

2019 Agricultural Research Update

NDSU Williston Research Extension Center

MSU Eastern Agricultural Research Center

Serving the MonDak Region



Regional Report No. 25 – December 2019



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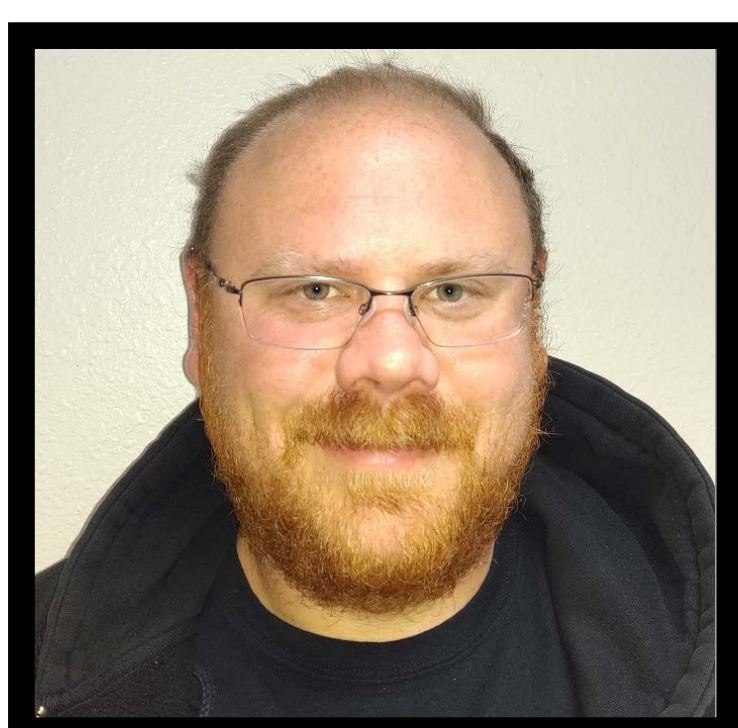
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Seed Processing Technician



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Irrigation Technician-Mechanic

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Off-Station Cooperators – Producers – CES Agents

MONTANA

SMALL GRAIN--PULSES:

Dagmar - Brian Kaae - Agent Colleen Buck
Poplar - Mark Swank - Agent Jeff Chilson
Richland - Richard Fulton - Agent Shelley Mills
Wibaux - Rick Miske - Agent Danielle Harper

SUGARBEET:

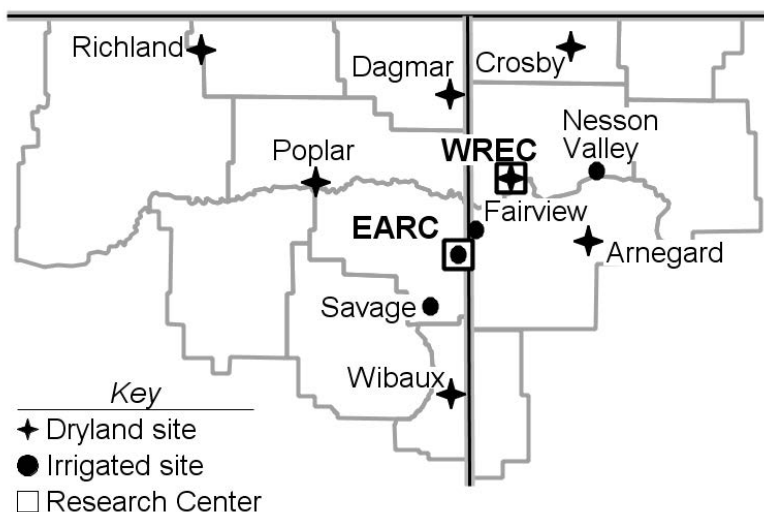
Culbertson - Dana Berwick
East Fairview - Texas-Red Enterprises, Inc.
Savage - Conradsen Land & Livestock, Inc.
Savage - Jeff Jorgensen
Sidney - Don Steinbeisser, Jr.

NORTH DAKOTA

SMALL GRAIN--PULSES--OIL SEEDS:

Crosby - Robert Kostek - Agent Brandon Biber
Arnegard - Beau Wisness - Agent Devon Leo

Location of Test Sites



We would like to take this opportunity to thank the County Agents, the County Ag Improvement Associations and especially the farm operators who permit the location of off-station plots on their land. ***All are to be commended for their cooperative efforts in helping determine crops and variety performance in the MonDak region.***

Results from tillage, chemical fallow, and field scale no-till trials, as well as other management trials on dryland and irrigated crops can be obtained by visiting with Center personnel.

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Weather Information

Weather Summary
Williston, ND

Weather Summary
Sidney, MT

| Month | Precipitation | | Temperature | | |
|----------------------|---------------|-------|---------------|------|---|
| | 2019 | Avg | 2019 | Avg | * |
| | - inches - | | - degrees F - | | |
| Oct-Dec. 2018 | 1.35 | 1.74 | | | |
| January-March | 1.94 | 1.19 | | | |
| April | 0.52 | 1.16 | 43.4 | 46.0 | 0 |
| May | 1.35 | 2.23 | 51.7 | 57.0 | 0 |
| June | 3.67 | 2.70 | 64.3 | 65.0 | 3 |
| July | 2.03 | 2.23 | 69.0 | 72.0 | 3 |
| August | 2.36 | 1.57 | 67.4 | 71.0 | 3 |
| September | 6.92 | 1.48 | 59.1 | 60.0 | 0 |
| April-July | 7.57 | 8.32 | | | |
| April-Sept | 16.85 | 11.37 | | | |
| Total-Oct 18-Sept 19 | 20.14 | 14.30 | | | |

| Month | Precipitation | | Temperature | | |
|-----------------------|---------------|-------|---------------|------|---|
| | 2019 | Avg | 2019 | Avg | * |
| | - inches - | | - degrees F - | | |
| Oct-Dec. 2018 | 1.88 | 1.85 | | | |
| January-March | 1.25 | 1.30 | | | |
| April | 1.12 | 1.15 | 44.5 | 44.5 | 0 |
| May | 1.78 | 2.16 | 50.3 | 56.0 | 0 |
| June | 2.39 | 2.73 | 63.4 | 64.6 | 2 |
| July | 3.28 | 2.08 | 68.3 | 70.2 | 6 |
| August | 1.52 | 1.46 | 67.1 | 68.7 | 4 |
| September | 9.28 | 1.39 | 58.2 | 58.0 | 2 |
| April-July | 8.57 | 8.12 | | | |
| April-Sept | 19.37 | 10.97 | | | |
| Total- Oct 18-Sept 19 | 22.50 | 14.12 | | | |

*Number of Days over 89° F

Last Spring Frost – May 12, 2019 (32° F)

First Fall Frost – October 10, 2019 (31° F)

*Number of Days over 89° F

Last Spring Frost – May 17, 2019 (31.8° F)

First Fall Frost – October 2, 2019 (31.9° F)

Off-Station Precipitation*

North Dakota

| Site | April | May | June | July | Aug | Sept | Total |
|---------------|-------|------|------|------|------|-------|-------|
| Beach | 1.59 | 2.53 | 2.86 | 3.51 | 1.65 | 6.75 | 18.89 |
| Crosby | 0.92 | 0.65 | 3.23 | 3.10 | 3.33 | 6.92 | 18.15 |
| Nesson Valley | 0.89 | 0.88 | 2.90 | 3.46 | 2.17 | 10.04 | 20.34 |
| Watford City | 0.49 | 1.50 | 1.77 | 4.25 | 2.32 | 5.77 | 16.10 |

*Actual rainfall received at plot location may have been more or less.

Off-Station Precipitation*

Montana

| Site | April | May | June | July | Aug | Sept | Total |
|------------|-------|------|------|------|------|-------|-------|
| Dagmar | 0.55 | 0.25 | 3.39 | 2.15 | 2.69 | 5.55 | 14.58 |
| E Fairview | 1.30 | 2.05 | 2.05 | 4.66 | 1.61 | 10.27 | 21.94 |
| Poplar | 1.64 | 1.88 | 4.50 | 2.73 | 1.59 | 6.32 | 18.66 |
| Richland | 1.15 | 0.79 | 4.72 | 0.38 | 1.64 | 3.81 | 12.49 |
| Savage | 1.37 | 2.26 | 2.57 | 2.38 | 2.41 | 10.30 | 21.29 |
| Wibaux | 1.16 | 3.85 | 2.72 | 2.73 | 2.47 | 7.55 | 20.48 |

*Actual rainfall received at plot location may have been more or less.

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HARD SPRING WHEAT VARIETY DESCRIPTIONS

| VARIETY | ORIGIN ¹ | YEAR RELEASED | HEIGHT | MATURITY | RESISTANCE TO ² | | | | | | QUALITY FACTORS | | |
|-----------------|---------------------|---------------|---------|----------|----------------------------|-----------|-----------|----------------|-----------|--------|-----------------|---------------|--------|
| | | | | | LODGING | STEM RUST | LEAF RUST | FOLIAR DISEASE | HEAD SCAB | SAWFLY | TEST WEIGHT | GRAIN PROTEIN | |
| AAC BRANDON | CANADA | 2014 | M TALL | M EARLY | M | NA | MR | NA | NA | M | NA | NA | NA |
| AAC GOODWIN | CANADA | 2018 | M TALL | M EARLY | M | NA | MR | NA | NA | NA | NA | NA | NA |
| AAC PENHOLD | CANADA | 2015 | MEDIUM | MEDIUM | MR | NA | MR | NA | NA | NA | NA | NA | NA |
| AKF-ASTRO | AKF-ASTRO | 2016 | SHORT | MEDIUM | NA | MR | MR | NA | S | NA | LOW | LOW | LOW |
| AMBUSH | DYNAGRO | 2016 | MEDIUM | M EARLY | M | R | MR/MS | NA | M | NA | NA | NA | NA |
| BARLOW | NDSU | 2009 | MEDIUM | M EARLY | M | R | MR/MS | MR | M | S | M HIGH | M HIGH | M HIGH |
| BOLLES | MN | 2015 | SHORT | M LATE | MR | NA | MR | MR | MR | NA | MEDIUM | HIGH | HIGH |
| BOOST | SD | 2016 | MEDIUM | MEDIUM | M | R | MR/MS | NA | M | NA | MEDIUM | HIGH | HIGH |
| BRENNAN | AGRIPRO | 2009 | SHORT | M EARLY | MR | R | MR | M | MS | S | MEDIUM | MEDIUM | MEDIUM |
| CALIBER | DYNAGRO | 2016 | SHORT | MEDIUM | R | R | MR | NA | S | NA | NA | NA | NA |
| CHOTEAU | MT | 2004 | M SHORT | M LATE | MS | R | MR/MS | MR | S | R | MEDIUM | MEDIUM | MEDIUM |
| DUCLAIR | MT | 2011 | MEDIUM | MEDIUM | MR | R | NA | NA | NA | R | MEDIUM | MEDIUM | MEDIUM |
| EGAN3 | MT | 2014 | MEDIUM | M LATE | MR | NA | NA | NA | NA | S | HIGH | M HIGH | M HIGH |
| ELGIN-ND | NDSU | 2012 | TALL | MEDIUM | M | R | MS | NA | M | S | M LOW | LOW | LOW |
| FALLER | NDSU | 2007 | M TALL | MEDIUM | M | R | S | MR | M | S | MEDIUM | LOW | LOW |
| GLENN | NDSU | 2005 | M TALL | M EARLY | MR | R | MR/MS | M | MR | S | HIGH | M HIGH | M HIGH |
| CP 3100 | CROPLAN | 2016 | MEDIUM | MEDIUM | MR | R | MR/MS | NA | MS | NA | NA | NA | NA |
| CP 3419 | CROPLAN | 2014 | M SHORT | LATE | MR | NA | MR | MR | MR | NA | M HIGH | MEDIUM | MEDIUM |
| CP 3504 | CROPLAN | 2015 | M SHORT | MEDIUM | MR | R | R | NA | MS | NA | NA | NA | NA |
| CP 3530 | CROPLAN | 2015 | TALL | LATE | MR | NA | NA | NA | NA | NA | M HIGH | HIGH | HIGH |
| CP 3616 | CROPLAN | 2016 | MEDIUM | MEDIUM | MR | NA | NA | NA | NA | NA | NA | NA | NA |
| CP 3888 | CROPLAN | 2017 | M TALL | MEDIUM | MR | NA | R | NA | MR | NA | NA | NA | NA |
| LANG-MN | MN | 2017 | M TALL | MEDIUM | MR | R | MR | NA | MS | NA | M HIGH | MEDIUM | MEDIUM |
| LANNING | MT | 2017 | MEDIUM | MEDIUM | MR | NA | NA | NA | M | NA | NA | NA | NA |
| LCS ANCHOR | LIMAGRAIN | 2016 | M SHORT | MEDIUM | MR | NA | NA | NA | NA | NA | NA | NA | NA |
| LCS BREAKAWAY | LIMAGRAIN | 2011 | M SHORT | M EARLY | M | NA | R | MS | M | S | M HIGH | MEDIUM | MEDIUM |
| LCS CANNON | LIMAGRAIN | 2018 | M SHORT | EARLY | MR | NA | MS | NA | M | NA | NA | NA | NA |
| LCS NITRO | LIMAGRAIN | 2015 | SHORT | MEDIUM | MR | NA | NA | NA | NA | NA | M HIGH | MEDIUM | MEDIUM |
| LCS PRIME | LIMAGRAIN | 2015 | MEDIUM | M EARLY | MR | MR | MR/MS | NA | M | NA | M HIGH | LOW | LOW |
| LCS REBEL | LIMAGRAIN | 2017 | MEDIUM | M EARLY | M | R | MS | NA | M | NA | NA | NA | NA |
| LCS TRIGGER | LIMAGRAIN | 2016 | MEDIUM | LATE | M | R | R | NA | M | NA | NA | NA | NA |
| LINKERT | MN | 2013 | M SHORT | M EARLY | R | R | MR | NA | M | NA | MEDIUM | HIGH | HIGH |
| MOTT | NDSU | 2009 | TALL | M LATE | MR | MR | S | MS | MS | R | MEDIUM | MEDIUM | MEDIUM |
| MS BARRACUDA | MERIDIAN | 2018 | MEDIUM | M EARLY | MR | NA | MR | NA | NA | NA | NA | NA | NA |
| MS CAMARO | MERIDIAN | 2016 | M SHORT | M EARLY | M | R | R | NA | MR | NA | HIGH | HIGH | HIGH |
| MS CHEVELLE | MERIDIAN | 2014 | SHORT | M EARLY | M | MR | R | NA | MR | NA | HIGH | HIGH | HIGH |
| ND VITPRO | ND | 2016 | MEDIUM | M EARLY | MR | R | MA | NA | M | NA | HIGH | HIGH | HIGH |
| NS PRESSER CLP | MT | 2016 | MEDIUM | MEDIUM | NA | NA | NA | NA | NA | S | MEDIUM | MEDIUM | MEDIUM |
| PRESTIGE | PULSE USA | 2015 | MEDIUM | M EARLY | MR | NA | NA | NA | NA | S | MEDIUM | MEDIUM | MEDIUM |
| PREVAIL | SDSU | 2014 | M SHORT | EARLY | M | NA | NA | NA | M | NA | HIGH | M HIGH | M HIGH |
| PROSPER | NDSU | 2011 | MEDIUM | MEDIUM | MR | R | S | M | M | S | MEDIUM | M HIGH | M HIGH |
| REDSTONE | PULSE USA | 2015 | SHORT | M LATE | R | NA | R | NA | MR | MA | M LOW | MEDIUM | MEDIUM |
| REEDER | NDSU | 1999 | MEDIUM | MEDIUM | MR | R | MS | S | S | S | MEDIUM | MEDIUM | MEDIUM |
| ROLLAG | MN | 2011 | MEDIUM | MEDIUM | MR | R | MS | MR | MR | NA | M HIGH | M LOW | M LOW |
| SHELLY | MN | 2016 | MEDIUM | MEDIUM | MR | NA | MR/MS | NA | M | NA | NA | NA | NA |
| SURPASS | SDSU | 2016 | M SHORT | EARLY | MR | NA | MR/MS | NA | MR | NA | NA | NA | NA |
| SY INGMAR | SYNGENTA | 2014 | MEDIUM | MEDIUM | MR | MR | MR | MS | MR | S | M HIGH | M HIGH | M HIGH |
| SY ROCKFORD | SYNGENTA | 2018 | MEDIUM | M LATE | M | MR | M | MR | MR | NA | M HIGH | M HIGH | M HIGH |
| SY ROWYN | SYNGENTA | 2013 | M SHORT | M EARLY | MR | MR | MR | NA | MR | S | M HIGH | M LOW | M LOW |
| SY SOREN | SYNGENTA | 2011 | M SHORT | M EARLY | MR | R | MR | M | M | S | M HIGH | MEDIUM | MEDIUM |
| SY VALDA | SYNGENTA | 2015 | MEDIUM | M EARLY | MR | R | MR | MR | M | NA | MEDIUM | M HIGH | M HIGH |
| TCG-CLIMAX | 21ST C GEN. | 2017 | M SHORT | LATE | MR | R | S | NA | MS | NA | HIGH | HIGH | HIGH |
| TCG-CORNERSTONE | 21ST C GEN. | 2015 | M SHORT | MEDIUM | MR | R | MR/MS | NA | MA | NA | NA | HIGH | HIGH |
| TCG-GLENVILLE | 21ST C GEN. | 2018 | M SHORT | M EARLY | MR | NA | R | NA | M | NA | NA | NA | NA |
| TCG-HEARTLAND | 21ST C GEN. | 2019 | M SHORT | M EARLY | MR | NA | R | NA | M | NA | NA | HIGH | HIGH |
| TCG-SPIRITFIRE | 21ST C GEN. | 2015 | M SHORT | MEDIUM | MR | R | NA | NA | MS | NA | NA | NA | NA |
| VELVA | NDSU | 2011 | M SHORT | M LATE | R | R | MR/MS | M | MS | S | MEDIUM | MEDIUM | MEDIUM |
| WB9879CLP* | WB | 2012 | MEDIUM | MEDIUM | R | S | S | MR | MS | R | MEDIUM | HIGH | HIGH |
| WB9479 | WB | 2017 | M SHORT | M EARLY | R | R | R | NA | MS | NA | NA | NA | NA |
| WB9590 | WB | 2017 | M SHORT | M EARLY | NA | R | MR | NA | MS | NA | NA | NA | NA |
| WB9653 | WB | 2015 | M SHORT | M EARLY | R | NA | MR | NA | MS | NA | MEDIUM | MEDIUM | MEDIUM |
| WB9719 | WB | 2013 | MEDIUM | M EARLY | R | NA | S | S | S | T | M HIGH | MEDIUM | MEDIUM |
| WB MAYVILLE | WB | 2011 | SHORT | M EARLY | R | R | MR/MS | MS | S | S | M HIGH | M HIGH | M HIGH |

¹Refers to developer: CANADA represents developer from that country; MN = University of Minnesota; MT = Montana State University; NDSU = North Dakota State University; SD = South Dakota State University; TS = Tigren Seed; WB = WestBred. ²Resistant to orange wheat blossom midge. *Clearfield wheat with imidazolinone tolerance.

