7	36.3	53.2	44.7
LG Seeds	LGS0355RX	XT	0.3	1.8	25	34.5	14.1	56.8	45.8	53.7	49.8
Integra	40209 E3	EN	0.2	2.3	22	35.2	14.5	56.1	--	47.7	--
Integra	20215 R2Y	RR	0.2	2.2	24	34.6	14.3	57.0	37.0	55.2	46.1
Integra	20300 R2Y	RR	0.3	2.5	25	34.5	14.5	53.1	--	46.0	--
Integra	50309N R2X	XT	0.3	1.5	26	34.1	14.7	57.2	36.6	51.0	43.8
Proseed	XT 60-09	XT	00.9	2.2	26	33.4	15.5	56.5	--	44.8	--
Proseed	50-10	RR	0.1	2.9	30	34.6	15.4	56.9	--	48.1	--
Proseed	XT 80-20	XT	0.2	1.6	25	34.1	14.4	57.2		53.7	--
Proseed	EL 80-093	EN	00.9	2.2	27	33.4	15.2	57.7	--	49.2	--
Peterson Farms Seed	18X008	XT	00.8	2.3	25	33.8	15.3	57.1	--	41.9	--
Peterson Farms Seed	20X01	XT	0.1	3.2	22	34.6	14.9	56.6	--	50.0	--
Peterson Farms Seed	19EN008	EN	00.8	1.6	28	33.2	15.4	57.5	--	45.5	--
P3 Genetics	2002E	EN	0.2	--	23	34.9	14.6	56.9	--	46.2	--
Dyna-Gro	S03XT29	XT	0.3	1.7	26	34.3	14.3	57.4	40.6	51.3	45.9
Dyna-Gro	S04XT77	XT	0.4	2.4	23	34.5	14.8	56.6	37.5	49.8	43.6
Dyna-Gro	S05EN70	EN	0.5	2.2	24	33.1	15.1	53.4	--	44.3	--
Thunder Seed	TE79009	EN	00.9	--	24	33.4	15.4	56.5	--	40.1	--
NDSU	ND18008GT	GT	00.7	2.8	23	36.1	15.4	57.8	30.0	33.4	31.7
NDSU	ND17009GT	GT	00.9	3.1	25	36.7	15.6	59.1	33.6	39.9	36.7
Trial Mean				2.4	25	34.4	14.9	56.5	37.2	46.5	--
C.V.%				22.6	6.7	1.3	1.6	0.9	8.8	9.5	--
LSD 5%				0.4	2	0.6	0.3	0.7	4.6	6.2	--
LSD 10%				0.3	2	0.5	0.3	0.6	3.9	5.2	--

[a] *IDC rating = Iron deficiency chlorosis rating: 1 - green, 3 - yellow, 5 - dead*

Planting Date: May 29 | *Harvest Date: October 8*

Planting Rate: 150,000 PLS/A | *Row Spacing: Solid Seeded (7" rows)*

Tillage: No-till | *Soil Type: Williams Bowbells loam*

Previous Crop: 2017 = spring wheat, 2018 = soybean

Note: Protein, oil, test weight and yield are adjusted to 13% moisture.

Soybean Variety Trial at Wilton
Cooperator: Wes Doepke, Wilton

Company/Brand	Variety	Herbicide System	Maturity Group	IDC Rating	Plant Height	Protein	Oil	Test Weight	Yield 2017	Yield 2018	Yield 2019	Yield 2 yr	Yield 3 yr
				1-5[a]	inchs	%	%	lbs/bu	bushels/acre				
REA Hybrids	RX00810	XT	00.8	2.4	21	36.0	15.4	56.9	--	--	40.5	--	--
REA Hybrids	RX0330	XT	0.3	1.9	24	36.0	15.2	57.3	--	--	44.5	--	--
REA Hybrids	RX0520	XT	0.5	2.1	20	36.8	14.9	57.8	--	--	44.1	--	--
LG Seeds	LGS0111RX	XT	0.1	2.6	25	38.1	14.7	57.7	--	32.6	47.1	39.8	--
LG Seeds	LGS0355RX	XT	0.3	1.8	23	37.0	14.2	57.5	--	33.1	46.5	39.8	--
LG Seeds	LGS0400RX	XT	0.4	2.5	24	35.5	15.3	57.6	--	--	45.2	--	--
Integra	40209 E3	EN	0.2	2.3	20	37.7	14.6	56.9	--	--	44.1	--	--
Integra	20300 R2Y	RR	0.3	2.5	22	37.7	14.6	57.5	47.5	30.8	42.0	36.4	40.1
Integra	50309N R2X	XT	0.3	1.5	22	36.1	14.7	57.8	--	33.6	48.6	41.1	--
Integra	INT40350	EN	0.3	--	20	36.7	15.1	57.6	--	--	38.3	--	--
Proseed	XT 60-09	XT	00.9	2.2	25	35.6	15.7	57.7	--	--	45.2	--	--
Proseed	EL 80-093	EN	00.9	2.2	27	37.3	14.5	57.7	--	--	47.3	--	--
Proseed	50-10	RR	0.1	2.9	27	36.8	15.7	57.9	--	--	49.7	--	--
Proseed	XT 80-20	XT	0.2	1.6	23	36.6	14.7	57.9	--	--	41.4	--	--
Peterson Farms	18X008	XT	00.8	2.3	24	35.3	15.9	57.7	--	--	44.9	--	--
Peterson Farms	19EN008	EN	00.8	1.6	25	36.7	14.8	57.8	--	--	49.4	--	--
Peterson Farms	20X01	XT	0.1	3.2	20	37.4	15.1	57.1	--	--	41.6	--	--
P3 Genetics	2002E	EN	0.2	--	20	37.7	14.4	57.1	--	--	42.9	--	--
Legacy Seeds	LS-0429 E3	EN	0.4	1.8	24	37.8	15.0	57.9	--	--	49.0	--	--
Legacy Seeds	LS-0438 RR2X	XT	0.4	2.6	22	38.3	15.1	57.5	48.0	35.7	46.1	40.9	43.3
Legacy Seeds	LS-0638N RR2X	XT	0.6	2.6	25	36.2	14.7	57.9	--	36.1	48.4	42.3	--
Dyna-Gro	S03XT29	XT	0.3	1.7	26	36.9	14.2	58.1	--	34.0	47.1	40.5	--
Dyna-Gro	S04XT77	XT	0.4	2.4	21	37.2	15.3	57.7	--	32.7	43.5	38.1	--
Dyna-Gro	S05EN70	EN	0.5	2.2	22	36.1	15.6	57.4	--	--	44.5	--	--
Dyna-Gro	S06XT59	XT	0.6	2.6	25	36.9	14.5	57.9	--	37.1	41.1	39.1	--
Thunder Seed	TE79009	EN	00.9	--	24	36.8	14.9	57.5	--	--	48.1	--	--
Thunder Seed	SB8903N	XT	0.3	1.8	25	37.1	14.4	57.8	--	31.2	46.8	39.0	--
Croplan	Croplan RX0426	XT	0.4	--	20	37.0	15.4	57.7	--	--	43.5	--	--
Croplan	Croplan RX0500	XT	0.5	--	19	37.3	15.2	57.5	--	--	43.4	--	--
NDSU	ND18008GT	GT	00.7	2.8	22	37.2	15.7	57.3	32.4	27.9	43.0	35.5	34.4
NDSU	ND17009GT	GT	00.9	3.1	24	38.4	15.3	59.0	41.5	24.7	43.8	34.2	36.7
Trial Mean				2.4	23	36.9	15.0	57.6	47.7	31.9	45.1	--	--
C.V.%				22.6	9.1	1.6	2.0	0.7	8.6	8.5	8.5	--	--
LSD 5%				0.4	3	0.8	0.4	0.6	5.8	3.8	5.4	--	--
LSD 10%				0.3	2	0.7	0.4	0.5	4.8	3.2	4.5	--	--

[a] *IDC rating = Iron deficiency chlorosis rating: 1 - green, 3 - yellow, 5 - dead*

Planting Date: May 29
Harvest Date: October 8
Planting Rate: 150,000 PLS/A
Row Spacing: Solid Seeded (7" rows)
Soil Type: Mandan silt loam
Tillage: No-till
Previous Crop: 2016 = spring wheat, 2017 = soybean, 2018 = corn
Note: Protein, oil, test weight and yield are adjusted to 13% moisture.

2019 RR Soybean Yield Results from the North Central Region

Company	Variety	Maturity Group	IDC Rating	------------------ Seed Yield ------------------ Garrison	Minot	Mohall	Rugby	Wilton
			1-5[a]	--------------------bushels/acre--------------------				
Croplan	Croplan RX0426	0.4	--	--	--	--	--	43.5
Croplan	Croplan RX0500	0.5	--	--	--	--	--	43.4
Dairyland Seed	DSR-0200/R2Y	0.2	1.7	--	47.8	--	--	--
Dairyland Seed	DSR-C999/R2y	00.9	2.8	--	52.3	--	--	--
Dyna-Gro	S005XT38	00.5	2.1	--	--	39.8	--	--
Dyna-Gro	S007XT27	00.7	2.2	--	--	39.5	--	--
Dyna-Gro	S009XT68	00.9	2.3	--	50.3	32.4	--	--
Dyna-Gro	S03XT29	0.3	1.7	51.3	52.9	--	--	47.1
Dyna-Gro	S04XT77	0.4	2.4	49.8	--	--	--	43.5
Dyna-Gro	S05EN70	0.5	2.2	44.3	--	--	--	44.5
Dyna-Gro	S06XT59	0.6	2.6	--	--	--	--	41.1
Hefty	H006x0	00.6	--	--	41.4	37.8	--	--
Hefty	H007x7	00.7	--	--	41.4	37.5	--	--
Hefty	H008x8	00.8	--	--	49.3	36.4	--	--
Hefty	H009x7	00.9	--	--	41.1	42.0	--	--
Hefty	H01E9	0.1	2.2	--	51.9	35.7	--	--
Hefty	H01x0	0.1	2.8	--	52.2	48.1	--	--
Hefty	H02E0	0.2	1.9	--	50.3	42.6	--	--
Hefty	H02x7	0.2	--	--	62.3	40.1	--	--
Hefty	H03x7	0.3	--	--	51.8	40.5	--	--
Hefty	H04E8	0.4	--	--	40.6	--	--	--
Integra	40350E3	0.3	--	--	61.0	--	--	--
Integra	20097 R2Y	00.9	2.7	--	--	43.7	--	--
Integra	20215 R2Y	0.2	2.2	55.2	51.2	--	41.9	--
Integra	20300 R2Y	0.3	2.5	46.0	--	--	--	42.0
Integra	40089 E3	00.8	1.9	--	--	39.1	--	--
Integra	40129 E3	0.1	1.4	--	--	35.7	34.6	--
Integra	40209 E3	0.2	2.3	47.7	--	37.3	35.9	44.1
Integra	50001 R2X	00.1	2.5	--	52.6	40.9	41.8	--
Integra	50060N	00.6	--	--	--	47.4	--	--
Integra	50309N R2X	0.3	1.5	51.0	48.6	--	40.7	48.6
Integra	INT40350	0.3	--	--	--	--	--	38.3
Legacy Seeds	LS-00639N RR2X	00.6	2.3	--	43.2	41.6	--	--
Legacy Seeds	LS-00930 RR2X	00.9	2.6	--	46.9	41.6	43.4	--
Legacy Seeds	LS-0239N RR2X	0.2	1.7	--	48.2	42.5	40.5	--
Legacy Seeds	LS-0429 E3	0.4	1.8	--	--	--	40.9	49.0
Legacy Seeds	LS-0438 RR2X	0.4	2.6	--	50.5	--	41.0	46.1
Legacy Seeds	LS-0638N RR2X	0.6	2.6	--	--	--	--	48.4
LG Seeds	LGS00663RX	00.6	2.1	--	46.8	36.8	33.5	--
LG Seeds	LGS00899RX	00.8	2.3	47.7	47.9	45.3	38.6	--
LG Seeds	LGS0111RX	0.1	2.6	53.2	52.8	56.7	45.7	47.1
LG Seeds	LGS0355RX	0.3	1.8	53.7	--	--	--	46.5
LG Seeds	LGS0400RX	0.4	2.5	--	--	--	--	45.2

Continued on next page

2019 RR Soybean Yield Results from the North Central Region Continued

Company	Variety	Maturity Group	IDC Rating	Garrison	Minot	Mohall	Rugby	Wilton
				------------------ Seed Yield ------------------				
			1-5[a]	--------------------bushels/acre--------------------				
NDSU	ND17009GT	00.9	3.1	39.9	49.6	33.7	35.3	43.8
NDSU	ND18008GT	00.7	2.8	33.4	36.0	31.8	36.8	43.0
Norcan	NOR004	00.4	--	--	41.1	--	--	--
Norcan	NOR005	00.5	--	--	44.2	--	--	--
Norcan	NOR04	0.4	--	--	38.2	--	--	--
NorthStar	NS 60065NXR2	00.6	2.2	--	--	35.9	--	--
NorthStar	NS 60092XR2	00.9	2.0	--	46.9	--	--	--
NorthStar	NS 60264NXR2	0.2	1.8	--	--	--	46.5	--
NorthStar	NS 90084NE3	00.7	1.8	--	--	36.7	--	--
NorthStar	NS 90094E3	00.9	1.4	--	45.9	41.5	--	--
NorthStar	NS 90214E3	0.2	2.5	--	46.6	--	42.0	--
NorthStar	NS 90334E3	0.3	2.4	--	--	--	46.3	--
P3 Genetics	2002E	0.2	--	46.2	47.4	38.7	37.7	42.9
Peterson Farms	18X008	00.8	2.3	41.9	46.5	40.9	35.2	44.9
Peterson Farms	19EN008	00.8	1.6	45.5	54.7	38.8	40.5	49.4
Peterson Farms	20X01	0.1	3.2	50.0	43.4	38.9	35.6	41.6
Proseed	50-10	0.1	2.9	48.1	53.3	42.1	42.5	49.7
Proseed	EL 80-093	00.9	2.2	49.2	57.0	45.7	38.9	47.3
Proseed	XT 60-09	00.9	2.2	44.8	52.7	44.1	37.5	45.2
Proseed	XT 80-20	0.2	1.6	53.7	41.9	37.7	44.0	41.4
REA Hybrids	RX00749	00.7	1.8	--	50.1	39.5	33.2	--
REA Hybrids	RX00810	00.8	2.4	43.4	46.1	52.3	38.6	40.5
REA Hybrids	RX0228	0.2	1.6	--	44.5	--	39.6	--
REA Hybrids	RX0330	0.3	1.9	42.1	50.8	38.6	41.7	44.5
REA Hybrids	RX0520	0.5	2.1	41.1	--	--	--	44.1
Thunder Seed	ASTRO R2Y	00.8	1.8	--	45.6	37.3	--	--
Thunder Seed	SB88007N	00.7	2.2	--	50.4	41.4	--	--
Thunder Seed	SB89006N	00.6	--	--	50.7	33.0	--	--
Thunder Seed	SB8903N	0.3	1.8	--	--	--	--	46.8
Thunder Seed	TE79009	00.9	--	40.1	48.4	--	--	48.1
U of M	M06R-614008GT	00.8	2.6	--	44.3	--	--	--
Trial Mean			2.4	46.5	48.1	40.1	39.4	45.1
C.V.%			22.6	9.5	7.0	14.0	9.1	8.5
LSD 5%			0.4	6.2	5.5	7.9	5.0	5.4
LSD 10%			0.3	5.2	4.6	6.6	4.2	4.5

[a] *IDC rating = Iron deficiency chlorosis rating: 1 = green, 3 = yellow, 5 = dead*

Dry Edible Bean Variety Trial at Minot

Variety	Market Type	Days to Mature	Plant Height	100 Seed wt.	Seed Yield 2017	2018	2019	2 year	3 year
		DAP*	inches	grams	pounds per acre				
Lariat	Pinto	93	15	32	2198	1723	2007	1865	1976
ND-Palomino	Pinto	93	14	32	2092	1679	1499	1589	1757
Monterrey	Pinto	92	13	31	2105	1155	1534	1345	1598
La Paz	Pinto	93	14	33	1578	1498	1619	1559	1565
Stampede	Pinto	90	14	30	1527	976	1603	1290	1369
Windbreaker	Pinto	89	14	33	1558	1064	1243	1153	1288
Torreon	Pinto	91	14	33	--	--	1916	--	--
Vibrant	Pinto	91	15	29	--	--	1544	--	--
ND-Falcon	Pinto	98	14	30	--	--	1443	--	--
Powderhorn	Great Northern	87	14	30	1551	1331	1841	1586	1574
ND-Pegasus	Great Northern	98	16	32	--	--	2113	--	--
Rosetta	Pink	101	14	29	2865	899	1365	1132	1710
Merlot	Small Red	98	16	33	1459	887	1399	1143	1248
Viper	Small Red	99	14	25	--	--	2043	--	--
Eclipse	Black	99	13	18	2509	713	1685	1199	1636
Zorro	Black	100	12	18	1748	1172	1485	1329	1468
Loreto	Black	101	15	18	1988	685	1081	883	1251
Black Tails	Black	98	14	17	--	--	1672	--	--
T9905	Navy	101	14	19	2123	964	1424	1194	1504
HMS Medalist	Navy	101	15	17	1411	898	1544	1221	1284
Blizzard	Navy	94	11	16	--	--	1544	--	--
Trial Mean		96	14	27	1876	1135	1599	--	--
C.V. %		1.0	8.3	3.8	8.0	14.6	11.6	--	--
LSD 5%		2	2	2	250	278	304	--	--
LSD 10%		1	2	1	207	231	253	--	--

**DAP = Days after planting.*

Planting Date: May 20
Harvest Date: September 17
Seeding Rate: 90,000 live seeds / Acre
Row Spacing: 15"
Previous Crop: 2016 = barley, 2017 = corn 2018 = spring wheat.
Tillage System: Minimum till
Soil Type: Williams Loam
Note: The 2018 trial sustained moderate drought growing conditions.

Precision Planting of Dry Edible Bean

Eric Eriksmoen, Research Agronomist, NDSU North Central Research Extension Center, Minot, ND.

Introduction: Seeding equipment utilizing seed singulation technologies is very expensive, but has been proven to enhance corn production by eliminating yield limiting skips and doubles. In other crops like canola, seed singulation technologies have lowered seeding rates by as much as 50%, while maintaining yields. For crops with high seed costs, this savings can be substantial. We now also recognize plant sensory systems as they relate to a plants tolerance to its neighbors and a plants need for its own growing space. Row spacing and plant population are directly related to this interaction. Dry beans are known to have some ability to branch and fill their growing space, and therefore may be an ideal crop for precision planting. A key question to precision seeding technology in dry bean is whether there is a true economic advantage over conventional seeding equipment. This study was initiated during the 2018 growing season and included pinto, navy, black and dark red kidney bean market classes. The 2018 trial sustained severe drought which adversely affected growing conditions and resulted in relatively poor yields. The 2019 trial used the same experimental design but reduced the market classes to just pinto and dark red kidney types.

Approach: The main objective of this replicated small plot research trial was to compare precision seeding vs. conventional seeding equipment. The 2018 trial consisted of "ND Palomino" pinto, "Avalanche" navy, "Eclipse" black and "Montcalm" dark red kidney bean, and the 2019 trial consisted of "ND Palomino" pinto and "Montcalm" dark red kidney beans. Beans were planted into 15 inch and 30 inch row spacing and these row spacing were planted in combination with three seeding rates: 50,000, 70,000 and 90,000 pure live seeds per acre for pinto and kidney beans, and 90,000, 110,000 and 120,000 pure live seeds per acre for navy and black beans, respectively. The trials were planted at the NDSU North Central Research Extension Center at Minot, North Dakota using a split block experimental design with three replications. Precision planted plots were planted with a 4 row SRES Classic Air Flex small plot planter using a Monosem seed singulation metering system and Great Plains double disc openers. The conventional planted plots were planted with a custom-built small plot cone seeder using John Deere MaxEmerge row units. The trials were planted on June 4, 2018 and June 5, 2019 into a minimally tilled Williams loam soil that was spring wheat the previous year. Soil fertility levels were adequate for a 3000 pound crop. All seed was treated with the appropriate strain of Rhizobia inoculant. Weeds were controlled with a preplant application of sulfentrazone & carfentrazone (Spartan Charge) + glyphosate and a post-emergence application of bentazon & imazamox (Varisto) in 2018 and imazamox (Raptor) in 2019. The trials were treated with a pre-harvest application of paraquat + flumioxazin (Valor). Fungicides were not applied. Individual plots were 5 feet wide by 25 feet long and trimmed to 19 feet long for harvest. Plots were direct harvested on September 18, 2018 and September 25, 2019 with a Kincaid small plot combine.

Results and discussion: Detecting positive and negative outcomes, understanding those outcomes and making realistic management decisions is the ultimate goal of this project. The 2018 trial sustained a severe season long drought, with total growing season precipitation of 5.57 inches. This drought obviously affected overall plant growth and seed production and therefore results from each year are shown separately.

Data was tabulated on days to seedling emergence, established plant stand, maturity date, plant height at harvest, lodging, 100 seed weight, test weight and seed yield. Days to seedling emergence was seven days after planting for all plots in 2018 (data not shown) and there was no observed lodging in either year (data not shown). Tables 1 and 2 compare overall means for planter type. Subsequent tables are broken down by market class and year.

The only statistically significant difference between planters in the 2018 trial was for 100 seed weight in which the conventional planted beans producing slightly heavier seed. This was not observed in the 2019 trial. The only statistically significant difference between planters in the 2019 trial was for a one-day difference in seedling emergence and a one-inch difference in plant height. This may be due to slight differences in planting depth, but in general these differences have little overall effect on the practical outcome of the trial.

Table 1. Overall combined mean comparisons between planters, 2018.

Planter	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
Conventional	68,190	24	12	23.7	60.0	540
Precision	72,761	24	12	22.3	59.7	460
LSD 0.05	NS	NS	NS	*	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 2. Combined mean comparisons between planters, 2019.

Planter	Days to Emerge	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	days	plants/A	Sept	inches	grams	lbs/bu	lbs/A
Conventional	13	62,113	18	12	42	58.8	1239
Precision	12	62,597	19	11	42	58.9	1147
LSD 0.05	*	NS	NS	*	NS	NS	NS

NS = no statistical difference between planters. *Statistically different.

<u>Pinto Bean (2018 and 2019)</u>

Statistical differences between planters was observed for maturity and seed weight in the 2018 trial (Table 3), with the conventional planted beans maturing a couple of days later and producing heavier seed than pinto beans planted with the precision planter. Crop maturity and seed weight typically have an inverse relationship with plant stand. When plant populations decrease, maturity and seed weight tend to increase. The 2019 trial (Table 4) did not show any statistical differences between planters except for a one-day difference for seedling emergence.