²M = Intermediate; MR = Moderately resistant; MS = Moderately susceptible; NA = Not adequately tested; R = Resistant; S = susceptible; VS = Very susceptible.

Hard Red Spring Wheat Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Days to heading (DAP) | Plant height (in) | Protein [†] (%) | Test weight (lb/bu) | Yield [#] | | |
|--------------------|--------------------------|----------------------|-----------------------------|------------------------|--------------------|--------------------|---------------------|
| | | | | | 2019 (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg* (bu/a) |
| TCG-Spitfire | 55 | 28.9 | 14.4 | 61.8 | 68.9 | 65.2 | 53.3 |
| Elgin-ND | 54 | 31.6 | 14.8 | 61.7 | 71.2 | 65.3 | 53.1 |
| SY Rockford | 54 | 29.1 | 14.7 | 61.3 | 69.8 | 62.6 | 52.8 |
| Shelly | 56 | 27.7 | 13.8 | 61.9 | 68.1 | 62.9 | 51.4 |
| Surpass | 52 | 31.6 | 15.2 | 61.1 | 69.9 | 61.1 | 50.8 |
| SY Valda | 53 | 26.5 | 14.3 | 61.3 | 69.3 | 61.2 | 50.6 |
| LCS Trigger | 60 | 29.5 | 12.4 | 62.1 | 68.1 | 64.5 | 50.1 |
| MS Chevelle | 53 | 28.5 | 13.7 | 61.8 | 71.7 | 60.2 | 50.0 |
| LCS Rebel | 52 | 27.8 | 14.7 | 63.0 | 68.3 | 58.8 | 48.4 |
| NDvitPro | 53 | 28.6 | 15.7 | 64.0 | 60.5 | 58.7 | 48.4 |
| MS Camaro | 53 | 24.5 | 16.5 | 62.5 | 62.3 | 57.2 | 48.2 |
| Glenn | 53 | 30.2 | 14.5 | 64.7 | 59.8 | 57.2 | 47.9 |
| Faller | 56 | 30.1 | 14.6 | 60.7 | 64.5 | 59.1 | 47.8 |
| SY Soren | 53 | 26.9 | 16.2 | 62.5 | 61.1 | 55.2 | 46.9 |
| LCS Breakaway | 52 | 25.7 | 15.5 | 63.1 | 61.9 | 56.0 | 46.8 |
| Barlow | 52 | 31.1 | 14.6 | 62.6 | 59.6 | 56.0 | 46.7 |
| Linkert | 54 | 25.9 | 15.8 | 62.0 | 55.9 | 54.9 | 45.8 |
| TCG-Climax | 58 | 28.0 | 17.0 | 63.1 | 57.7 | 55.2 | 45.3 |
| Boost | 56 | 30.6 | 15.0 | 60.9 | 63.6 | 51.1 | 43.8 |
| Bolles | 56 | 30.3 | 16.7 | 61.4 | 61.5 | 52.4 | 43.5 |
| Lang-MN | 54 | 27.8 | 15.5 | 61.8 | 62.8 | 51.2 | 43.3 |
| SY Ingmar | 52 | 24.7 | 14.5 | 62.6 | 60.0 | 50.8 | 43.2 |
| Lanning | 54 | 26.4 | 15.5 | 61.7 | 62.2 | 62.6 | - |
| AAC Brandon | 53 | 28.0 | 15.3 | 62.4 | 69.2 | 59.7 | - |
| Prevail | 52 | 30.4 | 13.7 | 61.4 | 64.1 | 59.5 | - |
| AAC Penhold | 52 | 26.5 | 13.6 | 61.7 | 65.5 | 59.1 | - |
| AAC Goodwin | 54 | 28.3 | 14.5 | 62.3 | 66.9 | 58.9 | - |
| LCS Cannon | 51 | 25.1 | 15.0 | 62.6 | 60.8 | 55.8 | - |
| MS Barracuda | 52 | 24.8 | 14.2 | 61.9 | 61.4 | 52.9 | - |
| CP3504 | 54 | 27.0 | 13.7 | 60.6 | 69.4 | - | - |
| SY McCloud | 53 | 28.9 | 16.8 | 63.2 | 67.6 | - | - |
| Dyna-Gro Commander | 53 | 25.5 | 15.2 | 62.2 | 67.5 | - | - |
| CP3910 | 52 | 25.2 | 15.1 | 62.5 | 67.5 | - | - |
| Dyna-Gro Ambush | 52 | 28.0 | 14.9 | 62.8 | 67.2 | - | - |
| TCG-Stalwart | 53 | 27.3 | 16.7 | 60.8 | 66.0 | - | - |
| SY Longmire | 52 | 26.5 | 15.6 | 63.0 | 65.7 | - | - |
| CP3616 | 53 | 27.2 | 16.9 | 61.6 | 64.5 | - | - |
| CP3915 | 53 | 27.0 | 15.9 | 62.6 | 64.0 | - | - |
| Mott | 54 | 32.9 | 16.1 | 61.9 | 63.5 | - | - |
| TCG-Heartland | 52 | 25.2 | 16.0 | 63.5 | 61.3 | - | - |
| CP3530 | 54 | 31.0 | 14.5 | 61.4 | 60.8 | - | - |
| CP3888 | 53 | 26.8 | 15.5 | 61.2 | 59.6 | - | - |
| CP3939 | 53 | 29.0 | 14.8 | 62.7 | 58.6 | - | - |
| MN Washburn | 54 | 26.4 | 14.6 | 61.7 | 58.3 | - | - |
| Mean | 53 | 28.1 | 15.2 | 62.1 | 64.3 | - | - |
| CV (%) | 1.3 | 5.2 | 5.7 | 0.5 | 7.0 | - | - |
| LSD (5%) | 1.1 | 2.4 | 1.4 | 0.5 | 7.3 | - | - |
| LSD (10%) | 0.9 | 2.0 | 1.2 | 0.4 | 6.1 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation

Previous crop: Soybeans

Planted: 5/8/2019

Harvested: 08/21/2019

Soil test to 6" in ppm: OM=2% pH=5.7

Soil type: Williams-Bowbells loam

Soil test to 24" in lb/a:

Applied fertilizers in lb/a: (60 lbs of MESZ with seed, 135 lbs of Urea broadcast at planting)

[†]Protein adjusted to 12% moisture

*Average of years 2017, 2018, and 2019

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18) ;

Supremacy @ 5 oz/a with Axial XL @ 16 oz/a (6/13/2019)

Spring Wheat Dryland Off-Station Variety Trial - NDSU **Divide County, ND 2019**

| Variety | Protein [†] | Test weight | Yield [#] | | |
|---------------|----------------------|-------------|--------------------|----------|----------|
| | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| | (%) | (lb/bu) | ------(bu/a)----- | | |
| SY Soren | 13.4 | 61.4 | 44.2 | 38.2 | 34.2 |
| Elgin-ND | 11.9 | 60.8 | 47.6 | 35.4 | 33.6 |
| Barlow | 11.9 | 60.8 | 42.5 | 35.4 | 33.1 |
| Mott | 12.8 | 61.1 | 47.0 | 35.2 | 30.2 |
| Bolles | 13.5 | 60.9 | 42.9 | 33.3 | 30.1 |
| SY Ingmar | 13.6 | 61.5 | 37.7 | 32.8 | 29.5 |
| Glenn | 12.5 | 63.8 | 37.4 | 28.2 | 28.5 |
| ND-Vitpro | 12.9 | 63.2 | 41.4 | 32.6 | - |
| ND828 | 12.7 | 62.3 | 46.8 | - | - |
| Lanning | 13.2 | 60.3 | 43.8 | - | - |
| Prestige | 12.4 | 60.4 | 41.7 | - | - |
| NDHRS16-13-97 | 12.6 | 61.5 | 40.3 | - | - |
| Mean | 12.88 | 61.60 | 42.78 | - | - |
| CV (%) | 4.02 | 0.40 | 11.36 | - | - |
| LSD (5%) | 0.88 | 0.42 | 8.23 | - | - |
| LSD (10%) | 0.73 | 0.34 | 6.81 | - | - |

Location: Crosby, ND; Latitude 48° 8' N; Longitude 103° 18' W; Elevation 2044 ft.

Planted: 05/6/2019

Previous crop: HRSW

Soil test to 6" in ppm: P=14 ppm; K=362; OM=3%

Harvested: 8/21/19

Soil test to 24" in lb/a: N=14 lb/a

Soil type: Farnuf-Alkabo.

Applied fertilizers in lb/a: N=77; P=24; K=0; S=6; Zn=0.6 (60 lbs of MESZ with seed, 152 lbs of Urea broadcast)

[†]Protein adjusted to 12% moisture.

[#]Yield reported on a 13.5% moisture basis.

Herbicide Application: Bison @ 1.5 pts/a with Tacoma @ 10 oz/a (6/25/2019)

Spring Wheat Dryland Off-Station Variety Trial - NDSU **McKenzie County, ND 2019**

| Variety | Protein [†] | Test weight | Yield [#] |
|---------------|----------------------|-------------|--------------------|
| | | | 2019 |
| | (%) | (lb/bu) | (bu/a) |
| Lanning | 16.1 | 60.5 | 52.4 |
| Prestige | 16.6 | 59.6 | 50.0 |
| Mott | 16.6 | 60.3 | 49.8 |
| Elgin-ND | 16.7 | 60.1 | 49.4 |
| SY Ingmar | 17.3 | 60.9 | 48.9 |
| Glenn | 17.2 | 63.1 | 48.7 |
| Barlow | 16.7 | 61.3 | 48.1 |
| SY Soren | 17.3 | 60.7 | 47.8 |
| Bolles | 19.1 | 60.2 | 45.9 |
| ND828 | 17.2 | 61.3 | 45.1 |
| ND-Vitpro | 18.1 | 62.1 | 44.8 |
| NDHRS16-13-97 | 16.7 | 60.9 | 40.1 |
| Mean | 17.1 | 60.9 | 47.6 |
| CV (%) | 4.3 | 0.4 | 4.5 |
| LSD (5%) | 1.3 | 0.4 | 3.6 |
| LSD (10%) | 1.0 | 0.4 | 3.0 |

Location: Arnegard ND, Lat. 47 48'N; Long. 103 25'W

Previous crop: lentils

Planted: 5/13/2019

Harvested: 8/21/19

Soil test to 6" in ppm: P=11 ppm; K=324; OM=2%

Soil type: Dooley-Zahl complex

Soil test to 24" in lb/a: N=8 lb/a

Applied fertilizers in lb/a: N=85; P=24; K=0; S=6; Zn=0.6 (60 lbs of MESZ with seed, 184 lbs of Urea broadcast)

[†]Protein adjusted to 12% moisture.

[#]Yield reported on a 13.5% moisture basis.

Herbicide Application: Bison @ 1.5 pt/s with Parity @ 8 oz/a (6/18/2019)

Spring Wheat Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Plant Height (in) | Days to Head (DAP*) | Lodging (0 - 9*) | Protein† | | | Test Weight (lb/bu) | Yield | | |
|--------------------|----------------------|------------------------|---------------------|-------------|-----------------|-----------------|------------------------|----------------|--------------------|--------------------|
| | | | | 2019 (%) | 2-Yr Avg (%) | 3-Yr Avg (%) | | 2019 (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg (bu/a) |
| TCG-Spitfire | 34 | 68 | 0 | 14.0 | 14.1 | 14.0 | 57.7 | 96.4 | 99.9 | 105.3 |
| SY Ingmar | 33 | 66 | 0 | 14.9 | 15.2 | 15.2 | 61.8 | 105.0 | 94.9 | 100.4 |
| Redstone | 34 | 60 | 1 | 14.4 | 14.4 | 14.7 | 59.4 | 93.1 | 91.5 | 97.6 |
| SY Soren | 33 | 63 | 0 | 14.6 | 15.4 | 15.3 | 60.9 | 104.6 | 90.4 | 97.3 |
| LCS Trigger | 37 | 70 | 0 | 13.0 | 13.1 | 13.3 | 57.3 | 92.1 | 91.6 | 97.3 |
| Faller | 35 | 66 | 1 | 13.6 | 14.0 | 14.2 | 58.4 | 90.8 | 87.3 | 97.2 |
| MS Chevelle | 33 | 62 | 0 | 13.5 | 14.1 | 14.2 | 58.3 | 94.1 | 91.1 | 97.2 |
| SY Valda | 34 | 65 | 0 | 13.8 | 14.3 | 14.4 | 59.0 | 94.0 | 89.4 | 97.1 |
| Prestige | 36 | 69 | 0 | 13.8 | 14.0 | 14.1 | 57.5 | 90.5 | 92.0 | 96.4 |
| Prosper | 37 | 66 | 0 | 14.5 | 14.9 | 14.8 | 59.6 | 94.9 | 87.5 | 96.3 |
| CP3504 | 32 | 66 | 0 | 13.9 | 14.4 | 14.4 | 57.3 | 99.9 | 92.7 | 96.2 |
| CP3419 | 35 | 75 | 0 | 13.8 | 14.0 | 14.1 | 55.8 | 89.1 | 90.6 | 95.5 |
| Surpass | 35 | 62 | 0 | 14.5 | 15.0 | 14.9 | 59.9 | 99.2 | 87.4 | 95.0 |
| SY Rockford | 36 | 67 | 0 | 15.6 | 15.4 | 15.2 | 56.7 | 79.5 | 84.5 | 94.8 |
| LCS Rebel | 37 | 61 | 1 | 14.6 | 15.3 | 15.6 | 61.1 | 97.5 | 92.7 | 94.8 |
| Velva | 37 | 65 | 1 | 14.5 | 14.9 | 15.0 | 58.3 | 92.3 | 89.0 | 93.2 |
| Linkert | 31 | 64 | 0 | 15.4 | 15.9 | 15.8 | 59.7 | 89.7 | 83.7 | 92.9 |
| Bolles | 35 | 67 | 0 | 16.3 | 17.0 | 17.0 | 58.7 | 93.6 | 85.5 | 92.9 |
| Reeder | 36 | 65 | 0 | 15.5 | 15.9 | 15.8 | 59.0 | 84.4 | 84.5 | 92.6 |
| Mott | 39 | 66 | 0 | 14.9 | 15.6 | 15.8 | 59.1 | 87.0 | 87.2 | 92.3 |
| CP3530 | 37 | 67 | 1 | 14.4 | 15.0 | 15.1 | 58.2 | 86.1 | 86.2 | 92.1 |
| Elgin-ND | 38 | 65 | 1 | 15.3 | 15.6 | 15.5 | 59.1 | 85.2 | 83.6 | 90.3 |
| Barlow | 37 | 62 | 2 | 15.2 | 15.8 | 15.8 | 61.5 | 91.9 | 84.2 | 90.1 |
| TCG-Climax | 37 | 69 | 0 | 16.6 | 16.8 | 16.9 | 59.9 | 87.5 | 84.3 | 89.8 |
| Glenn | 38 | 61 | 0 | 15.3 | 15.6 | 15.9 | 62.9 | 88.4 | 85.6 | 89.8 |
| Steele-ND | 36 | 64 | 2 | 14.5 | 15.2 | 15.3 | 58.8 | 77.8 | 80.2 | 89.1 |
| MS Camaro | 32 | 63 | 0 | 14.9 | 15.9 | 15.9 | 60.0 | 91.9 | 79.9 | 89.1 |
| ND-VitPro | 35 | 62 | 0 | 15.0 | 15.6 | 15.6 | 62.1 | 84.4 | 80.5 | 87.9 |
| Boost | 37 | 67 | 0 | 14.5 | 15.2 | 15.4 | 57.9 | 84.9 | 81.9 | 86.6 |
| Lanning | 34 | 63 | 0 | 15.3 | 15.7 | - | 57.3 | 88.9 | 89.0 | - |
| LCS Cannon | 33 | 59 | 1 | 14.6 | 15.1 | - | 62.1 | 102.4 | 87.8 | - |
| SY Rowyn | 34 | 65 | 2 | 14.2 | 14.6 | - | 58.7 | 91.7 | 86.0 | - |
| LCS Breakaway | 33 | 62 | 0 | 13.8 | 15.1 | - | 61.4 | 98.0 | 84.8 | - |
| Dyna-Gro Commander | 34 | 62 | 0 | 14.4 | - | - | 60.8 | 107.0 | - | - |
| SY McCloud | 35 | 62 | 0 | 14.9 | - | - | 61.8 | 106.1 | - | - |
| MS Barracuda | 32 | 61 | 0 | 15.2 | - | - | 60.4 | 102.5 | - | - |
| Dyna-Gro Ambush | 34 | 63 | 0 | 14.6 | - | - | 61.5 | 102.0 | - | - |
| CP3888 | 34 | 64 | 0 | 14.4 | - | - | 59.5 | 99.6 | - | - |
| TCG-Heartland | 32 | 62 | 0 | 15.1 | - | - | 61.3 | 99.2 | - | - |
| SY Longmire | 33 | 65 | 0 | 14.9 | - | - | 60.7 | 93.7 | - | - |
| TCG-Stalwart | 33 | 63 | 0 | 17.0 | - | - | 56.1 | 74.2 | - | - |
| MEAN | 34.8 | 64.4 | 0.3 | 14.71 | 15.10 | 15.14 | 59.45 | 92.95 | 87.50 | 94.03 |
| C.V. (%) | 3.3 | 4.0 | - | 3.46 | - | - | 2.29 | 8.73 | - | - |
| LSD (5%) | 1.6 | 3.6 | 0.8 | 0.71 | - | - | 1.91 | 11.37 | - | - |
| LSD (10%) | 1.4 | 3.0 | 0.7 | 0.60 | - | - | 1.60 | 9.52 | - | - |

* Days after planting * 0: no lodging - 9: plants lying flat on the ground † Protein content adjusted to 12% moisture

Location: Latitude 48 9.9222°N; Longitude 103 6.132°W

Elevation: 1902 ft

Soil test to (0-6 in.): P=22 ppm; K=177 ppm; pH=7.9 ; OM=2.2%

Previous crop: Field Pea

(0-24 in.): NO3-N=25 lb/a

Planted: 4/24/2019

Yield goal: 90 Bu/a

Harvested: 8/22/2019

Planting population: 1.5 million seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: 385 lb/a of Urea (46-0-0) [4/18]

Plot size: 92 ft^2

Herbicides applied: 2,4-D 1.5 pt/a, Talinor 14 oz/a, Tacoma 0.66 pt/a, and Goldsky 1 pt/a (6/5)

Rainfall: 9.6 inches (4/24 - 8/22)