Table 3. Combined mean comparisons between planters for pinto beans, 2018.

Planter	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
Conventional	50,551	24	13	28.3	58.3	540
Precision	58,295	22	12	26.8	58.3	450
LSD 0.05	NS	*	NS	*	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 4. Combined mean comparisons between planters for pinto beans, 2019.

Planter	Days to Emerge	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	days	plants/A	Sept	inches	grams	lbs/bu	lbs/A
Conventional	12	54,853	18	12	36.4	59.6	1394
Precision	11	62,275	18	11	36.8	59.5	1264
LSD 0.05	*	NS	NS	NS	NS	NS	NS

NS = no statistical difference between planters. *Statistically different.

Tables 5 and 6 show combined means for row spacing from the 2018 and 2019 trials, respectively. Results from both trials were similar with narrow rows producing more established plants and lower test weights. These are common observations where wider rows produce more plant-to-plant competition within the row which tends to reduce the overall established plant stand and seed size. Smaller seeds tend to produce a heavier test weight.

Table 5. Combined means for pinto bean row spacing, 2018.

Row Spacing	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
15"	60,446	24	12	27.6	57.9	527
30"	48,400	23	13	27.5	58.7	462
LSD 0.05	*	NS	NS	NS	*	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 6. Combined means for pinto bean row spacing, 2019.

Row Spacing	Days to Emerge	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	days	plants/A	Sept	inches	grams	lbs/bu	lbs/A
15"	17	61,307	16	12	36.9	59.2	1369
30"	17	55,821	15	11	36.3	59.9	1288
LSD 0.05	NS	NS	NS	NS	NS	*	NS

NS = no statistical difference between row spacing. *Statistically different.

Tables 7 and 8 show combined means for seeding rates from the 2018 and 2019 trials, respectively. Results from both trials showed no statistical differences for seeding rates in agronomic, seed quality or seed yields. For every incremental increase in seeding rate, there was an incremental decrease in the number of plants that survived and contributed to yield.

Table 7. Combined means for pinto bean seeding rates, 2018.

Seeding Rate	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
Seeds/A	plants/A	Aug	inches	grams	lbs/bu	lbs/A
50,000	48,400	24	12	28.0	58.3	458
70,000	52,595	23	13	27.2	58.3	482
90,000	62,275	24	13	27.5	58.2	545
LSD 0.05	7,734	NS	NS	NS	NS	NS

NS = no statistical difference between seeding rates.

Table 8. Combined means for pinto bean seeding rates, 2019.

Seeding Rate	Days to Emerge	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
Seeds/A	days	plants/A	Sept	inches	grams	lbs/bu	lbs/A
50,000	17	49,852	16	12	37.1	59.6	1242
70,000	17	60,500	16	12	36.6	59.7	1341
90,000	17	65,340	15	11	36.0	59.3	1352
LSD 0.05	NS	12,597	NS	NS	NS	NS	NS

NS = no statistical difference between seeding rates.

Dark Red Kidney Bean (2018 and 2019)

Statistical differences between planters were observed for maturity, seed weight and yield with the 2018 trial (Table 9). Although statistical differences between planters were detected for maturity, it appears that row spacing probably had a greater influence on this agronomic characteristic. Differences between planters for seed weight were similar to those for pinto bean. Yield differences were not a result of planter, row spacing or seeding rate interactions, but may be attributed to harvest losses during combining. There were no statistical differences for seed quality or seed yield in the 2019 trial (table 10). There were small but statistically significant differences between planters for seedling emergence and maturity. Differences for seedling emergence may be attributed to slight differences in planting depth between planters. Differences between maturities is typically related to plant populations, with thinner stands having longer maturities.

Table 9. Combined mean comparisons between planters for dark red kidney beans, 2018.

Planter	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
Conventional	51,949	26	12	38.4	55.7	446
Precision	55,606	28	12	35.5	55.5	297
LSD 0.05	NS	*	NS	*	NS	*

NS = no statistical difference between planters. *Statistically different.

Table 10. Combined mean comparisons between planters for dark red kidney beans, 2019.

Planter	Days to Emerge	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	days	plants/A	Sept	inches	grams	lbs/bu	lbs/A
Conventional	13	69,373	21	12	48	58.0	1084
Precision	12	62,920	22	11	48	58.2	1031
LSD 0.05	*	NS	*	NS	NS	NS	NS

NS = no statistical difference between planters. *Statistically different.

2018 and 2019 trial results of kidney bean row spacing are shown in tables 11 and 12, respectively. Plant maturities were indirectly influenced by row spacing in 2018 but not in the 2019 trial. Plant population tends to influence plant maturity to a higher degree which explains this agronomic difference. Similar to the 2019 pinto beans, 2019 kidney bean test weights were also influenced by row spacing.

Table 11. Combined means for kidney bean row spacing, 2018.

Row Spacing	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
15"	64,103	28	12	37.4	55.3	365
30"	43,352	26	12	36.6	55.9	377
LSD 0.05	*	*	NS	NS	NS	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 12. Combined means for kidney bean row spacing, 2019.

Row Spacing	Days to Emerge	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	days	plants/A	Sept	inches	grams	lbs/bu	lbs/A
15"	12	60,661	21	11	47.9	57.8	1071
30"	12	58,080	21	11	48.1	58.5	1044
LSD 0.05	NS	NS	NS	NS	NS	*	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 13 shows the 2018 seeding rate results for kidney beans. Differences were observed for yield with the 70,000 seeding rate yielding statistically more than the 50,000 rate, however, all yields were pathetically low. 2019 seeding rate results are shown in table 14. Even though established plant stands were significantly higher for the 90,000 seeding rate, this did not translate into higher yields. Agronomic, seed quality and seed yields were all statistically similar to each other, regardless of seeding rate.

Table 13. Combined means for kidney bean seeding rates, 2018.

Seeding Rate	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
Seeds/A	plants/A	Aug	inches	grams	lbs/bu	lbs/A
50,000	42,592	28	12	37.3	55.9	321
70,000	59,048	26	12	37.1	55.3	401
90,000	59,693	26	12	36.5	55.5	393
LSD 0.05	6,874	NS	NS	NS	NS	76

NS = no statistical difference between seeding rates.

Table 14. Combined means for kidney bean seeding rates, 2019.

Seeding Rate	Days to Emerge	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
Seeds/A	days	plants/A	Sept	inches	grams	lbs/bu	lbs/A
50,000	12	52,756	21	11	48.2	58.0	985
70,000	12	54,692	22	11	48.2	58.0	1086
90,000	12	70,664	21	12	47.6	58.3	1101
LSD 0.05	NS	14,880	NS	NS	NS	NS	NS

NS = no statistical difference between seeding rates.

Navy Bean (2018)

Small but statistically significant differences between planters were observed for seed weight and test weight (Table 15) with the conventional planter producing heavier seed and heavier test weight. Statistical analysis indicated that this difference was produced by an interaction between planter and row spacing (data not shown). Interactions between planter, row spacing and seeding rates did not account for the differences between planters for test weight.

Table 15. Combined mean comparisons between planters for navy beans, 2018.

Planter	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
Conventional	79,268	25	12	14.1	63.9	598
Precision	76,580	23	12	13.3	63.3	532
LSD 0.05	NS	NS	NS	*	*	NS

NS = no statistical difference between planters. *Statistically different.

Table 16 shows results of row spacing. The magnitude of established plants between row spacing was quite remarkable with 15 inch rows producing 41% more established plants than 30" rows. This difference, however, did not significantly affect agronomic characteristics, seed quality or yield.

Table 16. Combined means for navy bean row spacing, 2018.

Row Spacing	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
15"	91,207	24	12	13.6	63.7	599
30"	64,641	23	12	13.9	63.4	531
LSD 0.05	*	NS	NS	NS	NS	NS

NS = no statistical difference between row spacing. *Statistically different.

Table 17 shows results of seeding rates. Statistically significant differences were detected for yield. The 120,000 seeding rate produced a higher yield than the 110,000 rate, but had a similar yield to the 90,000 rate. This is probably related to adverse growing conditions and/or losses during harvest.

Table 17. Combined means for navy bean seeding rates, 2018.

Seeding Rate	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
Seeds/A	plants/A	Aug	inches	grams	lbs/bu	lbs/A
90,000	72,116	25	12	13.8	63.5	594
110,000	80,344	23	12	13.5	63.4	479
120,000	81,312	24	12	13.9	63.8	622
LSD 0.05	7,888	NS	NS	NS	NS	106

NS = no statistical difference between seeding rates.

Black Bean (2018)

Similar to pinto and kidney bean, the precision planter produced more established black bean plants than the conventional planter (Table 18), however, more plants did not translate into higher yields in this low yielding environment.

Table 18. Combined mean comparisons between planters for black beans, 2018.

Planter	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
Conventional	90,992	22	10	14.1	62.1	575
Precision	100,564	22	10	13.5	61.7	561
LSD 0.05	*	NS	NS	NS	NS	NS

NS = no statistical difference between planters. *Statistically different.

Table 19 shows results of row spacing. Like the other market classes, 15 inch row spacing significantly increased plant establishment, however, as stated above, more plants did not translate into significantly higher yields.

Table 19. Combined means for black bean row spacing, 2018.

Row Spacing	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
	plants/A	Aug	inches	grams	lbs/bu	lbs/A
15"	114,869	23	10	13.8	62.2	606
30"	76,687	21	10	13.7	61.7	531
LSD 0.05	*	NS	NS	NS	NS	NS

NS = no statistical difference between row spacing. *Statistically different.

As would be expected, there was a trend for increasing plant stands with increasing seeding rates (Table 20). This positive trend, however, did not enhance agronomic characteristics, seed quality or yield.

Table 20. Combined means for black bean seeding rates, 2018.

Seeding Rate	Plant Stand	Maturity Date	Plant Height	100 Seed Weight	Test Weight	Yield
Seeds/A	plants/A	Aug	inches	grams	lbs/bu	lbs/A
90,000	87,443	22	10	13.8	61.8	502
110,000	99,059	22	11	13.8	62.2	626
120,000	100,833	22	10	13.7	61.8	577
LSD 0.05	8,578	NS	NS	NS	NS	NS

[a]DAP=Days after Planting NS = no statistical difference between seeding rates.

Conclusions: As previously stated, concrete management decisions based on results derived from adverse growing conditions should be avoided. General observations from this study indicate: 1. the precision planter typically produced a more uniform and higher established plant stand but this did not translate into higher yields or better seed quality. 2. narrow rows tended to produce more established plants than wider rows, but again, these increased plant populations did not significantly enhance seed production, and 3. higher seeding rates tended to produce higher plant stands, but these increased stands also did not significantly enhance seed production. A benefit of higher seeding rates and narrow rows is enhanced crop competition with weeds. This is especially important in no-till or reduced tillage systems. In conventional tillage systems, wider rows allow for in-season cultivation for weed control and lower seeding rates reduces seed costs. From these trials and observations, it would be difficult to justify the additional cost of precision equipment for the sole purpose of dry bean production. A well maintained and properly calibrated conventional planter should provide the same production performance to precision planting equipment.

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2019 Field Pea Variety Yield Trial at Minot

Variety	Days to Flower	Days to Maturity	Canopy Height	Lodging	Seed Protein	1000 Seed Weight	Seeds/ Pound	Test Weight	Seed Yield	Significant Difference[5]
	DAP[1]	DAP[1]	cm	(0-9)[4]	%	g	#	lb/bu	bu/A	
Green Cotyledon										
Shamrock	53	82	65	2.0	25	252	1817	65.5	50.8	A
AAC Comfort	56	86	60	2.0	26	252	1813	64.5	49.2	A
CDC Greenwater	52	83	72	2.0	25	237	1913	65.9	48.3	A
CDC Dakota	56	83	70	1.0	28	219	2077	65.8	48.3	A
Arcadia	50	79	49	5.0	25	212	2144	64.9	47.9	A
CDC Striker	51	79	44	3.0	24	223	2036	65.2	47.3	A
Hampton	52	81	49	5.0	27	224	2027	65.0	46.1	A
Empire	52	81	80	1.0	25	225	2018	66.9	45.8	A
Cruiser	51	79	53	4.0	25	203	2235	64.4	40.6	B
Bluemoon	52	79	52	2.0	24	222	2077	64.6	33.1	C
Yellow Cotyledon										
CDC Amarillo	53	81	70	1.0	25	228	1990	65.9	59.1	A
CDC Inca	53	82	71	2.0	24	229	1984	66.0	53.7	A
AAC Profit	53	81	58	1.0	26	233	1953	65.9	52.5	A
DL Apollo	51	79	62	1.0	25	219	2069	66.7	51.9	A
AAC Chrome	52	81	49	1.0	24	244	1857	66.4	50.9	B
Earlystar	51	80	65	4.0	23	219	2078	65.6	50.5	B
AAC Asher	51	80	44	1.0	25	272	1670	65.3	49.7	B
CDC Spectrum	52	82	62	2.0	26	232	1959	65.6	49.2	B
Astronaute	51	75	58	2.0	25	240	1891	65.4	48.8	B
CDC Saffron	52	80	55	2.0	25	248	1830	65.6	48.7	B
Agassiz	51	80	60	3.0	26	226	2013	65.4	48.5	B
Jetset	51	79	59	2.0	26	263	1783	64.7	47.8	B
Hyline	52	81	59	2.0	24	228	1990	65.8	46.6	B
Spider	52	81	70	2.0	26	236	1936	66.0	46.3	B
AAC Carver	52	81	62	1.0	24	234	1946	65.3	46.0	B
DS Admiral	51	80	60	2.0	24	232	1955	65.1	45.6	B
Korando	49	78	48	2.0	26	248	1844	65.0	43.4	B
Salamanca	51	79	58	1.0	25	236	1925	65.6	43.2	B
Bridger	50	80	55	1.0	24	228	1988	65.9	42.9	C
Majestic	53	79	63	1.0	25	212	2148	64.2	42.6	C
LG Sunrise	48	79	56	1.0	24	237	1913	65.2	42.3	C
Durwood	51	81	67	1.0	25	233	1950	65.6	41.6	C
Viper	49	78	52	1.0	26	237	1913	64.6	40.4	C
LG Amigo	52	83	63	2.0	25	235	1936	65.0	38.2	C
Navarro	47	77	40	1.0	24	244	1884	64.4	36.9	C
Nette 2010	49	78	53	1.0	22	237	1925	65.8	34.6	D
Trial Mean	51	80	59	2	25	233	1962	65.4	45.9	
CV	2.2	2.7	13.1	76.6	3.9	7.3	6.9	0.9	15.0	
LSD 5%	1	3	9	2	1	20	158	0.7	8.1	

[1] *Days after planting*

[2] *Pod Height at Maturity/Pod Height*

[3] *Canopy Height/Vinelength*

[4] *Lodging: 0 = all plants erect, 9 = all plants lying flat on the ground*

[5] *Seed yields within a market class with different letters are significantly (p<0.05) different*

Planted: 4/30/2018

Harvested: 8/9/2018

2019 Lentil Variety Yield Trial at Minot

Variety	Days to Flower	Days to Maturity	Canopy Height	Lodging	Protein	1000 Seed Weight	Seeds/ Pound	Test Weight	Seed Yield	Significant Difference[3]
	DAP[1]	DAP[1]	cm	(0-9)[2]	%	g	#	lb/bu	bu/A	
Large Green										
Riveland	50	87	29	5.5	25	67	6836	56.6	30.2	A
CDC Greenland	52	90	31	3.8	26	57	7965	57.8	25.4	A
Pennell	52	89	30	3.3	25	59	7851	58.5	23.9	A
Medium Green										
Avondale	50	86	29	2.8	23	46	9918	60.8	36.6	A
CDC Richlea	52	85	30	5.3	24	46	9838	60.2	31.6	A
Small Green										
ND Eagle	50	85	26	4.3	25	35	13000	61.9	42.8	A
CDC Viceroy	50	88	32	3.0	26	35	13186	62.5	33.3	B
Small Brown										
Pardina	50	84	22	5.3	23	37	12538	62.6	32.0	n/a
Small Red										
CDC Rouleau	54	85	34	4.8	23	34	13597	61.2	39.1	A
CDC Redberry	54	87	30	3.5	26	41	11043	61.3	35.1	A
CDC Rosetown	54	88	31	3.3	26	28	16650	62.8	29.5	B
CDC Red Rider	55	86	28	4.5	24	44	10500	57.3	26.8	B
French Green										
CDC Lemay	55	87	29	4.8	24	31	14707	62.8	32.6	n/a
Trial Mean	51	86	28	4.7	24	45	10649	60.1	30.9	
CV	1.9	2.9	15.7	35.5	6.4	8.5	8.0	6.7	23.3	
LSD 5%	1	3	5	2.0	2	5	1004	4.8	8.5	

[1] *Days after planting*

[2] *Lodging: 0 = all plants erect, 9 = all plants lying flat on the ground*

[3] *Seed yields within a market class with different letters are significantly (p<0.05) different*

Planted: 5/9/2019

Harvested: 8/21/2019

2019 Chickpea Variety Yield Trial at Minot No-till

Variety	Days to Flower	Seed Size >9 mm	8-9 mm	7-8 mm	<7 mm	1000 Seed Weight	Seeds/ Pound	Seed Yield
	DAP[1]	%				g	#	bu/A
Kabuli								
CDC Luna	49	53.5	30.0	8.0	8.5	316	1437	17.4
Sierra	52	63.9	26.1	7.3	2.7	383	1185	15.1
Sawyer	50	43.0	33.5	17.0	6.5	346	1325	13.0
CDC Palmer	50	53.5	33.8	11.6	1.1	336	1360	11.2
CDC Frontier	57	36.5	41.2	14.4	4.9	296	1532	10.7
CDC Orion	50	62.0	26.5	9.0	2.5	375	1217	9.9
Desi								
CDC Anna	47	9.4	8.7	28.7	53.6	169	2763	17.2
Trial Mean	51	46.7	28.9	15.0	9.2	316	1524	11432.4
CV	1.4	31.0	23.1	32.6	44.5	9.8	8.2	24.9
LSD 5%	1	26.9	12.4	9.1	7.6	56	225	5109.0

[1] *Days after planting*

Planted: 5/13/2019

Harvested: 9/25/2019

-- **Note**: Only 2 reps were harvested and those names which are bolded had only one plot's worth of data

-- No significant differences in seed yield observed

Pulse Crop Production Under Non-Saline and Saline Conditions

Qi Zhang, Nonoy Bandillo, Thomas Stefaniak, Hannah Worral

High soil salinity is a major problem for agricultural production in North Dakota, including pulse crops. Salinity induces osmotic stress (i.e. physiological drought) and ion toxicity and imbalance, resulting in reduced plant growth and yield (quantity and quality) and even death under severe conditions. The objective of this research was to determine the effects of genotype and seed inoculant on pulse crop production under saline and non-saline conditions.

Two research sites were identified at the North Central Research and Experimental Station, Minot, ND in 2019: one with a soil electrical conductivity ($EC_{1:1}$) of 2.02 at the 0 – 6 inch (i.e. saline) and the other with an $EC_{1:1}$ of 1.36 dS m^{-1} (i.e. non-saline). Prowl (48 oz/A), Pursuit (2 oz/A), and Glyphosate (64 oz/A) were applied as a tank mixture on May 14, 2019 before seeding. Six pea, seven lentil, and four chickpea cultivars/advanced lines (Tables 1-3) were seeded at 7.6, 14, and 4 seed/ sq. ft., respectively, on May 21, 2019. Each experimental plot size was 6 x 30 ft with 8″ row spacing. Two seed inoculants, N-Dure (0.5 tsp/plot) and Tag Team (0.5 tsp/plot), were applied at seeding. Section 3EC (5.5 oz/A) and Asana (8 oz/A) were applied on June 10 and July 7, respectively, for weed control. Plant density was quantified on June 27, 2019 and crops were harvested on Sept. 6, 2019. Plant density, seed yield, and 1,000 seed weight (TSW) were analyzed.

No crops were harvested from the saline site due to a severe breakout of kochia, although plant density was measured in June. For field pea, Tag Team-treated plots had more plants than N-Dure-treated ones under the non-saline condition (Table 1). The highest TSW was observed in ‘LG Sunrise’ and ‘NDP130079’ and the lowest TSW was observed in ‘Cruiser’. However, no differences in the yield of field pea were observed. Similarly, Tag Team-treated lentils produced more seedlings than N-Dure-treated plants under the non-stress conditions (Table 2). Under the saline condition, ‘NDL140120’ and ‘NDL140122’ produced more plants than ‘NDL150418’. Lentil yield was affected by seed inoculant, while, TSW was affected by genotype. Genotype differences were observed in plant density under the non-saline condition and TSW in chickpea (Table 3), in which ‘CDC Frontier’ had lower plant density and TSW than other genotypes. Seed inoculant did not affect plant density and production in the present study in chickpea.

Table 1. Pea growth and yield as affected by genotype and seed inoculant. Yield and 1,000 seed weight were only analyzed under the non-saline condition.

	Plant density (Plant/A)		Yield	1,000 seed weight
Treatment	Non-saline	Saline	(lbs/A)	(g)
Genotype				
Agassiz	188,139a[†]	220,780a	2412.8a	203.5ab
Cruiser	170,899a	229,675a	1766.5a	180.4d
LG Sunrise	183,141a	155,671a	2330.2a	208.7a
NDP130079	190,997a	216,577a	2236.4a	213.0a
NDP130081	194,525a	154,152a	1749.5a	194.8bc
NDP150214	191,815a	216,061a	2256.3a	185.0cd
Inoculant				
N-Dure	167,002b	193,760a	2159.1a	197.8a
Tag Team	206,170a	203,879a	2091.4a	197.3a

[†]Means followed by the same letter within each column were not significantly different at $P \leq 0.05$ level.

Table 2. Lentil growth and yield as affected by genotype and seed inoculant. Yield and 1,000 seed weight were only analyzed under the non-saline condition.

Treatment	Plant density (Plant/A) Non-saline	Plant density (Plant/A) Saline	Yield (lbs/A)	1,000 seed weight (g)
Genotype (G)				
CDC Green	220,327a†	235,440ab	1287.6a	72.1a
CDC Richlea	233,750a	230,168ab	1385.0a	43.8bc
NDL140120	278,809a	300,641a	1108.7a	57.4b
NDL080187	232,899a	184,302ab	739.0a	51.8bc
NDL140122	239,676a	307,693a	1581.8a	41.4c
NDL140158	238,039a	204,381ab	1702.4a	44.5bc
NDL150418	225,358a	149,338b	1185.6a	48.7bc
Inoculant (I)				
N-Dure	214,837b	238,240a	1084.2b	51.1a
Tag Team	261,980a	222,322a	1484.4a	51.4a

†Means followed by the same letter within each column were not significantly different at $P \leq$ 0.05 level.