Fungicides applied: Tilt 4 oz/a (6/5), Prosaro 421 8 oz/a (7/2)

Dryland Advanced Yield Spring Wheat - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|------------------------------|-------------------------|----------------|-------------------------|
| AGRIPR 141 | 29.5 | 175 | 64.8 | 15.4 | 83.4 |
| AGRIPR 151 | 29.8 | 175 | 63.6 | 14.2 | 88.4 |
| AGRIPR 161 | 32.4 | 176 | 62.5 | 13.2 | 97.1 |
| BZ 92413R | 29.5 | 174 | 63.8 | 13.8 | 73.1 |
| BZ 996434 | 31.5 | 172 | 63.1 | 14.0 | 79.6 |
| CI 10003 | 40.9 | 179 | 61.5 | 14.3 | 77.6 |
| CI 13596 | 36.5 | 175 | 62.8 | 13.5 | 70.4 |
| CP3888 | 30.8 | 175 | 62.9 | 13.8 | 84.3 |
| CP3939 | 31.4 | 172 | 63.7 | 13.4 | 80.3 |
| CPx36619 | 26.6 | 171 | 63.2 | 13.7 | 82.3 |
| LIMAGR 171 | 30.8 | 172 | 64.3 | 14.2 | 84.4 |
| LIMAGR 191 | 29.4 | 174 | 63.7 | 13.3 | 83.4 |
| LIMAGR 192 | 30.7 | 172 | 63.2 | 14.3 | 89.2 |
| MT 1621 | 29.1 | 172 | 63.5 | 13.3 | 79.8 |
| MT 1673 | 30.7 | 171 | 62.0 | 14.8 | 84.7 |
| MT 1716 | 30.3 | 171 | 63.1 | 13.2 | 90.4 |
| MT 1736 | 31.6 | 177 | 61.4 | 12.9 | 80.4 |
| MT 1742 | 30.2 | 171 | 63.2 | 12.4 | 84.7 |
| MT 1743 | 31.1 | 176 | 62.1 | 12.8 | 93.0 |
| MT 1748 | 36.9 | 178 | 62.3 | 13.9 | 84.8 |
| MT 1750 | 32.3 | 172 | 63.9 | 13.0 | 89.9 |
| MT 1756 | 31.1 | 173 | 61.8 | 13.8 | 89.4 |
| MT 1767 | 30.6 | 172 | 62.2 | 13.5 | 90.9 |
| MT 1775 | 32.7 | 177 | 62.1 | 14.3 | 88.8 |
| MT 1807 | 32.3 | 172 | 62.3 | 13.4 | 92.0 |
| MT 1809 | 30.3 | 175 | 62.4 | 13.5 | 93.5 |
| MT 1811 | 33.5 | 175 | 63.3 | 14.0 | 81.2 |
| MT 1815 | 33.1 | 176 | 62.9 | 13.1 | 90.1 |
| MT 1818 | 33.1 | 175 | 63.4 | 14.6 | 91.5 |
| MT 1819 | 31.6 | 173 | 63.6 | 13.6 | 85.8 |
| MT 1821 | 31.8 | 176 | 64.4 | 14.2 | 83.0 |
| MT 1824 | 30.3 | 175 | 63.0 | 13.1 | 93.8 |
| MT 1826 | 31.5 | 175 | 60.9 | 14.2 | 87.1 |
| MT 1837 | 29.0 | 174 | 63.2 | 13.4 | 74.0 |
| MT 1838 | 29.7 | 172 | 62.0 | 13.1 | 87.9 |
| MT 1840 | 30.6 | 175 | 65.0 | 13.2 | 85.6 |
| MT 1846 | 31.9 | 174 | 63.8 | 14.7 | 83.4 |
| MT 1853 | 30.1 | 173 | 63.9 | 13.5 | 88.2 |
| MT 1855 | 35.2 | 176 | 63.3 | 13.9 | 93.0 |
| MT 1856 | 32.5 | 175 | 62.9 | 13.6 | 86.6 |
| MT 1857 | 32.0 | 175 | 64.2 | 13.6 | 98.5 |
| MT 1861 | 32.2 | 175 | 64.3 | 13.3 | 85.0 |
| MT 1862 | 31.6 | 172 | 63.0 | 13.3 | 86.7 |
| MT 1863 | 29.9 | 173 | 62.9 | 13.8 | 88.4 |
| MT 1865 | 31.8 | 175 | 62.4 | 13.4 | 90.7 |
| MT 1866 | 31.4 | 175 | 63.5 | 13.3 | 93.3 |
| MT 1867 | 31.1 | 174 | 63.8 | 13.2 | 86.9 |
| MT 1868 | 31.0 | 175 | 62.3 | 12.4 | 87.8 |
| MT 1870 | 30.7 | 172 | 63.1 | 13.8 | 85.9 |
| MT 1871 | 31.1 | 176 | 63.1 | 12.6 | 90.1 |
| MT 1872 | 31.5 | 172 | 63.1 | 14.5 | 93.9 |
| ND 695 | 33.7 | 173 | 63.6 | 13.5 | 85.2 |
| PI 574642 | 32.7 | 177 | 63.2 | 12.6 | 87.7 |

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| Dryland Advanced Yield Spring Wheat - MSU | | | | EARC, Sidney, MT 2019 | |
|---|------------------------|------------------------------|-------------------------|-----------------------|-------------------------|
| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
| PI 633974 | 30.2 | 175 | 62.5 | 13.4 | 91.1 |
| PI 642366 | 30.3 | 175 | 62.6 | 13.0 | 85.1 |
| PI 660981 | 30.6 | 171 | 62.6 | 12.8 | 87.4 |
| PI 671855 | 30.2 | 176 | 62.6 | 14.2 | 80.6 |
| PI 676978 | 29.7 | 171 | 63.0 | 15.3 | 82.8 |
| PI 679964 | 33.5 | 178 | 62.1 | 13.7 | 93.9 |
| SYN 181 | 29.0 | 172 | 64.4 | 15.2 | 78.7 |
| SYN 182 | 29.1 | 175 | 64.6 | 13.3 | 82.3 |
| SYN 183 | 28.2 | 173 | 64.9 | 13.0 | 86.3 |
| WB 143 | 25.7 | 170 | 63.1 | 15.9 | 72.6 |
| WB 171 | 26.5 | 172 | 63.5 | 13.7 | 83.8 |
| WB 173 | 30.3 | 176 | 66.5 | 13.5 | 98.3 |
| WB 9879 CLP | 30.8 | 175 | 62.8 | 12.8 | 85.8 |
| WSCIA | 31.5 | 175 | 64.0 | 13.0 | 89.9 |
| Mean | 31.2 | 174 | 63.2 | 13.6 | 86.4 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 4.15 | 0.46 | 0.44 | 5.89 | 6.27 |
| LSD (0.05) | 2.09 | 1.28 | 0.45 | 1.30 | 8.75 |

Planted: 4/18/19

Harvested: 8/19/19

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 39

N added (lb/ac): 60

Previous crop: Fallow

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 31

P₂O₅ added (lb/ac): 20



Ron Brown, EARC Farm Manager and Bill Franck, EARC Research Scientist



EARC: Summer students, Zava Zupan and Emily Skogen, assisting Samantha Hoesel, EARC Research Assistant

Irrigated Advanced Yield Spring Wheat - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|------------------------------|-------------------------|----------------|-------------------------|
| AGRIPR 141 | 31.5 | 183 | 64.4 | 14.9 | 102.9 |
| AGRIPR 151 | 32.3 | 183 | 63.7 | 14.9 | 96.6 |
| AGRIPR 161 | 33.5 | 184 | 61.0 | 14.7 | 98.9 |
| BZ 92413R | 31.4 | 183 | 62.6 | 14.7 | 77.5 |
| BZ 996434 | 32.5 | 181 | 62.4 | 15.7 | 81.5 |
| CI 10003 | 41.7 | 186 | 60.8 | 16.2 | 65.7 |
| CI 13596 | 37.0 | 180 | 61.2 | 15.5 | 67.4 |
| CP3888 | 32.7 | 182 | 62.1 | 14.7 | 98.4 |
| CP3939 | 33.2 | 182 | 62.8 | 15.6 | 94.8 |
| CPx36619 | 27.4 | 180 | 61.9 | 14.6 | 93.8 |
| LIMAGR 171 | 34.1 | 179 | 63.5 | 15.6 | 89.1 |
| LIMAGR 191 | 31.5 | 181 | 63.2 | 14.5 | 98.6 |
| LIMAGR 192 | 31.9 | 181 | 62.3 | 15.7 | 94.2 |
| MT 1621 | 32.3 | 180 | 62.4 | 15.8 | 96.0 |
| MT 1673 | 32.0 | 178 | 60.6 | 16.3 | 84.0 |
| MT 1716 | 33.3 | 179 | 63.0 | 15.6 | 90.2 |
| MT 1736 | 31.6 | 183 | 60.5 | 16.0 | 79.1 |
| MT 1742 | 32.8 | 178 | 62.1 | 15.7 | 86.7 |
| MT 1743 | 33.9 | 183 | 60.7 | 15.6 | 84.0 |
| MT 1748 | 37.5 | 184 | 60.9 | 16.1 | 93.9 |
| MT 1750 | 34.1 | 178 | 63.3 | 14.9 | 93.3 |
| MT 1756 | 33.1 | 181 | 60.1 | 15.1 | 93.8 |
| MT 1767 | 32.9 | 180 | 61.0 | 15.6 | 97.7 |
| MT 1775 | 34.6 | 283 | 60.4 | 16.1 | 87.7 |
| MT 1807 | 31.2 | 182 | 61.4 | 16.0 | 91.2 |
| MT 1809 | 33.1 | 182 | 61.2 | 16.3 | 93.9 |
| MT 1811 | 35.7 | 184 | 62.2 | 15.8 | 87.6 |
| MT 1815 | 34.0 | 183 | 61.6 | 15.4 | 92.4 |
| MT 1818 | 35.0 | 184 | 61.6 | 16.1 | 93.0 |
| MT 1819 | 34.4 | 183 | 62.3 | 15.1 | 97.9 |
| MT 1821 | 33.1 | 183 | 62.7 | 16.6 | 72.4 |
| MT 1824 | 32.0 | 182 | 61.9 | 14.7 | 100.0 |
| MT 1826 | 34.1 | 183 | 59.5 | 17.0 | 81.5 |
| MT 1837 | 29.9 | 183 | 60.9 | 16.4 | 81.8 |
| MT 1838 | 32.3 | 181 | 60.4 | 15.8 | 87.8 |
| MT 1840 | 32.0 | 182 | 63.3 | 14.6 | 86.2 |
| MT 1846 | 34.6 | 182 | 63.0 | 16.9 | 89.8 |
| MT 1853 | 34.0 | 183 | 62.8 | 15.7 | 95.9 |
| MT 1855 | 35.8 | 184 | 62.5 | 15.1 | 92.5 |
| MT 1856 | 33.7 | 183 | 61.1 | 16.6 | 83.6 |
| MT 1857 | 33.7 | 182 | 63.0 | 14.6 | 101.3 |
| MT 1861 | 32.0 | 183 | 63.4 | 16.1 | 92.1 |
| MT 1862 | 33.2 | 182 | 61.2 | 15.1 | 86.5 |
| MT 1863 | 32.9 | 183 | 61.7 | 16.5 | 90.5 |
| MT 1865 | 34.4 | 183 | 61.6 | 15.5 | 83.9 |
| MT 1866 | 34.0 | 181 | 62.7 | 15.5 | 97.8 |
| MT 1867 | 33.6 | 180 | 62.8 | 15.0 | 95.2 |
| MT 1868 | 33.2 | 183 | 61.1 | 14.4 | 95.4 |
| MT 1870 | 31.1 | 180 | 61.5 | 15.7 | 75.5 |
| MT 1871 | 33.7 | 183 | 62.6 | 15.6 | 91.8 |
| MT 1872 | 32.7 | 178 | 62.3 | 14.8 | 95.4 |
| ND 695 | 35.4 | 183 | 62.5 | 15.6 | 95.4 |

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Irrigated Advanced Yield Spring Wheat - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|-------------|------------------------|------------------------------|-------------------------|----------------|-------------------------|
| PI 574642 | 34.0 | 183 | 61.4 | 15.8 | 92.1 |
| PI 633974 | 32.5 | 182 | 61.5 | 15.1 | 83.4 |
| PI 642366 | 32.3 | 183 | 62.0 | 15.4 | 96.9 |
| PI 660981 | 32.5 | 179 | 61.5 | 15.1 | 87.7 |
| PI 671855 | 32.4 | 183 | 61.7 | 15.7 | 88.2 |
| PI 676978 | 32.5 | 181 | 61.4 | 16.0 | 96.3 |
| PI 679964 | 34.1 | 184 | 61.2 | 15.2 | 89.0 |
| SYN 181 | 32.7 | 180 | 63.7 | 15.6 | 91.0 |
| SYN 182 | 31.0 | 182 | 63.2 | 15.3 | 99.3 |
| SYN 183 | 29.4 | 181 | 63.9 | 14.8 | 106.4 |
| WB 143 | 26.2 | 178 | 62.3 | 17.5 | 79.9 |
| WB 171 | 29.1 | 179 | 62.5 | 15.8 | 93.9 |
| WB 173 | 31.0 | 183 | 65.1 | 15.1 | 97.3 |
| WB 9879 CLP | 32.2 | 183 | 61.0 | 15.8 | 80.9 |
| WSCIA | 32.9 | 182 | 63.0 | 15.0 | 84.6 |
| Mean | 33.0 | 183 | 62.0 | 15.5 | 90.1 |
| P-Value | <0.0001 | 0.43 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 3.48 | 11.6 | 0.55 | 3.04 | 4.62 |
| LSD (0.05) | 1.85 | 34.3 | 0.55 | 0.76 | 6.79 |

Planted: 5/6/99

Previous crop: Sugarbeet

Harvested: 8/27/19

Soil Type: William Clay Loam

(Julian*) is a continuous count of days since January 1

Plot Width: 5 ft.

† Test weight and grain yield adjusted to 12.0% moisture

Precipitation (2019): 22.5"

Soil Test N Avail (lb/ac): 25

Soil Test P₂O₅ (ppm): 25

N added (lb/ac): 100

P₂O₅ added (lb/ac): 30

Recrop Spring Wheat Evaluation - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|----------------|------------------------|------------------------------|-------------------------|----------------|-------------------------|
| Brennan | 28.5 | 171 | 64.5 | 16.8 | 60.3 |
| Choteau | 29.5 | 175 | 63.2 | 14.6 | 60.5 |
| Corbin | 29.1 | 172 | 63.8 | 15.3 | 64.7 |
| CP3888 | 30.6 | 174 | 63.3 | 14.6 | 79.1 |
| CP3939 | 31.1 | 172 | 64.5 | 15.6 | 74.7 |
| CPX36619 | 25.6 | 171 | 64.3 | 16.2 | 62.2 |
| Duclair | 32.7 | 172 | 63.1 | 14.8 | 66.6 |
| Egan | 30.7 | 176 | 62.3 | 17.1 | 71.9 |
| Lanning | 28.3 | 172 | 64.1 | 16.2 | 72.2 |
| MT 1617 | 31.4 | 175 | 63.4 | 14.3 | 77.2 |
| MT 1621 | 30.3 | 172 | 64.1 | 15.4 | 69.9 |
| MT 1716 | 29.5 | 174 | 64.3 | 14.9 | 71.6 |
| MT 1749 | 30.7 | 175 | 63.6 | 16.2 | 66.1 |
| NS Presser CLP | 31.0 | 175 | 63.3 | 14.6 | 79.2 |
| Reeder | 31.0 | 175 | 64.5 | 15.1 | 64.3 |
| SY Soren | 29.4 | 173 | 65.0 | 15.8 | 68.4 |
| Vida | 33.5 | 175 | 63.9 | 14.0 | 79.7 |
| Mean | 30.2 | 173 | 63.8 | 15.4 | 69.9 |
| P-Val | 0.0003 | <0.0001 | <0.0001 | 0.001 | 0.02 |
| CV (%) | 4.99 | 0.53 | 0.53 | 5.34 | 10.9 |
| LSD (0.05) | 2.50 | 1.53 | 0.56 | 1.37 | 12.4 |

Planted: 4/19/19

Previous crop: Pea

Harvested: 8/22/19

Soil Type: William Clay Loam

(Julian*) is a continuous count of days since January 1

Plot Width: 5 ft.

† Test weight and grain yield adjusted to 12.0% moisture

Precipitation (2019): 21.5"

Soil Test N Avail (lb/ac): 22

Soil Test P₂O₅ (ppm): 29

N added (lb/ac): 60

P₂O₅ added (lb/ac): 20

Roosevelt County Dryland Spring Wheat - MSU

Poplar, MT 2019

| Variety | Plant Height (inch) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|----------------|------------------------|-------------------------|----------------|-------------------------|
| Brennan | 27.7 | 64.7 | 15.4 | 76.5 |
| Choteau | 29.3 | 61.9 | 14.3 | 84.4 |
| Corbin | 28.0 | 62.5 | 14.2 | 68.3 |
| CP3888 | 29.7 | 62.0 | 14.2 | 81.5 |
| CP3939 | 30.1 | 63.8 | 14.5 | 82.2 |
| CPX36619 | 24.3 | 63.7 | 14.3 | 59.6 |
| Duclair | 29.7 | 62.9 | 13.4 | 81.8 |
| Egan | 30.7 | 61.2 | 15.5 | 78.7 |
| Lanning | 29.1 | 62.8 | 15.5 | 84.0 |
| MT 1617 | 32.8 | 62.1 | 13.6 | 86.5 |
| MT 1621 | 30.2 | 64.0 | 15.1 | 92.4 |
| MT 1716 | 30.2 | 63.2 | 14.3 | 87.7 |
| MT 1749 | 31.2 | 62.8 | 14.6 | 86.0 |
| NS Presser CLP | 32.9 | 60.3 | 14.5 | 88.9 |
| Reeder | 32.9 | 63.0 | 14.7 | 83.6 |
| SY Soren | 27.6 | 63.7 | 15.1 | 77.5 |
| Vida | 31.0 | 61.2 | 14.5 | 93.6 |
| Mean | 29.8 | 62.7 | 14.6 | 82.0 |
| P-Value | 0.0007 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 0.61 | 0.80 | 1.73 | 4.2 |
| LSD (0.05) | 3.28 | 0.83 | 0.42 | 5.69 |

Planted: 4/23/19

Previous crop: Fallow

Harvested: 8/28/19

Plot Width: 5 ft.

(Julian*) is a continuous count of days since January 1

Fertilizer: MESZ @ 80 lbs/ac

† Test weight and grain yield adjusted to 12.0% moisture

10-40-0-10sulfur-1Zn

Sheridan County Dryland Spring Wheat - MSU

Dagmar, MT 2019

| Variety | Plant Height (inch) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|----------------|------------------------|-------------------------|----------------|-------------------------|
| Brennan | 29.5 | 64.6 | 15.4 | 70.1 |
| Choteau | 34.4 | 62.3 | 15.3 | 71.3 |
| Corbin | 32.0 | 62.8 | 14.9 | 67.5 |
| CP3888 | 30.4 | 62.8 | 14.8 | 80.5 |
| CP3939 | 32.5 | 63.8 | 15.3 | 75.7 |
| CPX36619 | 23.6 | 62.1 | 13.9 | 56.3 |
| Duclair | 31.2 | 61.9 | 14.5 | 64.6 |
| Egan | 32.5 | 61.8 | 16.2 | 67.7 |
| Lanning | 29.0 | 62.3 | 16.2 | 67.5 |
| MT 1617 | 34.8 | 62.8 | 13.9 | 77.8 |
| MT 1621 | 31.0 | 62.6 | 15.5 | 72.8 |
| MT 1716 | 32.2 | 64.1 | 14.2 | 74.4 |
| MT 1749 | 32.7 | 62.3 | 15.6 | 67.2 |
| NS Presser CLP | 35.0 | 61.2 | 14.6 | 78.0 |
| Reeder | 36.0 | 63.2 | 14.6 | 73.3 |
| SY Soren | 31.0 | 64.4 | 15.2 | 74.7 |
| Vida | 34.3 | 62.4 | 14.1 | 75.0 |
| Mean | 31.9 | 62.8 | 15.0 | 71.4 |
| P-Val | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 4.36 | 0.73 | 2.93 | 6.20 |
| LSD (0.05) | 2.31 | 0.77 | 0.73 | 7.36 |

Planted: 4/24/19

Previous crop: Lentil

Harvested: 8/29/19

Plot Width: 5 ft.

(Julian*) is a continuous count of days since January 1

N added (lb/ac): 60

† Test weight and grain yield adjusted to 12.0% moisture

P₂O₅ added (lb/ac): 20

Wheat Variety Comparisons, Williston, ND 2019

Gautam Pradhan, Jerald Bergman, Kyle Dragseth

The gross return per acre was based on three-year average yield of spring wheat (2016, 2017, 2019) and two-year average yield of durum wheat (2017, 2019) from dryland varietal trials, and the market price obtained in the second week of December 2019 from different grain elevators in and around Williston. The market price of each spring wheat variety was adjusted for protein premium by using a linear equation obtained by plotting wheat market prices against percent proteins. In case of durum, the choice rate was used. There were several episodes of high wind, heavy rain, and hailstorm that affected crops in 2018. So, the data from 2018 was not included.

| Spring Wheat | | | | | Durum | | | | |
|---------------------|---------------|--------------|----------------------|--------------------------|--------------|---------------|--------------|----------------------|-------------------------|
| Variety | 3 Yr Avg. | | Gross Return \$/a | + or - Barlow \$/a | Variety | 2 Yr Avg. | | Gross Return \$/a | + or - Joppa \$/a |
| | Yield bu/a | Protein % | | | | Yield bu/a | Protein % | | |
| MS Chevelle | 53.0 | 15.2 | 258.26 | 31.01 | ND Riveland | 48.0 | 17.5 | 288.19 | 21.16 |
| Elgin-ND | 52.4 | 15.9 | 255.09 | 27.83 | Tioga | 47.3 | 17.1 | 283.76 | 16.73 |
| Prevail | 51.9 | 15.1 | 252.78 | 25.52 | Grenora | 46.6 | 16.9 | 279.71 | 12.68 |
| SY Valda | 51.2 | 15.2 | 249.54 | 22.29 | Maier | 45.8 | 18.4 | 274.64 | 7.60 |
| Faller | 49.4 | 15.2 | 240.66 | 13.40 | Mountrail | 45.7 | 17.3 | 274.39 | 7.35 |
| Mott | 48.1 | 17.0 | 234.41 | 7.15 | VT Peak | 45.6 | 17.2 | 273.40 | 6.37 |
| SY Ingmar | 47.6 | 15.5 | 231.67 | 4.42 | Alkabo | 45.3 | 16.9 | 272.00 | 4.96 |
| Glenn | 47.0 | 15.4 | 228.67 | 1.42 | Divide | 45.3 | 17.7 | 271.62 | 4.58 |
| SY Soren | 46.8 | 16.3 | 228.07 | 0.82 | AC Commander | 45.1 | 18.0 | 270.45 | 3.42 |
| Barlow | 46.7 | 15.9 | 227.26 | 0.00 | ND Grano | 44.9 | 17.9 | 269.12 | 2.09 |
| Linkert | 46.4 | 16.1 | 226.17 | -1.09 | Ben | 44.8 | 17.4 | 268.86 | 0.00 |
| LCS Breakaway | 46.4 | 16.2 | 225.84 | -1.42 | Rugby | 44.7 | 17.5 | 268.45 | 1.41 |
| ND VitPro | 45.3 | 17.4 | 220.84 | -6.42 | Joppa | 44.5 | 17.1 | 267.03 | 0.00 |
| Bolles | 43.0 | 17.5 | 209.52 | -17.74 | CDC Verona | 44.2 | 18.8 | 265.14 | -1.89 |
| | | | | | Strongfield | 44.1 | 18.3 | 264.58 | -2.45 |
| | | | | | Pierce | 44.0 | 17.2 | 263.92 | -3.11 |
| | | | | | Carpio | 43.3 | 17.5 | 259.52 | -7.51 |
| | | | | | Normanno | 41.7 | 17.4 | 249.98 | -17.05 |
| | | | | | Alzada | 40.9 | 17.4 | 245.43 | -21.60 |



Kyra Candee, WREC Irrigation Technician

DURUM VARIETY DESCRIPTIONS

| VARIETY | ORIGIN ¹ | YEAR RELEASED | HEIGHT | MATURITY | Resistance To ² | | | | | Quality Factors | | | |
|---------------|---------------------|---------------|---------|----------|----------------------------|-----------|----------------|----------|------|-----------------|--------------------------|---------------|-----------------|
| | | | | | LODGING | LEAF RUST | FOLIAR DISEASE | ROOT ROT | SCAB | TEST WEIGHT | KERNEL SIZE ³ | GRAIN PROTEIN | OVERALL QUALITY |
| AC COMMANDER | CANADA | 2002 | M SHORT | LATE | M | R | MS | M | VS | MEDIUM | LARGE | M HIGH | GOOD |
| AC NAVIGATOR | CANADA | 1999 | M SHORT | M LATE | M | R | M | S | S | MEDIUM | V LARGE | MEDIUM | GOOD |
| ALKABO | NDSU | 2005 | MEDIUM | MEDIUM | R | R | M | M | MS | HIGH | LARGE | M LOW | GOOD |
| ALZADA | WB | 2004 | SHORT | EARLY | M | R | S | M | VS | MEDIUM | LARGE | MEDIUM | EXCELLENT |
| BEN | NDSU | 1996 | TALL | MEDIUM | MR | R | MR | M | S | V HIGH | V LARGE | M HIGH | AVERAGE |
| CARPIO | NDSU | 2012 | TALL | M LATE | MS | R | M | NA | M | MEDIUM | LARGE | M HIGH | EXCELLENT |
| CDC FORTITUDE | CANADA | 2014 | M TALL | MEDIUM | R | R | R | NA | M | MEDIUM | MEDIUM | M HIGH | GOOD |
| CDC VERONA | CANADA | 2010 | M TALL | M LATE | M | R | MR | NA | S | MEDIUM | LARGE | M HIGH | GOOD |
| DIVIDE | NDSU | 2005 | M TALL | M LATE | M | R | M | M | MR | MEDIUM | MEDIUM | M HIGH | EXCELLENT |
| GRENORA | NDSU | 2005 | MEDIUM | M EARLY | M | R | M | MR | MS | MEDIUM | MEDIUM | MEDIUM | GOOD |
| JOPPA | NDSU | 2013 | MEDIUM | MEDIUM | R | R | M | NA | M | MEDIUM | LARGE | MEDIUM | GOOD |
| LEBSOCK | NDSU | 1999 | M TALL | MEDIUM | R | R | M | MS | MS | HIGH | LARGE | MEDIUM | AVERAGE |
| MAIER | NDSU | 1998 | M TALL | M LATE | M | R | M | M | S | HIGH | MEDIUM | HIGH | AVERAGE |
| MOUNTRAIL | NDSU | 1998 | M TALL | M LATE | M | R | M | M | S | MEDIUM | MEDIUM | MEDIUM | AVERAGE |
| ND GRANO* | NDSU | 2017 | MEDIUM | M LATE | MS | R | NA | NA | M | HIGH | MEDIUM | M HIGH | GOOD |
| ND RIVELAND* | NDSU | 2017 | TALL | MEDIUM | M | R | NA | NA | M | HIGH | MEDIUM | MHIGH | GOOD |
| PIERCE | NDSU | 2001 | M TALL | MEDIUM | M | R | MS | MR | S | V HIGH | MEDIUM | MEDIUM | EXCELLENT |
| RUGBY | NDSU | 1973 | TALL | M EARLY | R | R | MR | M | S | MEDIUM | MEDIUM | MEDIUM | POOR |
| SILVER | MT | 2012 | SHORT | EARLY | R | NA | M | NA | S | M HIGH | SMALL | M HIGH | GOOD |
| STRONGFIELD* | CANADA | 2004 | M TALL | M LATE | M | R | MS | NA | S | MEDIUM | M LARGE | V HIGH | GOOD |
| TIOGA | NDSU | 2010 | TALL | M LATE | MR | R | M | NA | MS | M HIGH | MEDIUM | M HIGH | EXCELLENT |
| TCG-BRIGHT | TCG | 2019 | MEDIUM | M EARLY | M | R | M | NA | S | HIGH | MEDIUM | MEDIUM | EXCELLENT |
| VT PEAK | VITERRA | 2010 | M TALL | MEDIUM | MS | NA | NA | NA | NA | MEDIUM | M SMALL | M HIGH | GOOD |

¹Refers to developer: CANADA represents developer from that country; DGP = Dakota Growers Pasta; MT = Montana State University; NDSU = North Dakota State University; TCG = 21st Century Genetics; WB = WestBred.

²MR = Moderately resistant; M = Intermediate; MS = Moderately susceptible; NA = Not adequately tested; R = Resistant; S = Susceptible; VS = Very susceptible. All varieties are resistant to current stem rust races. Foliar Disease = reaction to tan spot and septoria leaf spot complex.

³Number seeds/lb: Small = Less than 11,000; Medium = 11,000-12,000; Large = More than 12,000.

*Indicates low cadmium accumulating variety.



Groundbreaking ceremony for the new seed conditioning facility at WREC

Durum Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Days to heading | Plant height | Protein [†] | Test weight | Yield [#] | | |
|--------------|---------------------|--------------|----------------------|-------------|--------------------|-----------|------------|
| | | | | | 2019 | 2-Yr Avg* | 3-Yr Avg** |
| | (DAP ¹) | (in) | (%) | (lb/bu) | ------(bu/a)----- | | |
| Tioga | 57.3 | 24.1 | 15.5 | 62.6 | 66.1 | 51.5 | 43.9 |
| AC Commander | 55.3 | 16.9 | 17.2 | 61.6 | 63.4 | 50.5 | 42.6 |
| Alkabo | 55.3 | 20.6 | 16.1 | 62.5 | 63.0 | 49.2 | 42.0 |
| Strongfield | 57.0 | 23.4 | 17.4 | 61.9 | 63.4 | 50.4 | 41.9 |
| VT Peak | 56.3 | 21.8 | 16.8 | 63.1 | 64.3 | 49.2 | 41.7 |
| Mountrail | 56.7 | 21.4 | 16.4 | 61.9 | 67.6 | 50.6 | 41.7 |
| Joppa | 57.3 | 23.2 | 15.8 | 62.0 | 61.4 | 48.5 | 41.5 |
| ND Riveland | 56.3 | 21.8 | 16.6 | 61.7 | 68.5 | 48.4 | 41.4 |
| Maier | 56.3 | 22.4 | 16.9 | 62.3 | 65.4 | 49.1 | 41.4 |
| Divide | 57.0 | 22.5 | 16.6 | 62.1 | 63.6 | 48.3 | 41.2 |
| CDC Verona | 58.0 | 23.2 | 17.2 | 61.0 | 65.4 | 49.6 | 40.7 |
| Grenora | 56.0 | 22.0 | 15.8 | 61.4 | 67.6 | 49.8 | 40.6 |
| Carpio | 58.3 | 21.8 | 16.5 | 62.1 | 59.8 | 47.0 | 40.2 |
| ND Grano | 57.0 | 21.8 | 16.6 | 62.6 | 63.7 | 46.5 | 39.7 |
| Pierce | 56.3 | 21.7 | 16.6 | 62.4 | 61.6 | 46.1 | 39.5 |
| Ben | 56.3 | 22.1 | 16.6 | 62.9 | 63.0 | 45.9 | 39.5 |
| Alzada | 54.3 | 16.7 | 16.9 | 61.3 | 54.2 | 44.7 | 39.0 |
| Rugby | 55.7 | 25.4 | 16.3 | 62.3 | 64.4 | 45.8 | 38.9 |
| Normanno | 54.3 | 16.6 | 15.8 | 60.7 | 57.0 | 45.0 | 38.7 |
| AAC Cabri | 57.3 | 24.0 | 17.6 | 61.9 | 63.2 | - | - |
| TCG-Bright | 56.3 | 21.9 | 15.0 | 62.7 | 67.6 | - | - |
| TCG-Webster | 53.7 | 16.9 | 15.5 | 62.5 | 60.6 | - | - |
| Mean | 56.7 | 22.4 | 16.6 | 62.1 | 64.7 | - | - |
| CV (%) | 1.5 | 5.5 | 4.7 | 0.5 | 9.8 | - | - |
| LSD (5%) | 1.4 | 2.0 | 1.3 | 0.5 | 10.2 | - | - |
| LSD (10%) | 1.1 | 1.7 | 1.1 | 0.4 | 8.6 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Previous crop: soybeans

Planted: 5/7/2019

Harvested: 8/20/2019

Soil test to 6" in ppm: P=24 ppm K=363 ppm OM=2% pH=5.7

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=37.5 lb/a

Applied fertilizers in lb/a: N=70; P=24; K=0; S=6; Zn=0.6 (60 lbs of MESZ applied with seed, 136 lbs of Urea broadcast)

[†]Protein adjusted to 12% moisture.

[#]Yield reported on a 13.5% moisture basis.

*Averages of years 2018 and 2019. **Averages of years 2017, 2018, and 2019.

¹DAP = Days after planting.

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18) ; Bison @ 1.5 pts/a with Parity @ 8 oz/a (6/13/2019)

Durum Dryland Off-Station Variety Trial - NDSU **Divide County, ND 2019**

| Variety | Protein [†] | Test weight | Yield [#] | | |
|-------------|----------------------|-------------|--------------------|----------|----------|
| | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| | (%) | (lb/bu) | ------(bu/a)----- | | |
| Tioga | 14.3 | 60.5 | 52.4 | 43.5 | 37.5 |
| ND Riveland | 14.1 | 61.1 | 51.1 | 39.0 | 36.6 |
| Mountrail | 14.1 | 60.8 | 53.9 | 40.2 | 36.2 |
| ND Grano | 13.6 | 60.6 | 51.1 | 37.9 | 34.7 |
| Carpio | 13.9 | 60.9 | 51.2 | 37.4 | 34.1 |
| Divide | 14.0 | 60.6 | 52.1 | 37.5 | 34.1 |
| Joppa | 14.6 | 60.4 | 48.9 | 36.9 | 33.6 |
| Lebsock | 13.4 | 60.7 | 49.9 | 35.3 | 32.7 |
| Alkabo | 13.7 | 60.1 | 46.9 | 34.6 | 32.6 |
| Grenora | 13.6 | 60.3 | 52.1 | 35.0 | - |
| VT Peak | 13.5 | 61.4 | 49.6 | - | - |
| DG Max | 14.1 | 60.8 | 42.8 | - | - |
| Mean | 13.91 | 60.69 | 50.43 | - | - |
| CV (%) | 4.79 | 0.93 | 9.07 | - | - |
| LSD (5%) | 1.13 | 0.96 | 7.74 | - | - |
| LSD (10%) | 0.94 | 0.79 | 6.41 | - | - |

Location: Crosby, ND; Latitude 48° 8' N; Longitude 103° 18' W; Elevation 2044 ft.

Planted: 05/6/2019

Previous crop: HRSW

Soil test to 6" in ppm: P=14 ppm; K=362; OM=3%

Harvested: 8/21/19

Soil test to 24" in lb/a: N=14 lb/a

Soil type: Farnuf-Alkabo.

Applied fertilizers in lb/a: N=77; P=24; K=0; S=6; Zn=0.6

(60 lbs of MESZ with seed, 152 lbs of Urea broadcast)

[†]Protein adjusted to 12% moisture.

[#]Yield reported on a 13.5% moisture basis.

Herbicide Application: Bison @ 1.5 pts/a with Tacoma @ 10 oz/a (6/25/2019)

Durum Dryland Off-Station Variety Trial - NDSU **McKenzie County, ND 2019**

| Variety | Protein [†] | Test weight | Yield [#] |
|-------------|----------------------|-------------|--------------------|
| | | | 2019 |
| | (%) | (lb/bu) | (bu/a) |
| Tioga | 17.0 | 60.8 | 53.9 |
| ND Riveland | 17.0 | 60.8 | 52.9 |
| DG Max | 18.5 | 60.9 | 51.1 |
| ND Grano | 17.3 | 61.2 | 51.0 |
| VT Peak | 17.9 | 61.0 | 50.1 |
| Lebsock | 17.1 | 61.2 | 47.8 |
| Mountrail | 17.8 | 60.3 | 46.2 |
| Divide | 17.8 | 60.6 | 44.2 |
| Joppa | 17.5 | 60.4 | 42.9 |
| Carpio | 17.1 | 60.7 | 42.6 |
| Alkabo | 17.8 | 59.6 | 37.3 |
| Grenora | 17.6 | 59.5 | 34.7 |
| Mean | 17.5 | 60.6 | 46.2 |
| CV (%) | 3.6 | 1.0 | 6.9 |
| LSD (5%) | 1.1 | 1.0 | 5.4 |
| LSD (10%) | 0.9 | 0.9 | 4.5 |

Location: Arnegard ND, Lat. 47 48'N; Long. 103 25'W

Previous crop: lentils

Planted: 5/13/2019

Harvested: 8/21/19

Soil test to 6" in ppm: P=11 ppm; K=324; OM=2%

Soil type: Dooley-Zahl complex

Soil test to 24" in lb/a: N=8 lb/a

Applied fertilizers in lb/a: N=85; P=24; K=0; S=6; Zn=0.6

(60 lbs of MESZ with seed, 184 lbs of Urea broadcast)

[†]Protein adjusted to 12% moisture.

[#]Yield reported on a 13.5% moisture basis.