Table 3. Chickpea growth and yield as affected by genotype and seed inoculant. Yield and 1,000 seed weight were only analyzed under the non-saline condition.

Treatment	Plant density (Plant/A) Non-saline	Plant density (Plant/A) Saline	Yield (lbs/A)	1,000 seed weight (g)
Genotype (G)				
BGC090017	10,2667a†	9,9343a	2315.8a	406.1a
CDC Frontier	72,111b	6,7925a	2149.0a	336.8b
CDC Orion	111,833a	10,2119a	3181.6a	398.4a
Sawyer	110,000a	8,1762a	2293.0a	400.9a
Inoculant (I)				
N-Dure	103,889a	8,7502a	2505.5a	382.0a
Tag Team	9,4417a	8,8073a	2464.2a	389.1a

†Means followed by the same letter within each column were not significantly different at $P \leq$ 0.05 level.

2019 Evaluation and Enhancement of Dry Pea Protein Content

Shana Forster, Eric Eriksmoen, Hannah Worral, Thomas Stefaniak

Treatment[ƚ]	NDVI 1-Jul	NDVI 12-Jul	Test Weight	Yield	Protein
	0-100	0-100	lbs/bu	bu/A	%
AGASSIZ					
Untreated	67	71	63.7	48.0	25.7
1st flower	67	72	63.3	49.0	25.8
Mid bloom	65	71	63.7	48.1	26.0
90% bloom	65	72	63.8	47.7	25.8
ND Experimental					
Untreated	66	73	63.8	49.2	24.6
1st flower	67	73	63.5	49.6	25.0
Mid bloom	68	72	63.8	50.1	25.0
90% bloom	67	73	63.6	49.2	24.9
AAC CARVER					
Untreated	68	71	64.2	50.8	24.4
1st flower	66	70	64.8	50.6	24.2
Mid bloom	67	71	65.0	51.3	24.1
90% bloom	69	71	64.9	50.6	24.3
Trial Mean	67	72	64.0	49.5	25.0
C.V.%	4.2	1	0.6	3.6	1.2
LSD 5%	NS	1	0.4	NS	0.4
LSD 10%	NS	1	0.3	1.7	0.3

NDVI=Normalized Difference Vegetation Index

NS = no statistical difference between varieties.

ƚ Application of 20 gal/A with a 50:50 mixture of UAN and water applied with at hand held boom on June 26, June 30, and July 12 correspond to 1st flower, mid bloom, and 90% flower, respecitvely

Planted on May 7 with a seeding rate of 350,000 PLS/A and harvested on August 6.

Previous Crop: HRSW

Tillage: minimum till

A Comparison of Three Garden Soil Test Kits and a Certified Soil Testing Lab

By: Chris Augustin, Soil Health Extension Specialist; Ryan Buetow, Extension Cropping System Specialist; Jim Staricka, Soil Scientist; Alicia Harstad, Extension Agent; Jasper Teboh, Soil Scientist; and Beth Burdolski, Extension Agent

Introduction

Soil testing is important for fertility management. When soil tests are paired with fertilizer guidelines, good plant growth can be achieved while limiting the chance of creating a non-point source pollution issue. Whereas, fertilizing without a soil test may cause fertilizer being over applied and can cause adverse environmental issues; or fertilizer can be under applied which reduces plant growth.

Soil tests completed by a certified soil testing lab have undergone scrutiny by testing lab and university personnel. The certified lab tests are based on research that shows the most consistent and reliable results to a specific region. Many garden retailers offer soil test kits that offer fast results. However, the soil testing kits have not undergone the scrutiny that certified lab tests have.

This project compares the test results of three different soil test kits with a certified soil testing lab.

Materials and Methods

Soil test results from the North Dakota State University Soil Testing Lab (NDSU STL), a certified commercial soil testing lab were compared with the LaMotte[1] complete soil test kit (LaMotte), Luster leaf rapitest soil test kit[2] (Rapitest), and Luster leaf rapitest 4-way Analyzer[3] (4-way Analyzer). Sixteen different soils were tested. Soil series were collected based on location, taxonomy, and prevalence in North Dakota (Figure 1). Store bought compost[4] and potting soil[5] were also tested. Soils were collected by shovel at the 0-6 inch depth and stored in soil testing bags. Soils were dried, ground, homogenized, and divided into six separate soil testing bags. Three bags were randomly selected and analyzed by the NDSU STL. The other soil bags were kept for garden soil test kit analysis.

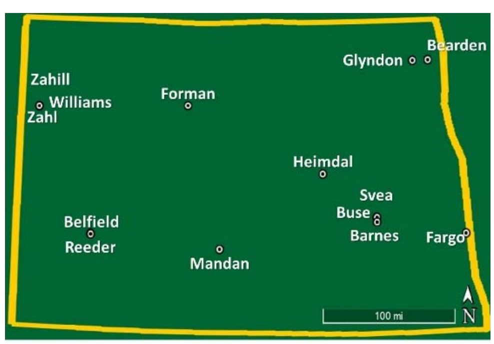

Figure 1. Location and soil series of tested soils.

Soil pH, nitrate, phosphorus, and potassium levels were determined. Instructions were followed by the respective soil test kits. Distilled water was used when soil test kit instructions required water. Soil test kit components were washed with distilled water. A 2:1 (soil:distilled water) mixture was created for the 4-way Analyzer. The mixture was allowed to equilibrate for an hour before testing. Soil test levels were statistically analyzed by Student's T-test procedure and compared only with the NDSU STL results (Table 1).

Results and Discussion

The LaMotte pH, nitrate, and phosphorus soil tests were similar to the NDSU STL (Table 1). The Rapitest soil pH and nitrate were similar to the NDSU STL results. The 4-way Analyzer soil tests were different from all NDSU STL soil tests (Table 1).

Table 1. Average soil test results of the different soil tests.

	pH	Nitrate	Phosphorus	Potassium
Soil Test		-lbs/ac-	----ppm----	
NDSU Soil Testing Lab	6.8	47.1	31.9	479.3
LaMotte Complete Soil Test Kit[1]	6.9	32.8	40.6	64.7***
Luster leaf rapitest Soil Test Kit[2]	6.8	49.9	14.8***	143.5***
Luster leaf rapitest 4-Way Analyzer[3]	6.1***	9.0***	1.4***	23.4***

***Significantly different at the 99.9% confidence level

Conclusions and Implications

In some instances, the soil garden test kits provided similar soil test results to the certified soil testing lab. However, garden soil test kits tended to measure less nutrients than the certified soil testing lab (Table 1).

North Dakota soils tend to have high levels of potassium. All garden soil test kits underestimated soil potassium levels (Table 1).

Using the garden soil test kits instead of a certified soil testing lab may cause over application of fertilizers. Unless, fertilizer recommendations are calibrated for the specific soil garden test kit.

Several other garden soil test kits are available. Many of the untested kits have similar extraction solutions as the ones tested. If using an untested kit, the extraction solutions should be noted by the user to determine if the kit is comparable to a certified testing lab.

References

[1]LaMotte COMPANY. 2019. LaMotte complete soil test kit. Chestertown, MD.
[2]Luster Leaf Products, Inc. 2019a. rapitest 4-Way Analyzer. Woodstock, IL.
[3]Luster Leaf Products, Inc. 2019b. rapitest Soil Test Kit. Woodstock, IL.
[4]Mountain West Products. 2019. Mountain magic compost and manure. Mountain West Products. 4212 South Highway 191, Rexburg, ID.
[5]Oldcastle Lawn & Garden Inc. 2019. Schultz premium potting soil plus. Old Castle Lawn & Garden Inc. PO Box 468567, Atlanta, GA.

Beet Lime Impacts on Spring Wheat

Chris Augustin, Soil Health Specialist
Ryan Buetow, Cropping Systems Specialist

Introduction

Soil pH is the measure of the concentration and activity of the hydrogen ion. North Dakota soil pH has historically been above 6. However, in areas west of highway 83, many are observing soil pH levels below 5.5. These acidic soils reduce yields because of reduced soil microbial activity, aluminum toxicity, and phosphorus tie-up. The cause of the soil acidification is believed to be caused by nitrogen fertilizers. As nitrogen fertilizers convert into plant available nitrate, hydrogen is released and acidifies the soil. Over time, hydrogen accumulates and can turn the soil acidic which reduce yields. Acidic soils can be managed by the application of lime. Lime is calcium-carbonate. Lime raises soil pH from carbonates reacting with the hydrogen ion. This produces free calcium, carbon-dioxide, and water.

Many states have developed lime recommendations based on their clay type, parent materials, and climate. Acidic soils in North Dakota is a new issue and consequently, lime recommendations have not been developed here. Commercial ag lime is not readily available in North Dakota. However, beet lime (a by-product of the sugarbeet refining process) is readily available from sugarbeet processing factories. Beet lime was used as the liming agent for this project. On a separate note, 100 tons of beet lime was hauled from Sidney Sugars in Sidney Montana to Minot for $41/ton. Whereas one ton of ag lime was quoted as $150/ton delivered to Minot.

Materials & Methods

This study occurred in Minot and Dickinson. Climate and soil parent material is different between the two environments. Soil samples were collected and tested prior to planting. Beet lime was surface applied at rates of 0, 0.25, 0.5, 1, 2, 3 and 4 tons/ac. Beet lime does contain nutrients (Table 1). All plots were fertilized for 50 bu/ac hard red spring wheat with urea and potash by mid-row band. Monammomium phosphate was applied in furrow.

Plots were 5ft by 25ft and assembled in a randomized complete block design with five replications. To reduce influence from an adjacent treatment, a one planter pass buffer strip of wheat was planted between each plot.

Spring wheat was planted by a no-till methods and grown using normal best management practices. A previous study at Dickinson observed that variety selection can influence the severity of acidic soil issues (Beutow, 2018). This project paired lime treatments with the wheat varieties Lanning (Montana State University) and Soren (Syngenta). Soils will be sampled in the spring of 2020 to determine lime effects to soil pH.

Table 1. Chemical analysis of beet lime.

pH	Nitrate	Phosphorus	Potassium	Moisture	CCE*	EC**
	-------------ppm-------------			--%--		mmhos/cm
8.6	213	2576	434	13	77	1.6

*Calcium carbonate equivalence

**Electrical conductivity

Results

Beet lime treatments did impact yield at Minot (Table 2). However, beet lime did not impact yield at Dickinson. Aluminum toxicity can be exacerbated by adequate rainfall and banded phosphorus. Both study sites received phosphorus. However, Minot was much drier than Dickinson which may have caused the lack of a yield response from beet lime at Dickinson.

Table 2. Lime treatment impacts on spring wheat yield in Minot.

Treatment	Yield (bu/ac)
4 t/ac	19.3a
0.25 t/ac	18.2ab
3 t/ac	17.5ab
Check	17.0ab
1 t /ac	16.0bc
2 t/ac	15.8bc
0.5 t/ac	14.0bc
P-value	<0.05

A similar study on soybean did not observe a yield or quality impact from beet lime. However, surface applied beet lime did increase soil pH to a depth of 4 inches. The initial soil pH was measured at the end of the May. The change in pH was determined by soil collected the first week of October (Table 3).

Table 3. Surface applied beet lime effects on soil pH by depth and soil horizon.

Depth (in)	Horizon*	Initial pH	2 Beet Lime (ton/ac)	4 Beet Lime (ton/ac)
		----------------pH----------------		
0-2	Ap	5.33ax**	6.5bx	6.7bx
2-4	Ap	5.4ax	6.1bx	6.2bx
4-6	Ap	5.4ax	5.6ay	5.7ay
6-12	Bt	5.8ay	5.9ay	5.9ay
12-24	BtK	7.7az	7.7az	7.7az

*Horizons were determined by observing push probe samples.