Herbicide Application: Bison @ 1.5 pt/s with Parity @ 8 oz/a (6/18/2019)

Durum Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Plant Height (in) | Days to Head (DAP*) | Lodging (0-9*) | Protein† | | | Test Weight (lb/bu) | Yield | | |
|--------------|-------------------|---------------------|----------------|----------|--------------|--------------|---------------------|-------------|-----------------|-----------------|
| | | | | 2019 (%) | 2-Yr Avg (%) | 3-Yr Avg (%) | | 2019 (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg (bu/a) |
| ND Riveland | 38 | 69 | 0 | 14.7 | 15.6 | 15.9 | 58.2 | 72.4 | 68.9 | 83.4 |
| Carpio | 35 | 71 | 0 | 14.5 | 15.3 | 15.8 | 59.6 | 70.0 | 67.3 | 80.3 |
| Joppa | 36 | 70 | 0 | 13.6 | 14.7 | 15.1 | 59.7 | 79.0 | 68.6 | 80.0 |
| Alkabo | 34 | 67 | 0 | 14.6 | 15.0 | 15.1 | 59.7 | 73.1 | 67.7 | 79.0 |
| ND Grano | 36 | 68 | 0 | 14.4 | 15.1 | 15.5 | 60.3 | 75.8 | 65.8 | 79.0 |
| Divide | 36 | 68 | 0 | 14.5 | 15.6 | 16.0 | 59.1 | 76.6 | 68.8 | 78.5 |
| Grenora | 34 | 67 | 0 | 14.4 | 15.2 | 15.5 | 58.4 | 72.6 | 68.1 | 78.4 |
| Tioga | 38 | 70 | 0 | 14.6 | 15.4 | 15.8 | 59.3 | 75.7 | 68.1 | 77.9 |
| Mountrail | 34 | 68 | 0 | 14.3 | 15.1 | 15.6 | 58.9 | 76.2 | 66.6 | 77.5 |
| Maler | 33 | 69 | 0 | 15.3 | 16.2 | 16.7 | 59.8 | 70.2 | 61.9 | 74.6 |
| Strongfield | 35 | 70 | 0 | 14.8 | 16.2 | 16.7 | 59.5 | 73.5 | 66.5 | 74.4 |
| CDC Verona | 37 | 71 | 0 | 15.7 | 16.9 | 17.0 | 57.4 | 58.9 | 59.6 | 72.9 |
| AC Commander | 29 | 67 | 0 | 14.1 | 15.0 | 15.3 | 58.1 | 80.4 | 66.0 | 72.9 |
| Pierce | 36 | 68 | 0 | 14.6 | 15.3 | 15.6 | 59.7 | 71.6 | 61.3 | 72.2 |
| Rugby | 37 | 66 | 0 | 15.0 | 15.8 | 16.1 | 59.0 | 69.9 | 62.5 | 71.5 |
| Lebsock | 32 | 65 | 0 | 14.8 | 15.5 | 15.8 | 59.9 | 69.5 | 62.6 | 71.3 |
| Alzada | 29 | 64 | 0 | 14.7 | 15.1 | 15.5 | 57.1 | 66.8 | 60.3 | 70.3 |
| Ben | 35 | 65 | 0 | 15.1 | 15.8 | 16.0 | 59.8 | 70.6 | 62.6 | 70.1 |
| Normanno | 26 | 64 | 0 | 16.3 | 16.1 | 16.3 | 55.5 | 65.7 | 57.8 | 70.0 |
| VT Peak | 35 | 67 | 0 | 14.7 | 14.7 | 14.7 | 60.0 | 72.9 | 72.9 | - |
| AAC Cabri | 36 | 71 | 0 | 15.0 | 15.0 | 15.0 | 59.9 | 73.8 | - | - |
| MEAN | 34.2 | 67.6 | 0.1 | 14.74 | 15.52 | 15.86 | 58.89 | 72.03 | 64.79 | 75.48 |
| C.V. (%) | 4.0 | 1.8 | - | 5.55 | - | - | 1.45 | 9.14 | - | - |
| LSD (5%) | 2.0 | 1.8 | ns | 1.16 | - | - | 1.21 | 9.33 | - | - |
| LSD (10%) | 1.6 | 1.5 | ns | 0.97 | - | - | 1.01 | 7.79 | - | - |

* Days after planting + 0: no lodging - 9: plants lying flat on the ground † Protein content adjusted to 12% moisture

Location: Latitude 48.9222°N; Longitude 103.6132°W

Elevation: 1902 ft

Soil test (0-6 in.): P=22 ppm; K=177 ppm; pH=7.9; OM=2.2%

Previous Crop: Soybean

(0-24 in.): NO3-N=25 lb/a

Planted: 4/23/2019

Yield goal: 90 bu/a

Harvested: 8/21/2019

Planting population: 1.5 million seeds/a

Soil Type: Lihen Loamy Fine Sand

Applied fertilizer: 385 lb/a of Urea (46-0-0) [4/18]

Plot size: 92 ftx2

Herbicides applied: 2,4-D 1.5 pt/a, Tallitor 14 oz/a, Tacoma 0.66 pt/a, and Goldsky 1 pt/a (6/5)

Rainfall: 9.6 inches (4/23 - 8/21)

Fungicides applied: Tilt 4 oz/a (6/5) and Prostaro 421 8 oz/a (7/2)

Statewide Dryland Durum - MSU **EARC, Sidney, MT 2019**

| Variety | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------------|-------------------------|----------------|-------------------------|
| Alkabo | 177 | 65.1 | 12.8 | 91.5 |
| Alzada | 175 | 64.0 | 13.4 | 71.0 |
| Carpio | 179 | 65.6 | 12.0 | 68.0 |
| Divide | 177 | 64.9 | 11.1 | 80.4 |
| Dynamic | 180 | 65.0 | 12.1 | 82.1 |
| Fortitude | 177 | 65.3 | 12.0 | 83.4 |
| Grano | 178 | 66.2 | 12.8 | 84.7 |
| Grenora | 177 | 64.2 | 13.1 | 84.6 |
| Joppa | 176 | 65.1 | 12.4 | 73.5 |
| Mountrail | 177 | 65.1 | 11.7 | 80.6 |
| MTD16001 | 178 | 64.2 | 10.9 | 68.4 |
| MTD16002 | 179 | 65.0 | 13.0 | 88.5 |
| MTD16004 | 178 | 65.8 | 12.6 | 78.0 |
| MTD16005 | 178 | 64.9 | 12.5 | 92.8 |
| MTD16006 | 177 | 64.9 | 12.7 | 77.8 |
| MTD16007 | 177 | 65.2 | 12.6 | 80.5 |
| MTD16008 | 177 | 64.0 | 12.4 | 81.5 |
| MTD16009 | 178 | 62.6 | 12.4 | 75.7 |
| MTD16010 | 178 | 65.8 | 13.1 | 74.9 |
| MTD16011 | 178 | 64.6 | 12.4 | 85.8 |
| Precision | 177 | 65.1 | 13.1 | 79.6 |
| Riveland | 178 | 65.0 | 12.8 | 73.5 |
| Tioga | 178 | 64.7 | 14.0 | 78.8 |
| Vivid | 178 | 65.6 | 13.6 | 93.8 |
| Mean | 178 | 64.9 | 12.6 | 80.4 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | 0.12 |
| CV (%) | 0.54 | 0.49 | 6.45 | 12.5 |
| LSD (0.05) | 1.57 | 0.53 | 1.33 | 16.5 |

Planted: 4/18/19 Previous crop: Fallow
 Harvested: 8/21/19 Soil Type: William Clay Loam
 (Julian*) is a continuous count of days since January 1 Plot Width: 5 ft.
 † Test weight and grain yield adjusted to 12.0% moisture Precipitation (2019): 21.5"
 Soil Test N Avail (lb/ac): 39 Soil Test P2O5 (ppm): 31
 N added (lb/ac): 60 P2O5 added (lb/ac): 20

Statewide Irrigated Durum - MSU **EARC, Sidney, MT 2019**

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|------------------------------|-------------------------|----------------|-------------------------|
| Alkabo | 37.1 | 183 | 62.3 | 15.8 | 90.0 |
| Alzada | 29.5 | 180 | 61.2 | 15.6 | 70.6 |
| Carpio | 38.8 | 186 | 62.9 | 16.1 | 94.6 |
| Divide | 37.4 | 185 | 62.4 | 16.4 | 84.1 |
| Dynamic | 38.7 | 186 | 63.2 | 16.8 | 92.8 |
| Fortitude | 34.6 | 184 | 61.4 | 16.4 | 88.8 |
| Grano | 38.2 | 186 | 63.3 | 15.9 | 95.7 |
| Grenora | 34.9 | 183 | 61.6 | 16.0 | 85.9 |
| Joppa | 38.1 | 184 | 62.4 | 16.0 | 81.4 |
| Mountrail | 38.6 | 184 | 62.2 | 16.3 | 92.3 |
| MTD16001 | 37.1 | 186 | 61.4 | 15.7 | 81.9 |
| MTD16002 | 40.6 | 186 | 61.8 | 16.5 | 80.4 |
| MTD16004 | 38.5 | 183 | 61.4 | 15.6 | 83.5 |
| MTD16005 | 38.2 | 186 | 62.3 | 16.3 | 90.0 |
| MTD16006 | 39.2 | 184 | 60.9 | 16.3 | 83.4 |
| MTD16007 | 37.9 | 185 | 62.2 | 16.1 | 87.9 |
| MTD16008 | 37.8 | 183 | 61.0 | 15.9 | 95.1 |
| MTD16009 | 39.8 | 185 | 60.3 | 16.1 | 91.3 |
| MTD16010 | 39.1 | 185 | 62.4 | 16.4 | 84.5 |
| MTD16011 | 39.4 | 185 | 62.0 | 15.6 | 92.3 |
| Precision | 36.9 | 183 | 62.1 | 16.2 | 91.1 |
| Riveland | 40.0 | 184 | 63.1 | 15.6 | 94.6 |
| Tioga | 39.4 | 183 | 61.9 | 16.5 | 85.0 |
| Vivid | 36.2 | 184 | 62.9 | 16.5 | 92.9 |
| Mean | 37.8 | 188 | 62.0 | 16.1 | 87.9 |
| P-Value | <0.0001 | 0.46 | <0.0001 | 0.11 | 0.0016 |
| CV (%) | 2.39 | 18.8 | 0.62 | 3.06 | 7.11 |
| LSD (0.05) | 1.49 | 58.2 | 0.64 | 0.81 | 10.3 |

Planted: 5/6/19 Previous crop: Sugarbeet
 Harvested: 8/26/19 Soil Type: William Clay Loam
 (Julian*) is a continuous count of days since January 1 Plot Width: 5 ft.
 † Test weight and grain yield adjusted to 12.0% moisture Precipitation (2019): 22.5"
 Soil Test N Avail (lb/ac): 25 Soil Test P2O5 (ppm): 25
 N added (lb/ac): 100 P2O5 added (lb/ac): 30

Evaluation of Recrop Durum - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield‡ (bu/ac) |
|------------|------------------------|------------------------------|-------------------------|----------------|-------------------------|
| Alkabo | 36.5 | 178 | 65.1 | 11.9 | 73.6 |
| Alzada | 33.7 | 177 | 64.2 | 12.4 | 64.6 |
| Carpio | 30.7 | 177 | 64.0 | 12.4 | 66.3 |
| Divide | 33.7 | 181 | 65.9 | 11.8 | 75.5 |
| Dynamic | 32.5 | 178 | 62.3 | 14.6 | 64.5 |
| Fortitude | 33.9 | 179 | 65.6 | 13.9 | 63.5 |
| Grano | 33.5 | 179 | 64.6 | 11.7 | 60.3 |
| Grenora | 36.7 | 179 | 65.1 | 13.0 | 65.9 |
| Joppa | 34.6 | 178 | 65.5 | 12.1 | 67.6 |
| Mountrail | 34.4 | 177 | 65.5 | 12.7 | 62.5 |
| MTD16001 | 34.1 | 181 | 66.4 | 12.9 | 67.4 |
| MTD16002 | 26.5 | 175 | 63.4 | 13.2 | 39.7 |
| MTD16004 | 32.4 | 180 | 64.9 | 13.6 | 50.3 |
| MTD16005 | 32.3 | 177 | 64.8 | 13.3 | 62.2 |
| MTD16006 | 31.2 | 177 | 65.1 | 13.5 | 52.3 |
| MTD16007 | 32.7 | 178 | 64.2 | 11.7 | 59.0 |
| MTD16008 | 32.7 | 178 | 65.6 | 13.1 | 56.6 |
| MTD16009 | 37.6 | 179 | 65.6 | 11.1 | 74.7 |
| MTD16010 | 34.6 | 179 | 65.6 | 12.0 | 68.0 |
| MTD16011 | 36.5 | 181 | 64.7 | 11.6 | 68.5 |
| Precision | 31.9 | 179 | 65.1 | 14.6 | 62.5 |
| Riveland | 34.5 | 177 | 65.0 | 11.6 | 64.7 |
| Tioga | 34.3 | 178 | 64.7 | 12.5 | 64.8 |
| Vivid | 30.1 | 179 | 65.0 | 14.3 | 59.6 |
| Mean | 33.4 | 178 | 64.9 | 12.8 | 62.9 |
| P-Value | 0.0047 | <0.0001 | <0.0001 | 0.0021 | 0.29 |
| CV (%) | 7.62 | 0.75 | 0.64 | 8.09 | 18.90 |
| LSD (0.05) | 4.27 | 2.24 | 0.69 | 1.73 | 20.0 |

Planted: 4/19/19

Harvested: 8/22/19

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 22

N added (lb/ac): 60

Previous crop: Pea

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 29

P₂O₅ added (lb/ac): 20



EARC Field Day attendees loading on trailers for the morning field tour

Dryland Uniform Regional Durum - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|------------------------------|-------------------------|----------------|-------------------------|
| ALKABO | 33.1 | 179 | 65.1 | 13.4 | 92.7 |
| CARPIO | 34.1 | 180 | 66.2 | 13.1 | 94.5 |
| D09555 | 32.8 | 177 | 65.8 | 13.3 | 92.2 |
| D111068 | 32.4 | 180 | 66.3 | 12.7 | 102.6 |
| D13500 | 34.4 | 179 | 65.8 | 13.4 | 94.6 |
| D13720 | 38.1 | 180 | 65.9 | 13.4 | 103.7 |
| D13750 | 36.7 | 179 | 65.6 | 13.4 | 90.2 |
| D13899 | 37.5 | 180 | 66.0 | 13.1 | 98.9 |
| D14053 | 36.0 | 179 | 65.5 | 13.8 | 99.9 |
| D14056 | 35.3 | 177 | 65.6 | 13.2 | 83.6 |
| D141103 | 36.2 | 179 | 66.2 | 14.5 | 97.6 |
| D14115 | 34.8 | 179 | 66.1 | 13.6 | 92.0 |
| D14935 | 34.1 | 179 | 65.4 | 12.0 | 97.3 |
| D15051 | 33.5 | 178 | 65.9 | 13.6 | 93.9 |
| D151012 | 33.1 | 177 | 65.5 | 13.5 | 97.9 |
| D15115 | 34.1 | 180 | 65.1 | 13.4 | 89.7 |
| D151190 | 35.7 | 179 | 65.6 | 13.1 | 95.4 |
| D15262 | 36.4 | 179 | 65.7 | 14.3 | 83.4 |
| D15428 | 35.3 | 179 | 65.3 | 14.0 | 89.0 |
| D15574 | 37.0 | 178 | 64.8 | 13.3 | 98.3 |
| D15677 | 33.2 | 178 | 64.7 | 13.2 | 95.9 |
| D15739 | 33.7 | 179 | 66.3 | 13.2 | 88.2 |
| D15838 | 35.6 | 178 | 65.0 | 13.5 | 94.6 |
| D15841 | 35.4 | 179 | 65.5 | 14.2 | 100.4 |
| D15935 | 36.4 | 179 | 65.5 | 11.9 | 100.6 |
| D15937 | 33.2 | 179 | 65.3 | 13.0 | 85.3 |
| D15946 | 33.2 | 179 | 66.0 | 13.0 | 94.7 |
| DIVIDE | 35.0 | 177 | 65.4 | 13.1 | 92.0 |
| JOPPA | 32.5 | 179 | 65.4 | 13.3 | 89.0 |
| MOUNTRAIL | 33.7 | 178 | 65.7 | 12.9 | 98.1 |
| NDGRANO | 32.0 | 179 | 66.1 | 13.4 | 92.4 |
| NDRIVELAND | 35.3 | 179 | 65.0 | 14.3 | 92.2 |
| Mean | 34.7 | 179 | 65.6 | 13.3 | 94.1 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0004 | <0.0022 |
| CV (%) | 4.29 | 0.34 | 0.59 | 4.41 | 6.20 |
| LSD (0.05) | 2.43 | 1.16 | 0.63 | 0.96 | 9.60 |

Planted: 4/19/19

Harvested: 8/21/19

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 39

N added (lb/ac): 60

Previous crop: Fallow

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 31

P₂O₅ added (lb/ac): 20

Roosevelt County Dryland Durum - MSU

Poplar, MT 2019

| Variety | Plant Height (inch) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|-------------------------|----------------|-------------------------|
| Alkabo | 32.9 | 64.9 | 12.6 | 76.3 |
| Alzada | 24.8 | 62.4 | 12.9 | 53.5 |
| Carpio | 34.5 | 64.4 | 13.4 | 86.3 |
| Divide | 31.1 | 64.1 | 14.0 | 75.8 |
| Dynamic | 34.3 | 63.3 | 13.8 | 81.8 |
| Fortitude | 30.8 | 62.8 | 13.6 | 80.3 |
| Grano | 35.2 | 64.9 | 13.2 | 81.4 |
| Grenora | 28.2 | 63.4 | 12.0 | 69.3 |
| Joppa | 32.8 | 64.8 | 12.9 | 78.6 |
| Mountrail | 31.6 | 64.1 | 13.1 | 78.0 |
| MTD16001 | 32.7 | 62.5 | 13.0 | 78.4 |
| MTD16002 | 34.6 | 63.8 | 13.6 | 79.7 |
| MTD16004 | 32.2 | 65.4 | 13.2 | 78.8 |
| MTD16005 | 33.9 | 63.4 | 13.6 | 78.7 |
| MTD16006 | 34.1 | 64.7 | 13.2 | 71.7 |
| MTD16007 | 32.4 | 64.2 | 13.1 | 74.2 |
| MTD16008 | 32.8 | 62.7 | 14.0 | 82.1 |
| MTD16009 | 32.5 | 59.4 | 14.8 | 72.5 |
| MTD16010 | 33.7 | 64.7 | 13.5 | 76.0 |
| MTD16011 | 32.7 | 63.0 | 13.9 | 75.4 |
| Precision | 32.2 | 63.8 | 13.8 | 81.1 |
| Riveland | 35.3 | 63.9 | 13.5 | 84.2 |
| Tioga | 36.1 | 64.3 | 12.9 | 78.9 |
| Vivid | 34.9 | 64.1 | 14.0 | 88.0 |
| Mean | 32.8 | 63.7 | 13.4 | 77.5 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 4.92 | 0.84 | 2.67 | 7.74 |
| LSD (0.05) | 2.65 | 0.88 | 0.59 | 9.87 |

Planted: 4/23/19

Previous crop: Fallow

Harvested: 8/28/19

Plot Width: 5 ft.

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Sheridan County Dryland Durum - MSU

Dagmar, MT 2019

| Variety | Plant Height (inch) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|-------------------------|----------------|-------------------------|
| Alkabo | 37.4 | 64.3 | 13.4 | 64.8 |
| Alzada | 26.4 | 61.5 | 13.1 | 37.9 |
| Carpio | 36.1 | 64.2 | 13.0 | 65.2 |
| Divide | 34.4 | 63.4 | 14.1 | 57.0 |
| Dynamic | 37.7 | 63.7 | 15.3 | 65.6 |
| Fortitude | 36.1 | 62.9 | 14.6 | 64.0 |
| Grano | 36.6 | 64.2 | 13.7 | 62.2 |
| Grenora | 33.2 | 62.8 | 14.6 | 57.7 |
| Joppa | 37.3 | 63.9 | 13.4 | 61.7 |
| Mountrail | 35.6 | 63.4 | 13.9 | 60.4 |
| MTD16001 | 32.9 | 62.2 | 13.9 | 52.4 |
| MTD16002 | 38.1 | 63.5 | 14.0 | 66.8 |
| MTD16004 | 31.4 | 64.6 | 13.7 | 60.8 |
| MTD16005 | 35.3 | 63.3 | 14.1 | 62.6 |
| MTD16006 | 36.5 | 63.3 | 12.8 | 50.9 |
| MTD16007 | 34.5 | 64.4 | 14.0 | 63.4 |
| MTD16008 | 37.7 | 62.7 | 14.4 | 65.1 |
| MTD16009 | 34.3 | 59.8 | 15.0 | 50.5 |
| MTD16010 | 33.7 | 64.1 | 13.8 | 50.5 |
| MTD16011 | 36.7 | 63.6 | 14.1 | 59.4 |
| Precision | 35.6 | 63.8 | 15.1 | 66.1 |
| Riveland | 36.2 | 64.2 | 13.3 | 61.2 |
| Tioga | 38.8 | 63.7 | 14.2 | 64.4 |
| Vivid | 37.9 | 63.7 | 14.7 | 67.8 |
| Mean | 35.5 | 63.4 | 14.0 | 60.2 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 4.51 | 0.90 | 2.24 | 7.69 |
| LSD (0.05) | 2.72 | 0.96 | 0.53 | 7.93 |

Planted: 4/24/19

Previous crop: Lentil

Harvested: 8/29/19

Plot Width: 5 ft.

(Julian*) is a continuous count of days since January 1

N added (lb/ac): 60

† Test weight and grain yield adjusted to 12.0% moisture

P2O5 added (lb/ac): 20

HARD RED WINTER WHEAT VARIETY DESCRIPTIONS

| VARIETY | ORIGIN ¹ | YEAR RELEASED | HEIGHT | MATURITY | WINTER HARDINESS ³ | RESISTANCE TO ² | | | QUALITY FACTORS | | |
|---------------|---------------------|---------------|---------|----------|-------------------------------|----------------------------|-----------|-----------|-----------------|-------------|---------------|
| | | | | | | LODGING | STEM RUST | LEAF RUST | FOLIAR DISEASE | TEST WEIGHT | GRAIN PROTEIN |
| AAC GATEWAY | CANADA | 2012 | M SHORT | MEDIUM | GOOD | R | R | R | NA | MEDIUM | MEDIUM |
| AAC GOLDRUSH | CANADA | 2017 | MEDIUM | MEDIUM | GOOD | NA | MR | R | M | NA | NA |
| AAC WILDFIRE | CANADA | 2015 | MEDIUM | MEDIUM | GOOD | NA | M | MS | NA | NA | NA |
| ACCIPITER | CANADA | 2008 | SHORT | MEDIUM | GOOD | R | R | MS | S | MEDIUM | MEDIUM |
| BEARPAW* | MT | 2011 | M SHORT | MEDIUM | FAIR | R | R | S | NA | MEDIUM | LOW |
| BRAWL CL PLUS | CO | 2011 | SHORT | EARLY | FAIR | NA | NA | NA | NA | M HIGH | M HIGH |
| BROADVIEW | CANADA | 2009 | MEDIUM | MEDIUM | GOOD | R | R | R | NA | MEDIUM | MEDIUM |
| CDC CHASE | CANADA | 2013 | MEDIUM | MEDIUM | GOOD | M | R | MR | R | M HIGH | MEDIUM |
| DECADE | MT/NDSU | 2010 | MEDIUM | M EARLY | GOOD | R | R | S | M | MEDIUM | MEDIUM |
| DENALI | CO/KSU | 2011 | MEDIUM | M LATE | NA | NA | MR | S | NA | MEDIUM | M HIGH |
| EMERSON | CANADA | 2011 | SHORT | MEDIUM | GOOD | NA | R | MS | NA | M HIGH | MEDIUM |
| FLOURISH | CANADA | 2010 | SHORT | EARLY | GOOD | R | MR | R | NA | MEDIUM | M LOW |
| FOUR OSIX | MT | 2018 | MEDIUM | MEDIUM | FAIR | NA | MR | MR | NA | M HIGH | M HIGH |
| IDEAL | SDSU | 2011 | SHORT | MEDIUM | GOOD | R | MR | MR | MS | MEDIUM | MEDIUM |
| KELDIN | WB | 2011 | SHORT | MEDIUM | GOOD | NA | MR | MR | MR | NA | NA |
| JERRY | NDSU | 2001 | MEDIUM | MEDIUM | GOOD | MR | R | MR | M | MEDIUM | M HIGH |
| JUDEE* | MT | 2011 | MEDIUM | MEDIUM | FAIR | R | S | S | NA | MEDIUM | M HIGH |
| LOMA | MT | 2016 | MEDIUM | M LATE | GOOD | NA | R | NA | NA | MEDIUM | MEDIUM |
| LYMAN | SDSU | 2008 | MEDIUM | MEDIUM | FAIR | M | R | R | MR | M HIGH | M HIGH |
| MOATS | CANADA | 2010 | MEDIUM | MEDIUM | GOOD | MS | R | MR | NA | M HIGH | MEDIUM |
| NORTHERN | MT | 2015 | M SHORT | M LATE | FAIR | NA | R | NA | NA | MEDIUM | MEDIUM |
| OVERLAND | NE | 2006 | M TALL | MEDIUM | FAIR | MS | MS | MR | NA | M HIGH | MEDIUM |
| PEREGRINE | CANADA | 2008 | MEDIUM | M LATE | V GOOD | MR | R | MR | NA | M HIGH | M LOW |
| RAY** | MT | 2019 | M TALL | M LATE | GOOD | MR | R | NA | NA | MEDIUM | MEDIUM |
| REDFIELD | SD | 2013 | SHORT | MEDIUM | FAIR | R | S | MS | NA | M HIGH | MEDIUM |
| SY MONUMENT | AGRIPRO | 2015 | M SHORT | MEDIUM | FAIR | NA | MR | MR | NA | M LOW | MEDIUM |
| SY SUNRISE | AGRIPRO | 2015 | SHORT | MEDIUM | GOOD | NA | NA | NA | NA | NA | NA |
| SY WOLF | AGRIPRO | 2010 | M SHORT | MEDIUM | POOR | R | R | MR | MR | HIGH | M LOW |
| TCG BOOMLOCK | TCG | 2019 | MEDIUM | MEDIUM | FAIR | NA | NA | NA | NA | MEDIUM | M HIGH |
| THOMPSON | SD | 2017 | MEDIUM | M EARLY | NA | R | MR | MR | NA | NA | NA |
| WARHORSE | MT | 2013 | SHORT | M LATE | FAIR | MR | R | S | NA | MEDIUM | MEDIUM |
| WB 4614 | WB | 2013 | MEDIUM | MEDIUM | GOOD | NA | NA | NA | NA | M HIGH | MEDIUM |
| WB4483 | WB | 2016 | M SHORT | LATE | GOOD | NA | MS | MR | MR | MEDIUM | M LOW |
| WB4575 | WB | 2016 | M SHORT | MEDIUM | NA | NA | NA | NA | NA | MEDIUM | M LOW |
| WB-MATLOCK | WB | 2010 | MEDIUM | MEDIUM | GOOD | MR | R | MS | MS | MEDIUM | MEDIUM |
| WB-QUAKE* | WB | 2011 | MEDIUM | LATE | FAIR | MR | NA | MR | NA | M LOW | M LOW |
| YELLOWSTONE | MT | 2005 | MEDIUM | MEDIUM | GOOD | M | S | MS | M | LOW | M HIGH |

¹REFERS TO DEVELOPER: CANADA REPRESENTS DEVELOPERS FROM THAT COUNTRY; MT = MONTANA STATE UNIVERSITY; NDSU = NORTH DAKOTA STATE UNIVERSITY; NE = UNIVERSITY OF NEBRASKA; TCG = 21ST CENTURY GENETICS; SDSU = SOUTH DAKOTA STATE UNIVERSITY; WB = WESTBRED.

²M = INTERMEDIATE; MR = MODERATELY RESISTANT; MS = MODERATELY SUSCEPTIBLE; NA = DATA NOT AVAILABLE; R = RESISTANT, S = SUSCEPTIBLE.

³VARIETIES WITH FAIR TO POOR WINTER HARDINESS SHOULD NOT BE SEEDED ON BARE SOIL.

*SAWFLY RESISTANT. **DUAL PURPOSE-GRAIN/FORAGE

HARD WHITE WINTER WHEAT VARIETY DESCRIPTIONS

| VARIETY | ORIGIN ¹ | YEAR RELEASED | HEIGHT | MATURITY | WINTER HARDINESS ³ | RESISTANCE TO ² | | | QUALITY FACTORS | | |
|-------------|---------------------|---------------|---------|----------|-------------------------------|----------------------------|-----------|-----------|-----------------|-------------|---------------|
| | | | | | | LODGING | STEM RUST | LEAF RUST | FOLIAR DISEASE | TEST WEIGHT | GRAIN PROTEIN |
| ALICE | SDSU | 2006 | SHORT | EARLY | FAIR | MR | MR | S | NA | M HIGH | M LOW |
| GARY | ID | 2001 | MEDIUM | M LATE | FAIR | MR | NA | NA | NA | MEDIUM | LOW |
| HYALITE* | MT/WB | 2005 | M SHORT | M EARLY | FAIR | MR | R | S | NA | MEDIUM | MEDIUM |
| NU DAKOTA | AGRIPRO | 2007 | SHORT | MEDIUM | POOR | R | MR | MR | NA | MEDIUM | MEDIUM |
| NU FRONTIER | GM/AGRIPRO | NA | M SHORT | EARLY | FAIR | R | NA | NA | NA | M HIGH | LOW |
| NU HORIZON | GM/AGRIPRO | NA | SHORT | EARLY | POOR | R | NA | NA | NA | HIGH | M LOW |
| NU SKY | MSU | 2001 | MED | M LATE | GOOD | R | MR | S | MR | MEDIUM | MEDIUM |
| NU WEST | MSU/GM | 1994 | MED | MEDIUM | GOOD | R | MR | S | MR | M LOW | MEDIUM |
| WENDY | SDSU | 2004 | SHORT | EARLY | GOOD | NA | NA | NA | NA | MEDIUM | MEDIUM |

¹REFERS TO DEVELOPER: GM = GENERAL MILLS; ID = UNIVERSITY OF IDAHO; MT = MONTANA STATE UNIVERSITY; SDSU = SOUTH DAKOTA STATE UNIVERSITY; WB = WESTBRED.

²R = RESISTANT, MR = MODERATELY RESISTANT; S = SUSCEPTIBLE; NA = DATA NOT AVAILABLE.

³VARIETIES WITH FAIR TO POOR WINTER HARDINESS SHOULD NOT BE SEEDED ON BARE SOIL.

*CLEARFIELD WHEAT WITH IMIDAZOLINONE TOLERANCE.

Winter Wheat Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Plant height | Days to heading | Protein [†] | Winter Survival | Test weight | Yield [#] | | |
|---------------|--------------|-----------------|----------------------|-----------------|-------------|--------------------|----------|----------|
| | | | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| | (in) | (julian) | (%) | (%) | (lb/bu) | ------(bu/a)----- | | |
| Peregrine | 21.3 | 162.7 | 16.0 | 73.3 | 60.8 | 63.4 | 54.8 | 54.8 |
| Ideal | 23.1 | 163.7 | 16.0 | 61.7 | 60.3 | 63.7 | 52.2 | 52.2 |
| Jerry | 22.0 | 163.7 | 16.6 | 66.7 | 59.8 | 57.2 | 49.5 | 49.5 |
| Loma | 22.3 | 166.0 | 15.9 | 61.7 | 60.4 | 63.5 | 48.4 | 48.4 |
| SY Monument | 19.3 | 160.7 | 16.8 | 76.7 | 60.4 | 57.6 | 48.1 | 48.1 |
| Northern | 19.4 | 163.3 | 16.8 | 68.3 | 60.8 | 59.0 | 46.1 | 46.1 |
| AC Emerson | 26.9 | 163.7 | 16.5 | 68.3 | 61.3 | 55.6 | 45.5 | 45.5 |
| Keldin | 20.7 | 161.0 | 16.1 | 71.7 | 61.4 | 59.3 | 44.9 | 44.9 |
| SY Wolf | 20.7 | 161.0 | 17.7 | 70.0 | 61.7 | 57.3 | 39.4 | 39.4 |
| Oahe | 20.3 | 161.3 | 17.3 | 70.0 | 61.0 | 57.3 | 39.3 | 39.3 |
| Overland-Fhb1 | 21.5 | 160.0 | 18.6 | 73.3 | 59.0 | 50.0 | 37.4 | 37.4 |
| Thompson | 20.9 | 161.0 | 17.7 | 74.2 | 60.1 | 56.9 | 52.1 | - |
| NHH1444913-3 | 20.1 | 159.7 | 18.5 | 68.3 | 59.1 | 49.8 | 46.7 | - |
| WB4595 | 22.8 | 162.7 | 16.7 | 68.3 | 62.7 | 61.6 | - | - |
| 14Nord-01 | 21.9 | 162.3 | 16.3 | 70.0 | 61.2 | 59.9 | - | - |
| Ray | 24.3 | 165.0 | 16.0 | 76.7 | 59.6 | 53.8 | - | - |
| WB4462 | 23.2 | 159.0 | 16.7 | 70.0 | 61.1 | 54.2 | - | - |
| Decade-Fhb1 | 20.1 | 160.5 | 18.6 | 70.0 | 60.8 | 53.0 | - | - |
| TCG-Boomlock | 17.1 | 161.3 | 18.5 | 46.7 | 60.7 | 44.5 | - | - |
| Mean | 21.5 | 162.0 | 17.0 | 69.4 | 60.7 | 57.5 | - | - |
| CV (%) | 8.2 | 0.8 | 6.9 | 10.7 | 0.9 | 8.7 | - | - |
| LSD (5%) | 2.9 | 2.1 | 1.9 | 12.3 | 0.9 | 8.3 | - | - |
| LSD (10%) | 2.4 | 1.7 | 1.6 | 10.2 | 0.8 | 6.9 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Previous crop: soybeans

Planted: 09/26/2018

Harvested: 8/14/2019

Soil test to 6" in ppm: P=23 ppm K=369 ppm OM=2.8% pH=5.1

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=96 lb/a

Applied fertilizers in lb/a: N=7.2; P=24; K=0; S=6; Zn=0.6 (60 lbs. of MESZ with seed)

[†]Protein adjusted to 12% moisture.

[#]Yield reported on a 13.5% moisture basis.

¹DAP = Days after planting.