**a and b show significance across treatments. x, y, and z show significance across depths within a treatment. Significance is at the 0.05 level.

Conclusions

Surface applied beet lime can improve soil pH over the course of a growing season. However, beet lime may not improve yields as observed by hard red spring wheat grown at Dickinson and soybean grown in Minot. More research is needed to develop a method to recommend lime applications to surface applied soil.

References

Buetow, R. 2018. Acidic soils in southwest, ND. p. 66-67 *In* Thirty-fifth annual western Dakota crops day research report 2018. NDSU Dickinson Research Extension Center, Dickinson, ND and NDSU Hettinger Research Extension Center, Hettinger, ND.

This project was funded by the North Dakota Wheat Commission and North Dakota Soybean Council.

Soil Disturbance Impacts on Spring Wheat Yield and Quality

Chris Augustin, NCREC Soil Health Specialist

Introduction

Excavation and replacement of soil is a necessity for the installation of utilities and infrastructure. Soil excavation and replacement can greatly impact soil physical characteristics. If the soil is not replaced to its respective depth/horizon, soil function may change and impact crop growth and yield.

Materials and Methods

To better understand soil impacts from soil disturbance, soil was excavated and immediately replaced to the same hole. Plot dimensions were 5ft by 20ft. Soil was disturbed to a depth of 5 ft. The four treatments were undisturbed (Check); soil was removed and replaced by soil horizon (Good); the top six inches was replaced to its initial location while all B horizon material was mixed (Poor); and all soil was removed and mixed while being replaced (Very Poor). The soil disturbance and replacement occurred approximately two weeks before planting. The experiment was set up as a complete randomized block design with four replications. Barlow hard red spring wheat was planted on May 8, 2019 at 1.25 million live seeds/ac. Potash and urea was applied by mid-row band at 30 and 60 lbs/ac respectively. Monammonium phosphate was applied with seed at 30 lbs/ac. The crop was managed using local best management practices. Plots were harvested by plot combine, cleaned in the lab; and analyzed for protein, test weight, and yield.

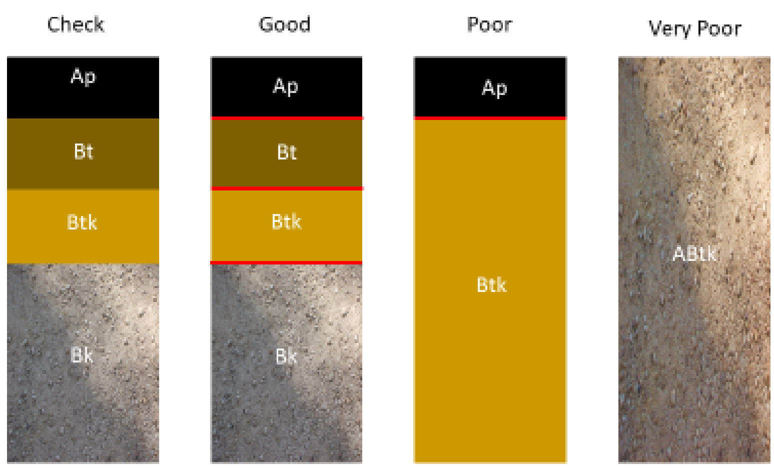

Figure 1. Visual conception of soil disturbance and replacement. Red lines indicate the different depths of soil replacement.

Results

Soil replacement methods did not impact yield, protein (Table 1), and test weight (not reported). The 2019 growing season was abnormally dry. During the excavation process, the Btk horizon did have moisture (not tested). Whereas, the topsoil was dry. Soil moisture content was never recorded. It is possible the Very Poor treatment had a greater surface soil moisture content that impacted spring wheat growth.

Soil will be tested this spring at specific depths for pH, nutrients, moisture and bulk density. This site will be monitored using a "typical" crop rotation to track crop and soil trends over the next few years.

Table 1. Grain yield and protein of each treatment.

Treatment	Yield (bu/ac)	Protein (%)
Check	2	16.6
Good	1	17.0
Poor	1	16.7
Very Poor	4	16.5
P-value	0.263	0.404
Variance	3.213	0.145
CV	80.9	2.2

Salinity Soil Management *via* Perennial Cropping Systems

Chris Augustin, NCREC Soil Health Specialist

Introduction

Salinity is caused by the translocation of water soluble salts in the soil that accumulate in a discharge area. Salts prevent crops' ability to uptake water and nutrients. These white spots are common along the landscape and reduce yields. The only way to manage salinity is through water management. Water management strategies can be drainage (subsurface and surface) or through cropping systems. Cropping system strategies include, high water use crops, cover cropping after harvest, and perennial cropping. A study at the North Central research Extension Center in Minot and near Bowbells was initiated in 2013 and 2014 respectively to look at perennial cropping effects on reducing soil salinity. Regardless of the management strategy, soil salinity will take three or more years to observe a significant improvement.

Electrical conductivity (E.C.) is the measurement of salinity. The E.C. units are mmhos/cm. Most crops will grow well when E.C. is 2 mmhos/cm or less. When salinity is greater, yield reduction is observed on salt sensitive crops like soybean, corn, and alfalfa. Salt tolerant alfalfa appears to grow well up to an E.C. of 3 mmhos/cm. Salt tolerant crops (barley, sunflower, canola, and sugar beet) may see a yield reduction, but can still fair well when the E.C. is 4 mmhos/cm. However, salt levels greater than this can greatly reduce yield and quality. When E.C. is greater than 5 mmhos/cm, salt tolerant perennial grasses like tall wheat grass, NewHy hybrid wheatgrass (AC Saltlander), western wheatgrass, and beardless wildrye have the best chance of establishing and using soil moisture.

Materials and Methods

Contour maps of the soil salinity were created by grid sampling (approximately every 50 feet) and measuring the E.C. (0-6 in depth) of the grid point. Latitude and longitude were recorded by G.P.S. at each soil sample location. This was done to see if E.C. changed from the perennial cropping management. The maps were created by QGIS (QGIS Development Team, 2002).

Results

When this study was initiated, a majority of both sites were too saline to support cash crop growth (Figure 1). Since the initiation of this project, the prevalence and severity of saline soils has greatly decreased at Minot (NCREC) and Bowbells (Figure 1). The average electrical conductivity at Bowbells decreased from 2.8 in 2015 to 1.8 mmhos/cm in 2019. The Minot mean E.C. decreased from 3.2 in 2013 to 1.0 mmhos/cm. The decrease in E.C. at all sites was significant at the 0.001 level (Table 1). This project will evaluate the salinity one more year and may convert the area back to a cash crop and continue to monitor soil salinity changes.

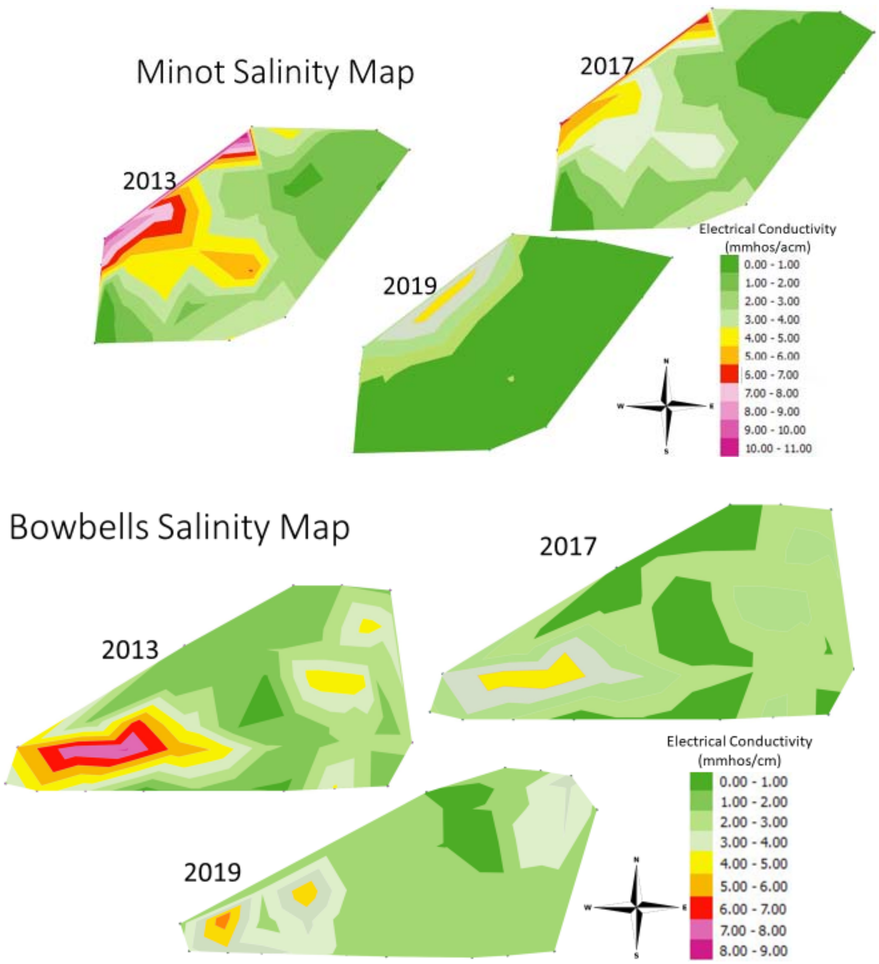

Figure 1. Salinity map of different years at Minot (NCREC) and Bowbells.

Table 1. Mean electrical conductivity, range, and P-value of the sites.

Site	Year	Mean	Minimum	Maximum	Median	P-value
		-Electrical Conductivity (mmhos/cm)-				
Bowbells	2015	2.8	0.5	8.1	2.1	<0.001
	2019	1.8	0.3	5.7	1.3	
Minot	2013	3.2	0.4	11.0	2.7	
	2019	1.0	0.2	4.5	0.6	

Burndown weed control with Gramoxone + Metribuzin tank mixes.

The objective of the study was to evaluate Gramoxone alone or with Metribuzin (Tricor) and 2,4-D in a burndown for kochia control. All treatments were applied May 28 when weeds were 2- to 3-inches tall.

The 3-way mix of Gramoxone + Tricor + 2,4-D provided significantly better control of kochia, Russian thistle, and common lambsquarters compared to Gramoxone alone or Gramoxone + Tricor. 2,4-D significantly increased control of Russian thistle and lambsquarters. 2,4-D only slightly improved kochia control.

Dry conditions likely limited the soil residual effectiveness of Tricor (metribuzin). Essentially no rain fell until 17 days after the herbicide application when we received 0.34 inches of rain. Late rains in June likely helped increase the soil activity of Tricor. The July kochia evaluation tended to show better kochia control as Tricor rate increased. Had a significant rainfall event occurred soon after application, we would expect better residual kochia control with Tricor.

Table. Burndown Weed Control with Gramoxone + Metribuzin Tank Mixes. (1903)

		Weed Control					
		Kochia		Ruth[b]		Colq[b]	
Treatment[a]	Rate	6-Jun	6-Jul	6-Jun	6-Jul	6-Jun	6-Jul
		---%---					
Untreated		0	0	0	0	0	0
Gramoxone	3 pt	98	67	100	63	77	30
Gramoxone + Tricor	3 pt + 1 oz	95	61	100	65	88	48
Gramoxone + Tricor	3 pt + 2 oz	98	65	100	63	99	53
Gramoxone + Tricor	3 pt + 3 oz	98	65	100	61	99	52
Gramoxone + Tricor	3 pt + 4 oz	99	68	100	63	99	57
Gramoxone + 2,4-D ester	3 pt	99	71	100	98	100	98
Gramoxone + Tricor + 2,4-D ester	3 pt + 1 oz + 2.1 pt	99	71	100	98	100	97
Gramoxone + Tricor + 2,4-D ester	3 pt + 2 oz + 2.1 pt	98	76	100	98	100	98
Gramoxone + Tricor + 2,4-D ester	3 pt + 3 oz + 2.1 pt	99	82	100	97	100	97
Gramoxone + Tricor + 2,4-D ester	3 pt + 4 oz + 2.1 pt	99	82	100	97	100	98
LSD		2.4	8.1	0.3	12.5	7.8	4.7

[a] *All treatments applied postemergence with NIS (0.25%) to 2- to 3-inch weeds*

[b] *Ruth=Russian Thistle; Colq=Common lambsquarters*

Weed control with fall-applied Fierce.

The objective of the study was to evaluate three rates of Fierce (Zidua + Valor) compared to Spartan applied in the fall. These treatments were also compared to fall-applied Fierce followed by spring-applied Spartan Charge. All treatments were tank mixed with Glyphosate. Fall and spring treatments were applied Oct 18, 2018 and May 14, 2019, respectively. Kochia was about 0.50-inch tall and about 3 plants/ft^2 at the spring application. However, more plants emerged after the spring application. No crop was planted. Individual treatments were replicated three times.

The low and high rates of fall-applied Fierce generally provided good kochia control through June. Kochia control was lower with the middle rate (4.5 oz), likely due to higher weed pressure in two of the three replications. Fierce followed by Spartan Charge provided excellent kochia control through early July (the last evaluation date). This study shows that fall applied Fierce (or Valor) can help control early spring-emerging kochia. However, the fall applications likely will not provide season-long weed control. A spring-applied herbicide likely will be needed for season-long weed control.

Title. Weed control with fall-applied Fierce. (1906)

			Weed Control							
			Kochia				Shep[c]		Dandelion	
Treatment[a]	Rate	Timing	14-May	23-May	5-Jun	3-Jul	14-May	5-Jun	14-May	5-Jun
			--------------------				%			--------------------
Untreated			0	0	0	0	0	0	0	0
Glyphosate	32 oz	Fall	0	0	0	0	78	60	90	85
Fierce + Glyphosate	3.75 oz + 32 oz	Fall	96	91	85	78	98	90	85	73
Fierce + Glyphosate	4.5 oz + 32 oz	Fall	79	78	71	56	98	96	93	82
Fierce + Glyphosate	6 oz + 32 oz	Fall	97	97	92	82	100	100	88	82
Spartan + Glyphosate	4 oz + 32 oz	Fall	83	78	74	64	90	87	90	82
Fierce + Gly / Spartan Charge + Gly[b]	4.5 oz + 32 oz / 5 oz + 32 oz	Fall / Spring	93	100	99	96	96	100	92	88
LSD			16.0	16.4	16.6	23.2	10.1	13.5	9.0	10.8

[a] *Glyphosate (Roundup Powermax) applied with AMS 2.5 gal/100 gal*

[b] *Applied with MSO (1%)*

[c] *Shep = Shepherdspurse*

Preemergence weed control alternatives in barley.

The objective of the study was to evaluate barley tolerance to soil-applied herbicides. Only Group 1 grass herbicides such as Puma (fenoxaprop) and Axial XL (pinoxaden) can be used in barley. Many farmers have wild oat and green foxtail that are resistant to these Group 1 herbicides. This study was conducted to evaluate barley tolerance to soil-applied herbicides that have different modes of action, which could provide suppression or control of wild oat or green foxtail. The soil was a loam with pH 5.3 and 3.5% organic matter. Herbicide treatments were applied preemergence on May 14, 2019. We received 0.59 inches of rain 10 days after application and 0.34 inches 4 weeks after application.

Dual, Outlook, and Pre-Pare caused severe injury at the June and early July evaluations. Although barley in these treatments recovered somewhat over time, barley density and yield tended to be lower in these treatments. All herbicide treatments tended to be slightly lower in density, height, yield, and test weight compared to the untreated.

Table. Preemergence Weed Control Alternatives in Barley. (1908)

			Injury			Density	Height		Yield	Test wt
Treatment[a]	Rate	Timing	22-Jun	8-Jul	24-Jul	4-Jun	27-Jun	23-Jul	16-Aug	16-Aug
			---------%---------			# per m of row	----cm----		bu/A	lb/bu
Untreated			0	0	0	27.7	45.3	80.4	95	45.1
Zidua	3 oz	PRE	14	11	11	24.8	42.5	77.7	87	44.7
Warrant	1.5 qt	PRE	2	3	2	25.7	43.8	73.6	89	44.8
Dual II Magnum	1.67 pt	PRE	34	21	13	21.6	42.3	76.6	81	44.6
Pre-Pare	0.3 oz	PRE	47	35	24	20.4	31.3	74.4	79	43.4
Prowl H2O	3 pt	PRE	5	3	1	26.8	42.2	74.4	87	44.9
Valor	2 oz	PRE	11	10	9	25.3	42.5	68.6	84	44.6
Outlook	18 oz	PRE	58	46	26	20.4	39.1	74.2	70	44.7
Fierce	3 oz	PRE	16	9	8	25.9	42.4	75.6	91	44.2
LSD			17.4	17.8	13.2	4.1	7.4	NS	NS	0.90

[a] *All treatments applied preemergence*

Canola tolerance to sulfentrazone.

The objective of the study was to evaluate canola tolerance to sulfentrazone (Spartan) applied preemergence, at cracking, at the 1-leaf stage, and the 2-3 leaf stage. We have observed that sometimes a plant will tolerate Spartan more once it has emerged. The current Spartan label indicates a 24-month rotation interval for planting canola after a Spartan application. The objective was to determine if canola has sufficient tolerance to Spartan applied PRE or early POST. Even if there is not enough tolerance PRE or early POST, could there be enough tolerance that the rotation interval could be reduced from 24 months to 12 months or less?

Canola was planted May 8, 2019. PRE, Cracking, 1-leaf, and 2-3 leaf treatments were applied May 9, 16, 23, and 28, respectively. We received 0.11, 0.59, and 0.34 inches of rain on May 11, May 24, and Jun 14, respectively. The canola struggled early under these dry conditions. Up to 18% visual injury was observed about 1 month after planting. Canola tended to recover over time, especially with late June and early July rains. Yields for treatments applied PRE, Cracking, and 1-leaf tended to be about 100-300 lb/A lower that the untreated check.

Table. Canola Tolerance to Sulfentrazone. (1915)

			Injury			Density	Height		Yield	Test wt.
Treatment	Rate	Timing	12-Jun	5-Jul	25-Jul	4-Jun	27-Jun	26-Jul	19-Aug	19-Aug
			---------%---------			---m---	----cm----		bu/A	lb/bu
Untreated			0	0	0	10.8	71.6	98.8	2088	50.8
Spartan	2 oz	PRE	8	6	3	10.0	67.2	95.3	1994	51.2
Spartan	4 oz	PRE	18	14	7	7.9	64.5	95.9	1899	50.6
Spartan	2 oz	Cracking	17	13	3	6.8	67.1	94.4	1754	50.7
Spartan	4 oz	Cracking	12	8	6	6.7	68.5	95.1	1843	51.0
Spartan	2 oz	1-leaf	13	10	3	8.4	63.9	100.2	1830	50.8
Spartan	4 oz	1-leaf	18	17	8	9.1	70.1	97.4	1838	50.9
Spartan	2 oz	2-3 leaf	6	5	3	9.5	74.0	99.9	2124	51.3
Spartan	4 oz	2-3 leaf	14	11	7	10.1	72.7	97.2	2025	51.1
Glyphosate[a]	11 oz	2-3 leaf	0	0	0	10.4	74.5	96.7	1975	51.1
LSD			4.1	4.9	5.0	2.6	NS	NS	NS	NS

[a] *Applied with AMS (2.5 gal/100 gal)*

Faba bean tolerance to herbicides.

The objective of the study was to evaluate faba bean tolerance to herbicides applied preemergence (PRE) and postemergence (POST). Faba bean was planted May 7. PRE and POST treatments were applied May 9 and June 12, respectively. The crop was about 2-5 inches tall at the POST application. The soil was a loam with 5.1 pH and 2.5% organic matter.

Treatments containing Metribuzin (Metribuzin and Authority MTZ) caused some plants to turn black and die. However, yield was not significantly reduced. A lighter soil with higher pH and lower organic matter could see more injury from Metribuzin.

Spartan applied at higher rates (8 and 12 fl oz) caused slight initial injury, but yielded similar to other treatments. Other soil-applied herbicide treatments caused only minor or no visible crop injury. Raptor applied alone POST caused significant crop stunting after application. The crop recovered somewhat over time, but still yielded slightly lower than other treatments. Raptor tank mixed with Basagran caused significantly less crop injury compared to Raptor applied alone.

Table. Faba Bean Tolerance to Herbicides. (1918)

			Injury			Density	Height		Yield	Test wt.
Treatment	Rate	Timing	5-Jun	5-Jul	25-Jul	4-Jun	27-Jun	26-Jul	6-Sep	6-Sep
			--------%--------			m of row	-----cm-----		lb/A	lb/bu
Untreated			0	0	0	7.4	30.8	74.9	1043	61.9
Sharpen	2 oz	PRE	0	0	0	6.5	32.3	82.9	2238	65.7
Spartan	4 oz	PRE	1	0	0	6.3	32.5	83.6	2083	66.2
Spartan + Sharpen	4 oz + 1 oz	PRE	3	1	0	7.0	33.2	82.8	2093	66.1
Authority MTZ	12 oz	PRE	19	12	11	6.5	31.8	80.3	1912	66.4
BroadAxe	25 oz	PRE	6	2	0	6.2	31.7	78.0	1913	65.8
Metribuzin	0.5 lb	PRE	35	16	14	5.6	32.0	90.0	2325	66.6
Prowl H2O	3 pt	PRE	0	0	0	6.4	34.4	85.8	2253	66.4
Valor	2 oz	PRE	0	0	0	6.5	35.3	83.0	2230	66.0
Fierce	3 oz	PRE	0	0	0	6.4	35.2	81.6	2146	66.1
Prowl H2O / Basagran[a]	2 pt / 1.6 pt	PRE / POST	0	3	4	6.9	34.1	86.2	1911	66.1
Prowl H2O / Raptor[b]	2 pt / 4 oz	PRE / POST	0	57	40	6.6	22.7	72.6	1810	65.8
Prowl H2O / Basagran + Raptor[c]	2 pt / 0.8 pt + 4 oz	PRE / POST	0	7	7	5.4	33.8	77.8	2087	66.0
Dual II Magnum	1.67 pt	POST	0	8	3	6.4	32.0	78.5	1893	66.1
Prowl H2O + Handweeded	1.5 pt	PRE	0	0	0	6.2	31.7	87.7	2371	66.1
Spartan	8 oz	PRE	12	0	0	5.1	31.5	79.8	1975	67.5
Spartan	12 oz	PRE	14	0	0	5.5	33.3	77.6	2039	66.3
LSD			4.1	5.5	4.7	NS	4.0	NS	526	1.6

[a] Applied with COC (1.5 pt)

[b] Applied with 28% + MSO (2.5 gal/100 gal + 1.5 pt)

[c] Applied with MSO (1%)

Rotation intervals for Faba bean.