Herbicide Application: Goldsky @ 1 pt/a (5/19/2019)

Winter Wheat Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Winter Survival (%) | Days to Head (Julian [†]) | Plant Lodge (0 - 9 ⁺) | Plant Height (in) | Protein† | | | Test Weight | | | Yield | | |
|--------------|---------------------|-------------------------------------|-----------------------------------|-------------------|----------|---------------------------|---------------------------|--------------|-------------|------------------------------|------------------------------|--|--|
| | | | | | 2019 (%) | 2-Yr Avg [‡] (%) | 3-Yr Avg [§] (%) | 2019 (lb/bu) | 2019 (bu/a) | 2-Yr Avg [‡] (bu/a) | 3-Yr Avg [§] (bu/a) | | |
| Peregrine | 97 | 165 | 1 | 34 | 12.2 | 11.2 | 11.7 | 62.6 | 113.3 | 123.6 | 119.3 | | |
| Accipiter | 96 | 167 | 0 | 31 | 12.4 | 11.2 | 11.7 | 62.3 | 112.5 | 124.4 | 117.2 | | |
| Decade | 80 | 164 | 0 | 28 | 15.0 | 12.7 | 12.9 | 61.8 | 98.0 | 117.0 | 111.0 | | |
| Northern | 94 | 168 | 1 | 30 | 13.2 | 11.9 | 12.4 | 61.7 | 112.2 | 112.7 | 109.3 | | |
| Jerry | 98 | 164 | 0 | 33 | 14.4 | 12.0 | 12.5 | 61.3 | 97.8 | 102.9 | 99.7 | | |
| Cahe | 99 | 163 | 0 | 27 | 15.0 | 13.1 | - | 60.9 | 97.6 | 115.9 | - | | |
| Ideal | 92 | 164 | 1 | 26 | 13.6 | 11.5 | - | 62.7 | 95.7 | 115.2 | - | | |
| SY Wolf | 99 | 164 | 0 | 28 | 13.9 | 12.6 | - | 61.7 | 94.7 | 112.6 | - | | |
| AC Broadview | 84 | 164 | 1 | 29 | 13.6 | 11.8 | - | 62.2 | 81.2 | 106.7 | - | | |
| WB Matlock | 99 | 166 | 0 | 31 | 15.0 | 13.8 | - | 62.1 | 103.2 | 104.7 | - | | |
| AC Gateway | 68 | 168 | 0 | 29 | 13.9 | 12.8 | - | 62.2 | 81.7 | 100.7 | - | | |
| Yellowstone | 95 | 165 | 1 | 31 | 12.8 | - | - | 61.1 | 113.1 | - | - | | |
| CDC Chase | 85 | 166 | 1 | 34 | 13.0 | - | - | 62.8 | 108.5 | - | - | | |
| FourSix | 98 | 164 | 0 | 28 | 14.0 | - | - | 61.3 | 105.5 | - | - | | |
| Loma | 94 | 167 | 1 | 28 | 13.4 | - | - | 59.5 | 103.0 | - | - | | |
| AAC Wildfire | 97 | 168 | 1 | 31 | 13.4 | - | - | 61.2 | 100.3 | - | - | | |
| SY Monument | 98 | 164 | 0 | 27 | 13.3 | - | - | 60.9 | 99.5 | - | - | | |
| AAC Goldrush | 96 | 168 | 0 | 32 | 12.9 | - | - | 61.9 | 96.9 | - | - | | |
| Redfield | 99 | 162 | 1 | 27 | 14.1 | - | - | 62.7 | 96.7 | - | - | | |
| SY Sunrise | 98 | 163 | 1 | 21 | 15.4 | - | - | 61.4 | 60.5 | - | - | | |
| MEAN | 93.3 | 169.2 | 0.4 | 29.3 | 13.72 | 12.24 | 12.22 | 61.71 | 98.60 | 112.40 | 111.31 | | |
| C.V. (%) | 14.5 | 0.7 | - | 4.9 | 6.95 | - | - | 1.32 | 16.43 | - | - | | |
| LSD (5%) | 19.1 | 1.5 | 0.8 | 2.0 | 1.35 | - | - | 1.16 | 22.94 | - | - | | |
| LSD (10%) | 16.0 | 1.3 | 0.7 | 1.7 | 1.13 | - | - | 0.96 | 19.15 | - | - | | |

+ Days after January 1, 2018 * 0: no lodging - 9: plants lying flat on the ground † Protein content adjusted to 12% moisture

‡ 2-Yr average from 2017 and 2019 § 3-Yr average from 2016, 2017, and 2019

Location: Latitude 48.9, 9222'N; Longitude 103.6, 132'W

Soil test (0-6 in.): P=22 ppm; K=177 ppm; pH=7.9; OM=2.2%

(0-24 in.) NO3-N=25 lb/a

Yield goal: 100 bu/a

Planting population: 1.5 million seeds/a

Applied fertilizer: 385 lb/a of Urea (46-0-0) [4/18]

Herbicides applied: 2,4-D 1.5 pt/a, Tallor 14 oz/a, Tacoma .66 pt/a, and Goldsky 0.5 pt/a (6/5)

Fungicides applied: Tilt 4 oz/a (6/5) and Prostaro 421 8 oz/a (7/2)

Elevation: 1902 ft

Previous crop: Field Pea

Planted: 9/11/2018

Harvested: 8/2/2019

Soil type: Lihen Loamy Fine Sand

Plot size: 92 ft²

Rainfall: 8.2 in (1/1 - 8/2)

Dryland Intrastate Winter Wheat Evaluation-MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield‡ (bu/ac) |
|-------------------|--------------------------------|--------------------------------------|---------------------------------|------------------------|---------------------------------|
| 08BC379-40-1 | 24.3 | 160 | 61.7 | 15.3 | 25.2 |
| AAC Wildfire | 30.1 | 168 | 64.5 | 13.1 | 87.8 |
| ASC107 | 21.0 | 162 | N/A | 14.9 | 5.4 |
| ASC116 | 23.9 | 157 | 59.2 | 17.9 | 20.4 |
| ASC122 | 22.0 | 164 | 61.3 | 15.4 | 15.3 |
| Brawl CLP | 26.1 | 157 | 63.4 | 15.8 | 35.3 |
| Byrd CL Plus | 28.9 | 161 | 63.0 | 12.8 | 50.6 |
| Canvas | 26.5 | 161 | 64.9 | 13.9 | 46.2 |
| Decade | 30.4 | 162 | 63.3 | 14.6 | 68.0 |
| FourOsix | 27.0 | 163 | 62.8 | 14.1 | 63.9 |
| Incline AX | 27.2 | 164 | 60.9 | 12.9 | 47.7 |
| Judee | 28.9 | 162 | 65.2 | 13.9 | 80.1 |
| Keldin | 29.3 | 164 | 64.0 | 14.2 | 66.0 |
| LCS Chrome | 29.0 | 162 | 63.3 | 15.0 | 50.1 |
| LCS Jet | 23.6 | 164 | 59.5 | 13.0 | 74.7 |
| LCS Mint | 24.9 | 161 | 62.2 | 15.5 | 45.3 |
| Loma | 26.2 | 167 | 62.1 | 13.7 | 71.0 |
| Long Branch | 25.9 | 157 | 63.6 | 13.4 | 50.2 |
| LWW14-73915 | 24.7 | 163 | 58.0 | 13.8 | 50.1 |
| MT1564 | 27.0 | 159 | 64.1 | 13.7 | 65.8 |
| MT1642 | 29.7 | 165 | 61.5 | 13.3 | 67.6 |
| MT1683 | 29.8 | 164 | 62.4 | 13.2 | 78.0 |
| MT1745 | 28.7 | 164 | 63.8 | 12.9 | 86.9 |
| MT1746 | 25.3 | 163 | 64.1 | 13.4 | 69.3 |
| MT1747 | 25.7 | 162 | 63.3 | 13.8 | 52.2 |
| MT1750 | 25.6 | 164 | 62.7 | 13.8 | 45.6 |
| MT1773 | 26.2 | 163 | 63.7 | 13.2 | 69.9 |
| MT1782 | 28.3 | 163 | 64.0 | 15.1 | 59.1 |
| MT1787 | 24.3 | 165 | 63.0 | 14.3 | 67.8 |
| MT1793 | 28.7 | 161 | 63.3 | 15.1 | 64.4 |
| MT1796 | 28.3 | 161 | 63.4 | 16.4 | 62.8 |
| MTCL1732 | 26.2 | 164 | 62.9 | 12.9 | 64.2 |
| MTCL1737 | 25.9 | 165 | 62.6 | 13.4 | 75.3 |
| MTCS1601 | 28.7 | 165 | 64.5 | 14.0 | 78.5 |
| MTS1588 | 26.2 | 165 | 64.2 | 13.4 | 64.5 |
| MTS1731(w) | 26.1 | 162 | 63.7 | 14.3 | 67.3 |
| MTW1491 | 31.1 | 164 | 63.6 | 12.6 | 86.3 |
| Northern | 28.2 | 166 | 63.3 | 13.7 | 85.6 |
| Oahe | 30.1 | 161 | 62.8 | 14.8 | 38.2 |
| Ray | 31.1 | 169 | 60.1 | 14.0 | 63.9 |
| SY 517 CL2 | 24.3 | 157 | 63.5 | 16.0 | 26.0 |
| SY Clearstone 2CL | 28.2 | 164 | 63.0 | 13.3 | 72.9 |
| SY Legend CL2 | 26.0 | 162 | 63.0 | 14.3 | 38.2 |
| SY Monument | 24.0 | 161 | 60.9 | 14.1 | 38.2 |
| Warhorse | 28.7 | 165 | 62.7 | 15.8 | 52.8 |
| WB4269 | 22.7 | 160 | 63.2 | 14.2 | 33.5 |
| WB4311 | 24.0 | 161 | 63.0 | 15.7 | 44.8 |
| WB4418 | 25.6 | 158 | 62.6 | 13.1 | 40.2 |
| Yellowstone | 29.1 | 165 | 62.3 | 13.6 | 72.5 |
| Mean | 26.8 | 163 | 62.8 | 14.2 | 56.9 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 5.94 | 0.66 | 1.53 | 3.35 | 17.7 |
| LSD (0.05) | 2.58 | 1.74 | 1.57 | 0.77 | 16.3 |

Planted: 9/27/2018

Harvested: 8/6/2019

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 39

N added (lb/ac): 73

Previous crop: Fallow

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 31

P₂O₅ added (lb/ac): 21

Barley Variety Descriptions

| VARIETY | ORIGIN ¹ | USE ² | YEAR RELEASED | HEIGHT | MATURITY | LODGING | RESISTANCE TO ³ | | | | QUALITY FACTORS | |
|------------------|---------------------|------------------|---------------|---------|----------|---------|----------------------------|------------|------------|-------------|-----------------|---------------|
| | | | | | | | STEM RUST | LOOSE SMUT | NET BLOTCH | SPOT BLOTCH | TEST WEIGHT | GRAIN PROTEIN |
| Two-Row | | | | | | | | | | | | |
| AAC SYNERGY | SY | M/F | 2015 | M SHORT | M LATE | MR | MR | NA | MR | MR | NA | NA |
| ABI BALSTER | BARI | M/F | 2015 | M SHORT | MEDIUM | M | NA | NA | NA | NA | NA | NA |
| ABI GROWLER | BARI | M/F | 2015 | M SHORT | MEDIUM | MR | NA | NA | NA | S | NA | NA |
| AC METCALFE | CANADA | M | 1997 | MEDIUM | LATE | M | S | MR | MS | MS | MEDIUM | MEDIUM |
| CDC BOW | CANADA | M | 2019 | MEDIUM | LATE | MR | R | MS | MS | MR | HIGH | MEDIUM |
| CDC COPELAND | CANADA | M | 1999 | TALL | M LATE | MS | MR | S | MS | VS | LOW | MEDIUM |
| CDC MEREDITH | CANADA | M | 2008 | MEDIUM | LATE | M | MR | NA | MS | S | NA | NA |
| CELEBRATION | BARI | M/F | 2008 | M SHORT | MEDIUM | MR | S | NA | MS/S | MR/R | NA | NA |
| CHAMPION | WB | F | 1997 | MEDIUM | MEDIUM | MR | R | S | MR | NA | M LOW | MEDIUM |
| CONLON | NDSU | F/M | 1996 | M SHORT | EARLY | MS | S | S | MR | MS | M HIGH | M LOW |
| CONRAD | BARI | M | 2007 | M TALL | M LATE | MR | NA | S | NA | NA | M HIGH | M LOW |
| CRAFT | MT | F/M | | TALL | MEDIUM | MR | NA | S | S | NA | M HIGH | M HIGH |
| ESLICK | MT | F | 2003 | MEDIUM | M LATE | MS | S | NA | NA | MS | MEDIUM | M LOW |
| EXPLORER | SECOBRA | M | NA | M SHORT | M LATE | MR | NA | NA | MR | S | NA | NA |
| HAXBY | MT | F | 2003 | MEDIUM | MEDIUM | MS | S | S | S | MS | V HIGH | MEDIUM |
| HOCKETT | MT | F/F | 2008 | MEDIUM | MEDIUM | MS | S | S | NA | NA | MEDIUM | M HIGH |
| LCS GENIE | LIME | M | NA | SHORT | MEDIUM | MR | NA | NA | MS | S | NA | NA |
| LCS ODYSSEY | LIME | M/F | NA | SHORT | MEDIUM | M | NA | NA | NA | NA | NA | NA |
| ND GENESIS | NDSU | F/F | 2015 | MEDIUM | M LATE | MR | S | NA | MR | MR | HIGH | LOW |
| PINNACLE | NDSU | F/F | 2006 | MEDIUM | M LATE | MR | S | S | MS | MR | HIGH | LOW |
| SIRISH | SYNGENTA | M | NA | SHORT | M LATE | MR | S | S | MS | MS | MEDIUM | MEDIUM |
| Six-Row | | | | | | | | | | | | |
| CELEBRATION | BARI | F/M | 2008 | M SHORT | MEDIUM | R | S | S | MS/S | MR/R | MEDIUM | MEDIUM |
| INNOVATION | BARI | M | 2009 | M SHORT | MEDIUM | MR | S | S | MS/S | MR/R | MEDIUM | MEDIUM |
| LACEY | MN | F/M | 1999 | M SHORT | MEDIUM | MR | S | S | MS/S | MR/R | MEDIUM | MEDIUM |
| QUEST | MN | M | 2010 | M SHORT | MEDIUM | MS | S | S | MR | MR/R | M LOW | MEDIUM |
| STELLAR-ND | NDSU | F/M | 2005 | M SHORT | MEDIUM | R | S | S | MS/S | MR/R | MEDIUM | M LOW |
| TRADITION | BARI | F/M | 2003 | M SHORT | MEDIUM | R | S | S | MS/S | MR/R | MEDIUM | M LOW |
| SPECIALTY | | | | | | | | | | | | |
| HAYBET | MT | H | 1989 | TALL | MEDIUM | S | NA | S | NA | NA | LOW | MEDIUM |
| HAYS | MT | H | 2003 | M TALL | MEDIUM | MS | NA | NA | NA | NA | LOW | MEDIUM |

¹Refers to developer: BARI = Busch Ag Resources; Inc.; CANADA represents developers from that country; Lime = Limagrain; MN = University of Minnesota; MT = Montana State University; NDSU = North Dakota State University; SY = Syngenta; WB = WestBred.

²F = Feed; M = Malt.

³MR = Moderately resistant; M = Intermediate; MS = Moderately susceptible; NA = Not available; R = Resistant; S = Susceptible; VS = Very susceptible.

WREC Staff seeding
Cropping Sequence
Study



Barley Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Days to heading (DAP ¹) | Plant height (in) | Plumps (%) | Thins (%) | Protein [†] (%) | Test weight (lb/bu) | Yield [#] | | |
|----------------|--|----------------------|---------------|--------------|-----------------------------|------------------------|--------------------|-----------|------------|
| | | | | | | | 2019 | 2-Yr Avg* | 3-Yr Avg** |
| Two-Row | | | | | | | | | |
| ABI Balster | 63.3 | 25.7 | 87.3 | 1.6 | 10.1 | 52.6 | 106.4 | 83.9 | 75.0 |
| ND Genesis | 61.3 | 26.4 | 92.8 | 0.5 | 9.9 | 52.6 | 109.5 | 82.0 | 74.4 |
| Pinnacle | 63.0 | 27.8 | 95.9 | 0.5 | 10.0 | 54.0 | 109.4 | 83.6 | 73.2 |
| Explorer | 60.7 | 19.9 | 89.0 | 1.4 | 9.1 | 52.2 | 105.7 | 79.0 | 71.8 |
| Hockett | 63.0 | 28.0 | 86.7 | 1.6 | 10.0 | 54.2 | 99.0 | 74.1 | 70.3 |
| AAC Synergy | 62.5 | 25.7 | 94.5 | 0.7 | 11.5 | 52.2 | 75.7 | 71.3 | 66.6 |
| Conlon | 58.3 | 26.0 | 96.0 | 0.5 | 11.5 | 54.1 | 92.6 | 70.8 | 62.0 |
| CDC Bow | 61.0 | 25.0 | 93.5 | 0.7 | 10.3 | 53.0 | 97.9 | - | - |
| AAC Connect | 61.0 | 23.6 | 85.1 | 2.0 | 10.8 | 51.8 | 95.2 | - | - |
| Six-Row | | | | | | | | | |
| Lacey | 59.3 | 25.7 | 87.6 | 0.6 | 11.9 | 52.9 | 85.6 | 65.8 | 62.8 |
| Tradition | 62.0 | 24.8 | 88.7 | 0.7 | 11.9 | 52.6 | 73.4 | 63.5 | 61.1 |
| Mean | 60.8 | 25.0 | 91.9 | 0.9 | 10.7 | 52.9 | 99.2 | - | - |
| CV (%) | 3.1 | 6.9 | 1.5 | 23.1 | 6.4 | 1.0 | 8.9 | - | - |
| LSD (5%) | 3.1 | 2.9 | 2.2 | 0.4 | 1.1 | 0.9 | 14.7 | - | - |
| LSD (10%) | 2.6 | 2.4 | 1.8 | 0.3 | 0.9 | 0.7 | 12.2 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Previous crop: soybeans

Planted: 4/26/2019

Harvested: 8/9/2019

Soil test to 6" in ppm: P=24 ppm K=363 OM=2.0 pH=5.7

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=37.5 lb/a

Applied fertilizers in lb/a: N=57.2; P=24; K=0; S=6; Zn=0.6 (60 lbs of MESZ with seed, 108 lbs of Urea broadcast)

[†]Protein adjusted to 0% moisture.

[#]Yield reported on a 13.5% moisture basis.

*Averages of years 2018 and 2019. **Averages of years 2017, 2018, and 2019.

¹DAP = Days after planting.

Herbicide applications: Valor @ 3 oz/a with LV6 @ 1 pt/a (10/22/18) ; Supremacy @ 5 oz/a with Axial XL @ 16 oz/a (6/13/2019)



Jerry Bergman, WREC Director



Chengci Chen, EARC Superintendent

Barley Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Plant Height (in) | Days to Head (DAP*) | Lodging (0 - 9*) | Protein† | | | Test Weight (lb/bu) | Plump % >6/64 | Yield | | |
|----------------|----------------------|------------------------|---------------------|----------|--------------|--------------|------------------------|------------------|-------------|-----------------|-----------------|
| | | | | 2019 (%) | 2-Yr Avg (%) | 3-Yr Avg (%) | | | 2019 (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg (bu/a) |
| Six Row | | | | | | | | | | | |
| Tradition | 35 | 62 | 1 | 14.6 | 14.6 | 14.6 | 51.0 | 81 | 143.4 | 126.3 | 137.5 |
| Lacey | 37 | 61 | 0 | 15.1 | 14.8 | 14.7 | 52.3 | 82 | 142.7 | 126.0 | 134.7 |
| Celebration | 36 | 60 | 3 | 15.6 | 15.8 | 15.5 | 51.3 | 79 | 137.1 | 127.7 | 133.1 |
| Innovation | 36 | 71 | 4 | 14.5 | 14.8 | 14.8 | 51.9 | 91 | 127.4 | 123.6 | - |
| Two Row | | | | | | | | | | | |
| ABI Balster | 32 | 67 | 3 | 14.5 | 14.6 | 14.4 | 50.6 | 82 | 133.8 | 119.5 | 132.5 |
| AAC Synergy | 34 | 69 | 4 | 15.1 | 14.8 | 14.5 | 50.2 | 82 | 121.4 | 113.4 | 124.1 |
| Pinnacle | 36 | 62 | 2 | 13.6 | 13.5 | 13.3 | 52.3 | 92 | 139.8 | 120.0 | 122.9 |
| ND Genesis | 26 | 63 | 1 | 13.4 | 13.1 | 13.1 | 52.6 | 97 | 132.5 | 115.3 | 120.6 |
| Explorer | 29 | 66 | 1 | 14.2 | 14.6 | 14.6 | 50.7 | 84 | 138.5 | 106.9 | 119.4 |
| Hockett | 29 | 64 | 5 | 15.0 | 14.3 | 14.4 | 51.3 | 78 | 123.4 | 109.5 | 117.7 |
| Conlon | 32 | 59 | 1 | 14.3 | 14.4 | 14.6 | 53.8 | 98 | 111.6 | 99.5 | 111.8 |
| AAC Connect | 34 | 65 | 0 | 14.4 | 14.4 | 14.4 | 51.9 | 91 | 141.0 | - | - |
| MEAN | 32.9 | 64.0 | 2.0 | 14.54 | 14.49 | 14.42 | 51.64 | 86.0 | 131.97 | 117.07 | 125.43 |
| C.V. (%) | 13.6 | 2.1 | 99.9 | 4.08 | - | - | 2.22 | 8.4 | 9.28 | - | - |
| LSD (5%) | 6.4 | 2.0 | 2.7 | 0.85 | - | - | 1.65 | 10.4 | 17.72 | - | - |
| LSD (10%) | 5.4 | 1.6 | 2.2 | 0.71 | - | - | 1.37 | 8.7 | 14.74 | - | - |