The objective of the study was to evaluate faba bean tolerance to wheat herbicides applied the previous year. Wheat was planted May 17, 2018 and postemergence herbicides were applied June 19, 2018. Faba bean was planted May 7, 2019. The soil was a loam with pH 7.0 and 3.2% organic matter. Individual plots were 10 by 30 feet with four replications.

Significant early chlorosis and some stunting was observed in the Everest treatment. Less chlorosis and stunting was observed from Ally. WideMatch caused some growth regulator-type symptoms (e.g., stem and leaf curling) in some areas. Huskie symptoms (bleaching) were observed in some areas, but tended to be minor. Generally, for most treatments, the herbicide symptoms disappeared over time. Slight stunting could be seen with Everest later in the season as well as stem and leaf curling in random areas with WideMatch. Despite the observed crop injury, crop yield was not affected by any of the herbicide treatments.

Table. Rotation Intervals for Faba Bean. (1821)							
		Injury			Height	Yield	Test wt.
Treatment	Rate	13-Jun	12-Jul	26-Jul	26-Jul	6-Sep	6-Sep
		----------%----------			cm	lb/A	lb/bu
Untreated		0	0	0	78.1	1760	65.8
Everest 3.0	2 oz	23	21	17	78.7	2032	66.4
Ally XP	0.1 oz	12	9	6	78.3	1876	66.5
Widematch	1 pt	18	20	18	77.9	1783	66.1
Huskie	11 oz	12	11	4	80.5	2038	65.8
Talinor	13.7 oz	1	0	0	81.4	2009	66.3
Quelex	0.75 oz	0	0	0	82.1	1850	66.5
LSD		14.8	15.3	13.3	NS	NS	0.53

Rainfall in 2018 and 2019.

2018	Rain (in)	Departure from normal (in)
June	4.93	1.44
July	1.44	-1.11
August	1.12	-0.88
September	1.08	-0.36
October	1.10	-0.31
2019		
April	0.93	-0.33
May	0.74	-1.83
June	3.14	-0.35
July	1.76	-0.79
August	2.84	0.84

Evaluation of various herbicides for pre-harvest wheat desiccation.

The objective of the study was to evaluate alternatives to Glyphosate to be used as a pre-harvest desiccant in wheat. Herbicide treatments were applied pre-harvest (August 8) when the wheat was still mostly green (soft dough stage) to better evaluate the herbicides as desiccants. Normally, a desiccant is applied at the hard dough stage when the plant is no longer green.

On the day of application, the wheat had recently begun to "turn color". One week after treatment, Liberty and Reglone provided the fastest desiccation (99 and 93%), which was slightly faster than Glyphosate (81%). Sharpen and Drexel Defol were not effective as wheat desiccants. Two weeks after treatment, Glyphosate, Liberty, and Reglone had provided nearly complete visual wheat desiccation.

In this study, Liberty and Reglone provided wheat desiccation equal to glyphosate. To re-emphasize, we intentionally applied the desiccants early to give a better opportunity to evaluate visual desiccation. It would be difficult to evaluate desiccation if the wheat had already turned color before applying the desiccants. Thus, due to the early application (soft dough), which is never recommended in commercial fields, wheat yield and test weight tended to be lower in the Glyphosate, Liberty, and Reglone treatments. Had the desiccants been applied at the normal hard dough stage, we would expect no impact on yield or test weight. As of 2019, Liberty and Reglone are not currently labeled for use as wheat desiccants.

Table. Evaluation of Various Herbicides for Pre-Harvest Wheat Desiccation. (1927)

		Wheat					Weed Control
		Desiccation			Yield	Test Wt.	Green Foxtail
Treatment	Rate	8-Aug	15-Aug	22-Aug	29-Aug	29-Aug	22-Aug
		---------%---------			bu/A	lb/bu	-----%-----
Untreated		15	59	83	35	63.8	0
Glyphosate + AMS	22 oz + 2.5 gal	16	81	99	29	64.2	94
Liberty + AMS	32 oz + 8.825 gal	15	99	100	23	61.7	83
Reglone + NIS	24 oz + 0.25 %	14	93	100	24	62.0	93
Sharpen + MSO + AMS	1 oz + 1 % + 2.5 gal	14	59	85	38	64.2	48
Drexel Defol + MSO	4.8 qt + 1 %	15	68	88	33	63.8	50
LSD		NS	3.6	2.1	5.3	0.74	7.9

Flax tolerance to soil-applied herbicides.

The objective of the study was to evaluate flax tolerance to soil-applied herbicides. These herbicides were selected because they may have activity on two problem weeds in flax, pigweed and green foxtail. Generally, redroot pigweed is not adequately controlled with the postemergence herbicides labeled in flax (Bronate or generic equivalent and Curtail M). Some green foxtail populations in the state are resistant to Group 1 herbicides such as Assure II and Select. Other herbicides are needed that can help control these weeds.

The herbicide treatments were applied preemergence (PRE) on May 14. Soil conditions were generally dry through most of May and June. The only rain received in the first month after planting was May 24 (0.59 inches) and June 14 (0.34 inches). Very little crop injury was observed with any treatment. The unanswered question is: Was there very little flax injury because the herbicides are safe to the crop or because the herbicides were not activated due to dry conditions? This study should be repeated to provide more confidence of crop safety under more normal rainfall conditions.

Table. Flax Tolerance to Soil-Applied Herbicides. (1931)

			Injury			Height		Yield	Test wt.	Oil
Treatment	Rate	Timing	26-Jun	12-Jul	7-Aug	27-Jun	26-Jul	16-Sep	16-Sep	16-Sep
			--------%--------			-----cm-----		bu/A	lb/bu	---%---
Untreated			0	0	0	23.0	53.1	18.4	40.1	42.1
Zidua	3 oz	PRE	7	0	0	23.3	49.8	15.9	40.0	42.8
Spartan + Zidua	4 oz + 1.5 oz	PRE	6	0	0	24.9	50.1	16.2	39.0	41.9
Warrant	1.5 qt	PRE	2	0	0	22.5	54.4	20.5	43.0	43.3
Dual II Magnum	1.5 pt	PRE	6	0	0	21.9	50.6	18.0	40.7	42.3
Spartan Elite + Dual II Magnum	22.8 oz + 5.2 oz	PRE	8	0	0	21.7	53.9	20.6	42.4	42.5
Fierce	3 oz	PRE	7	1	1	22.9	56.2	21.0	42.1	41.7
Prowl H2O	3 pt	PRE	6	1	1	23.5	51.3	19.4	42.8	42.7
Valor	2 oz	PRE	12	2	1	23.2	55.1	19.9	41.4	43.7
Outlook	18 oz	PRE	8	0	0	22.0	53.7	18.2	40.6	43.0
LSD			5.5	NS	NS	NS	NS	NS	2.0	1.17

Flax tolerance to POST-applied herbicides.

The objective of the study was to evaluate flax tolerance to postemergence (POST) herbicides. These herbicides were selected because they may have activity on redroot pigweed and/or green foxtail. Generally, redroot pigweed is not adequately controlled with the postemergence herbicides labeled in flax (Bronate or generic equivalent and Curtail M). Some green foxtail populations in the state are resistant to Group 1 herbicides such as Assure II and Select. Other herbicides are needed that can help control these weeds.

The herbicide treatments were applied postemergence on June 18. Soil conditions were generally dry through most of May and June. The only rain received in the first month after planting was May 24 (0.59 inches) and June 14 (0.34 inches). The herbicide treatments caused low to moderate crop injury. Raptor caused up to 42% injury when applied alone, but about 20% injury when tank mixed with Basagran. Bison (bromoxynil + MCPA), the commercial standard, caused up to 24% injury and reduced crop height early in the season. Armezon, Basagran, and Laudis caused similar or less injury than Bison. Laudis was not applied with an adjuvant. There was no difference in yield, test weight, or oil content between treatments. This study should be repeated to provide more confidence of crop safety under more normal rainfall conditions.

Table. Flax Tolerance to POST-Applied Herbicides. (1954)

			Injury			Height		Yield	Test wt	Oil content
Treatment	Rate	Timing	26-Jun	12-Jul	7-Aug	27-Jun	26-Jul	16-Sep	16-Sep	16-Sep
			--------%--------			-----cm-----		bu/A	lb/bu	%
Untreated			0	0	0	26.6	58.3	19.5	38.7	42.0
Armezon[a]	0.5 oz	POST	15	11	5	25.6	56.3	20.1	40.0	41.7
Armezon[a]	0.75 oz	POST	19	12	8	25.7	57.3	19.9	38.6	41.6
Bison	1 pt	POST	24	21	11	16.7	58.7	17.5	41.5	41.4
Basagran[a]	1 pt	POST	10	2	2	24.7	58.7	21.3	40.1	41.9
Raptor[b]	4 oz	POST	42	36	26	20.5	56.4	20.9	42.9	41.2
Basagran + Raptor[c]	1 pt + 4 oz	POST	20	17	15	20.6	54.1	17.7	40.7	41.5
Laudis	3 oz	POST	21	7	5	32.3	59.6	18.2	40.1	41.9
LSD			3.7	5.4	4.6	NS	NS	NS	NS	NS

[a] *COC applied at 1% v/v*

[b] *Applied with NIS + 28% (0.25% + 2.5 gal/100 gal)*

[c] *Applied with MSO*

Oat tolerance to herbicides applied PRE and early POST.

The objective of the study was to evaluate oat tolerance to preemergence (PRE) and postemergence herbicides (POST). There are no herbicides labeled for use in oat to control grasses. In this study, herbicides were applied PRE (May 14) or at the 1-leaf (May 29) or 4-leaf (June 18) oat stage. Soil conditions were generally dry through most of May and June. The only rain received in the first month after planting was May 24 (0.59 inches) and June 14 (0.34 inches). Significant rains fell on June 29 (1.71 inches) and July 9 (1.00 inches).

Zidua and Outlook applied PRE caused severe oat injury. The other herbicides applied PRE caused 16% visible crop injury or less. None of the treatments applied POST caused more than 15% crop injury. In previous years, Armezon applied at the 4-leaf stage has caused severe crop injury. The study should be repeated to verify the results under different environmental conditions.

Table. Oat Tolerance to Herbicides Applied PRE and Early POST. (1951)

			Injury			Height	Yield	Test wt.
Treatment	Rate	Timing	22-Jun	8-Jul	24-Jul	23-Jul	16-Aug	16-Aug
			---------%---------			cm	bu/A	lb/bu
Untreated			0	0	0	88	55	35.3
Zidua	3 oz	PRE	87	83	82	72	18	34.4
Warrant	1.5 qt	PRE	15	15	13	82	51	35.2
Dual II Magnum	1.67 pt	PRE	16	12	7	86	58	36.3
Prowl	3 pt	PRE	9	4	1	91	62	35.8
Outlook	18 oz	PRE	70	57	52	76	45	35.7
Zidua	3 oz	1-leaf Oat	10	10	19	82	53	35.2
Warrant	1.5 qt	1-leaf Oat	6	6	5	84	57	34.9
Dual II Magnum	1.67 pt	1-leaf Oat	15	14	13	75	55	36.2
Prowl	3 pt	1-leaf Oat	10	7	4	81	60	35.2
Outlook	18 oz	1-leaf Oat	14	12	9	74	59	36.3
Armezon + COC	1 oz + 1 %	1-leaf Oat	7	8	4	83	57	35.5
Armezon + COC	1 oz + 1 %	4-leaf Oat	14	12	11	82	58	34.9
LSD			11.8	12.5	13.2	NS	16.1	NS