* Days after planting + 0: no lodging - 9: plants lying flat on the ground † Protein content adjusted to 0% moisture

Location: Latitude 48 9.9222 N; Longitude 103 6.132 W

Soil test (0-6 in.): P=22 ppm; K=177 ppm; pH=7.9; OM=2.2%

(0-24 in.): NO3-N=25 lb/a

Yield goal: 120 bu/a

Planting population: 1.25 million seeds/a

Applied fertilizer: 265 lb/a of Urea (46-0-0) [4/18]

Herbicides applied: 2,4-D 1.5 p/a, Tallnor 14 oz/a, and Tacoma .66 p/a (6/5)

Fungicides applied: Tilt 4 oz/a (6/5) and Prostaro 421 8 oz/a (7/2)

Elevation: 1902 ft

Previous crop: Field Pea

Planted: 4/24/2019

Harvested: 8/14/2019

Soil type: Linen Loamy Fine Sand

Plot size: 92 ftx2

Rainfall: 9.4 inches (4/24 - 8/14)

Dryland Intrastate Barley Evaluation - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Plump >6/64 (%) | Regular 5/64 (%) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|---------------------|---------------------------|-----------------|------------------|----------------------|-------------|----------------------|
| 21M14-8212 | 28.0 | 171 | 96.7 | 3.1 | 52.8 | 11.2 | 128.6 |
| Bow | 31.2 | 176 | 97.8 | 2.2 | 53.5 | 12.0 | 125.8 |
| Ellinor | 24.9 | 175 | 95.9 | 3.7 | 50.0 | 10.3 | 131.6 |
| Fraser | 27.8 | 172 | 98.3 | 1.7 | 52.2 | 11.1 | 126.7 |
| Genie | 25.1 | 173 | 91.7 | 7.2 | 54.0 | 11.6 | 130.6 |
| Hockett | 28.2 | 172 | 96.0 | 3.6 | 54.7 | 12.1 | 125.4 |
| IK14-8413 | 29.8 | 172 | 96.9 | 2.7 | 53.9 | 12.1 | 137.7 |
| Leandra | 24.1 | 176 | 96.4 | 3.3 | 52.1 | 11.2 | 143.7 |
| Merit 57 | 31.2 | 175 | 94.4 | 5.0 | 51.7 | 11.2 | 135.0 |
| Metcalfe | 29.4 | 172 | 95.4 | 2.1 | 52.8 | 12.6 | 128.6 |
| MT090202 | 28.3 | 173 | 95.2 | 4.2 | 53.4 | 11.2 | 121.4 |
| MT124112 | 28.0 | 172 | 96.7 | 3.0 | 52.8 | 11.4 | 123.5 |
| MT16M00209 | 29.1 | 169 | 99.0 | 1.0 | 50.4 | 11.5 | 135.5 |
| MT16M00305 | 26.4 | 169 | 95.3 | 4.2 | 50.9 | 11.8 | 120.3 |
| MT16M00406 | 30.3 | 174 | 97.8 | 2.1 | 52.5 | 11.5 | 137.6 |
| MT16M00407 | 29.5 | 171 | 98.4 | 1.5 | 51.5 | 12.5 | 109.9 |
| MT16M00408 | 31.0 | 172 | 99.2 | 0.7 | 51.0 | 12.3 | 110.2 |
| MT16M00504 | 30.4 | 169 | 98.5 | 1.4 | 51.9 | 12.0 | 127.4 |
| MT16M00603 | 27.4 | 171 | 98.4 | 1.4 | 51.5 | 12.1 | 139.1 |
| MT16M00610 | 28.9 | 169 | 98.2 | 1.7 | 53.5 | 12.1 | 109.8 |
| MT16M00707 | 32.0 | 173 | 97.8 | 2.0 | 53.6 | 11.6 | 123.4 |
| MT16M00709 | 31.0 | 172 | 97.6 | 2.2 | 53.5 | 10.6 | 131.3 |
| MT16M00806 | 29.4 | 172 | 97.0 | 2.7 | 52.7 | 12.1 | 128.0 |
| MT16M00807 | 31.1 | 169 | 99.0 | 0.9 | 51.2 | 12.0 | 121.2 |
| MT16M01204 | 26.5 | 168 | 97.3 | 2.6 | 51.5 | 11.4 | 107.5 |
| MT16M01405 | 28.7 | 170 | 98.2 | 1.7 | 53.3 | 11.1 | 118.5 |
| MT16M01705 | 29.4 | 168 | 95.4 | 4.1 | 53.7 | 12.1 | 116.8 |
| MT16M01801 | 31.2 | 173 | 93.4 | 5.5 | 52.5 | 10.8 | 129.2 |
| MT16M01803 | 27.7 | 169 | 95.5 | 4.1 | 53.5 | 11.9 | 118.6 |
| MT16M01806 | 30.1 | 171 | 95.1 | 4.3 | 53.4 | 10.9 | 123.3 |
| MT16M01819 | 28.6 | 169 | 98.5 | 1.4 | 53.0 | 12.3 | 109.3 |
| MT16M01901 | 27.0 | 171 | 98.1 | 1.8 | 52.5 | 11.4 | 109.0 |
| MT16M01902 | 31.1 | 170 | 91.4 | 7.5 | 50.9 | 11.8 | 113.8 |
| MT16M02003 | 27.4 | 171 | 93.7 | 5.6 | 52.9 | 11.6 | 105.0 |
| MT16M02008 | 30.8 | 169 | 99.3 | 0.7 | 52.2 | 11.6 | 109.9 |
| MT16M02101 | 29.1 | 169 | 93.2 | 5.7 | 50.3 | 11.3 | 127.0 |
| MT16M02106 | 29.5 | 170 | 95.7 | 4.0 | 52.1 | 11.3 | 110.7 |
| MT16M02107 | 29.4 | 169 | 97.0 | 2.7 | 54.6 | 11.5 | 118.6 |
| MT16M02201 | 28.2 | 169 | 97.4 | 2.3 | 50.9 | 11.5 | 133.6 |
| MT16M05403 | 29.8 | 176 | 93.3 | 5.6 | 54.2 | 11.4 | 124.1 |
| MT16M05610 | 29.0 | 175 | 96.1 | 3.5 | 53.3 | 11.1 | 116.5 |
| MT16M05902 | 27.0 | 168 | 98.0 | 1.7 | 54.0 | 11.7 | 105.7 |
| MT16M06110 | 29.4 | 172 | 95.8 | 3.8 | 53.5 | 11.0 | 123.2 |
| MT16M06404 | 28.1 | 172 | 98.4 | 1.5 | 55.2 | 11.6 | 108.9 |
| MT16M07806 | 30.1 | 174 | 97.6 | 2.3 | 54.4 | 11.7 | 129.7 |
| MT16M09602 | 25.7 | 169 | 96.7 | 2.9 | 53.7 | 11.3 | 123.5 |
| MT16M10204 | 33.5 | 174 | 91.2 | 7.2 | N/A | N/A | 107.5 |
| Odyssey | 24.8 | 175 | 95.4 | 4.0 | 51.5 | 10.7 | 142.9 |
| Opera | 23.5 | 176 | 92.8 | 5.7 | 49.8 | 10.6 | 132.3 |
| Mean | 28.7 | 172 | 96.4 | 3.2 | 52.6 | 11.5 | 122.8 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 |
| CV (%) | 5.83 | 0.55 | 1.14 | 29.0 | 1.13 | 3.7 | 9.51 |
| LSD (0.05) | 2.72 | 1.52 | 1.78 | 1.49 | 0.97 | 0.69 | 18.9 |

Planted: 4/16/2019

Harvested: 8/9/2019

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 39lb/ac

N added (lb/ac): 60lb/ac

Previous crop: Fallow

Soil Type: William Clay Loam

Plot Width: 5 ft

Precipitation (2019): 21.5"

Soil Test P2O5 (ppm): 31lb/ac

P2O5 added (lb/ac): 20lb/ac

Dryland Intrastate Barley Evaluation - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Plump >6/64 (%) | Regular 5/64 (%) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|---------------------|---------------------------|-----------------|------------------|----------------------|-------------|----------------------|
| 21M14-8212 | 28.0 | 171 | 96.7 | 3.1 | 52.8 | 11.2 | 128.6 |
| Bow | 31.2 | 176 | 97.8 | 2.2 | 53.5 | 12.0 | 125.8 |
| Ellinor | 24.9 | 175 | 95.9 | 3.7 | 50.0 | 10.3 | 131.6 |
| Fraser | 27.8 | 172 | 98.3 | 1.7 | 52.2 | 11.1 | 126.7 |
| Genie | 25.1 | 173 | 91.7 | 7.2 | 54.0 | 11.6 | 130.6 |
| Hockett | 28.2 | 172 | 96.0 | 3.6 | 54.7 | 12.1 | 125.4 |
| IK14-8413 | 29.8 | 172 | 96.9 | 2.7 | 53.9 | 12.1 | 137.7 |
| Leandra | 24.1 | 176 | 96.4 | 3.3 | 52.1 | 11.2 | 143.7 |
| Merit 57 | 31.2 | 175 | 94.4 | 5.0 | 51.7 | 11.2 | 135.0 |
| Metcalfe | 29.4 | 172 | 95.4 | 2.1 | 52.8 | 12.6 | 128.6 |
| MT090202 | 28.3 | 173 | 95.2 | 4.2 | 53.4 | 11.2 | 121.4 |
| MT124112 | 28.0 | 172 | 96.7 | 3.0 | 52.8 | 11.4 | 123.5 |
| MT16M00209 | 29.1 | 169 | 99.0 | 1.0 | 50.4 | 11.5 | 135.5 |
| MT16M00305 | 26.4 | 169 | 95.3 | 4.2 | 50.9 | 11.8 | 120.3 |
| MT16M00406 | 30.3 | 174 | 97.8 | 2.1 | 52.5 | 11.5 | 137.6 |
| MT16M00407 | 29.5 | 171 | 98.4 | 1.5 | 51.5 | 12.5 | 109.9 |
| MT16M00408 | 31.0 | 172 | 99.2 | 0.7 | 51.0 | 12.3 | 110.2 |
| MT16M00504 | 30.4 | 169 | 98.5 | 1.4 | 51.9 | 12.0 | 127.4 |
| MT16M00603 | 27.4 | 171 | 98.4 | 1.4 | 51.5 | 12.1 | 139.1 |
| MT16M00610 | 28.9 | 169 | 98.2 | 1.7 | 53.5 | 12.1 | 109.8 |
| MT16M00707 | 32.0 | 173 | 97.8 | 2.0 | 53.6 | 11.6 | 123.4 |
| MT16M00709 | 31.0 | 172 | 97.6 | 2.2 | 53.5 | 10.6 | 131.3 |
| MT16M00806 | 29.4 | 172 | 97.0 | 2.7 | 52.7 | 12.1 | 128.0 |
| MT16M00807 | 31.1 | 169 | 99.0 | 0.9 | 51.2 | 12.0 | 121.2 |
| MT16M01204 | 26.5 | 168 | 97.3 | 2.6 | 51.5 | 11.4 | 107.5 |
| MT16M01405 | 28.7 | 170 | 98.2 | 1.7 | 53.3 | 11.1 | 118.5 |
| MT16M01705 | 29.4 | 168 | 95.4 | 4.1 | 53.7 | 12.1 | 116.8 |
| MT16M01801 | 31.2 | 173 | 93.4 | 5.5 | 52.5 | 10.8 | 129.2 |
| MT16M01803 | 27.7 | 169 | 95.5 | 4.1 | 53.5 | 11.9 | 118.6 |
| MT16M01806 | 30.1 | 171 | 95.1 | 4.3 | 53.4 | 10.9 | 123.3 |
| MT16M01819 | 28.6 | 169 | 98.5 | 1.4 | 53.0 | 12.3 | 109.3 |
| MT16M01901 | 27.0 | 171 | 98.1 | 1.8 | 52.5 | 11.4 | 109.0 |
| MT16M01902 | 31.1 | 170 | 91.4 | 7.5 | 50.9 | 11.8 | 113.8 |
| MT16M02003 | 27.4 | 171 | 93.7 | 5.6 | 52.9 | 11.6 | 105.0 |
| MT16M02008 | 30.8 | 169 | 99.3 | 0.7 | 52.2 | 11.6 | 109.9 |
| MT16M02101 | 29.1 | 169 | 93.2 | 5.7 | 50.3 | 11.3 | 127.0 |
| MT16M02106 | 29.5 | 170 | 95.7 | 4.0 | 52.1 | 11.3 | 110.7 |
| MT16M02107 | 29.4 | 169 | 97.0 | 2.7 | 54.6 | 11.5 | 118.6 |
| MT16M02201 | 28.2 | 169 | 97.4 | 2.3 | 50.9 | 11.5 | 133.6 |
| MT16M05403 | 29.8 | 176 | 93.3 | 5.6 | 54.2 | 11.4 | 124.1 |
| MT16M05610 | 29.0 | 175 | 96.1 | 3.5 | 53.3 | 11.1 | 116.5 |
| MT16M05902 | 27.0 | 168 | 98.0 | 1.7 | 54.0 | 11.7 | 105.7 |
| MT16M06110 | 29.4 | 172 | 95.8 | 3.8 | 53.5 | 11.0 | 123.2 |
| MT16M06404 | 28.1 | 172 | 98.4 | 1.5 | 55.2 | 11.6 | 108.9 |
| MT16M07806 | 30.1 | 174 | 97.6 | 2.3 | 54.4 | 11.7 | 129.7 |
| MT16M09602 | 25.7 | 169 | 96.7 | 2.9 | 53.7 | 11.3 | 123.5 |
| MT16M10204 | 33.5 | 174 | 91.2 | 7.2 | N/A | N/A | 107.5 |
| Odyssey | 24.8 | 175 | 95.4 | 4.0 | 51.5 | 10.7 | 142.9 |
| Opera | 23.5 | 176 | 92.8 | 5.7 | 49.8 | 10.6 | 132.3 |
| Mean | 28.7 | 172 | 96.4 | 3.2 | 52.6 | 11.5 | 122.8 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 |
| CV (%) | 5.83 | 0.55 | 1.14 | 29.0 | 1.13 | 3.7 | 9.51 |
| LSD (0.05) | 2.72 | 1.52 | 1.78 | 1.49 | 0.97 | 0.69 | 18.9 |

Planted: 4/16/2019

Previous crop: Fallow

Harvested: 8/9/2019

Soil Type: William Clay Loam

(Julian*) is a continuous count of days since January 1

Plot Width: 5 ft

† Test weight and grain yield adjusted to 12.0% moisture

Precipitation (2019): 21.5"

Soil Test N Avail (lb/ac): 39lb/ac

Soil Test P2O5 (ppm): 31lb/ac

N added (lb/ac): 60lb/ac

P2O5 added (lb/ac): 20lb/ac

Evaluation of Early Yield of Barley - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Plump >6/64 (%) | Regular 5/64 (%) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|----------------|----------------------------|----------------------------------|---------------------------|-------------------------|-----------------------------|--------------------|-----------------------------|
| Hockett | 29.5 | 172 | 93.4 | 5.4 | 55.0 | 12.2 | 133.4 |
| Merit 57 | 29.8 | 176 | 92.6 | 6.2 | 52.3 | 12.2 | 137.6 |
| Metcalfe | 29.7 | 171 | 94.3 | 5.2 | 53.3 | 13.0 | 131.2 |
| MT124112 | 27.6 | 172 | 95.9 | 3.5 | 53.0 | 54.3 | 124.8 |
| MT16M01303 | 30.4 | 172 | 97.4 | 2.3 | 52.9 | 12.8 | 124.0 |
| MT16M01820 | 26.5 | 171 | 93.9 | 4.6 | 51.9 | 11.6 | 120.8 |
| MT16M06007 | 27.3 | 168 | 95.6 | 3.9 | 53.7 | 13.4 | 129.2 |
| MT16M06402 | 29.0 | 172 | 94.9 | 4.4 | 54.1 | 12.5 | 143.2 |
| MT16M07910 | 27.3 | 172 | 88.3 | 9.2 | 53.8 | 11.8 | 127.3 |
| MT16M08502 | 27.0 | 175 | 94.8 | 4.7 | 54.6 | 12.4 | 117.8 |
| MT17M00210 | 30.1 | 168 | 97.8 | 1.8 | 52.7 | 13.6 | 119.8 |
| MT17M00301 | 29.1 | 174 | 97.5 | 2.2 | 51.9 | 12.3 | 127.8 |
| MT17M00302 | 29.8 | 175 | 95.1 | 4.2 | 54.1 | 11.3 | 149.9 |
| MT17M00502 | 29.1 | 169 | 97.7 | 2.1 | 51.6 | 12.5 | 132.5 |
| MT17M00504 | 29.0 | 169 | 95.7 | 3.8 | 52.2 | 12.6 | 135.7 |
| MT17M00710 | 29.7 | 170 | 98.8 | 1.1 | 53.0 | 11.8 | 130.8 |
| MT17M01302 | 27.2 | 168 | 96.8 | 2.9 | 52.2 | 12.8 | 134.5 |
| MT17M01306 | 29.1 | 170 | 97.5 | 2.1 | 52.3 | 12.9 | 142.2 |
| MT17M01710 | 27.2 | 169 | 94.5 | 4.8 | 53.7 | 11.9 | 122.8 |
| MT17M01711 | 28.5 | 171 | 89.6 | 7.1 | 50.7 | 12.2 | 114.3 |
| MT17M01801 | 31.0 | 171 | 95.9 | 3.6 | 54.0 | 11.5 | 126.6 |
| MT17M01808 | 25.2 | 169 | 93.8 | 5.1 | 52.6 | 12.8 | 123.9 |
| MT17M01906 | 28.1 | 171 | 94.9 | 4.3 | 51.3 | 12.5 | 130.3 |
| MT17M01908 | 29.4 | 169 | 97.9 | 1.9 | 52.4 | 11.6 | 121.4 |
| MT17M01912 | 32.4 | 172 | 98.4 | 1.5 | 53.3 | 10.9 | 134.1 |
| MT17M02003 | 29.4 | 170 | 97.9 | 1.5 | 51.4 | 12.5 | 117.7 |
| MT17M02009 | 30.3 | 172 | 96.8 | 2.9 | 51.4 | 11.6 | 125.8 |
| MT17M02106 | 26.9 | 169 | 93.6 | 5.2 | 52.0 | 12.6 | 120.3 |
| MT17M02507 | 29.8 | 173 | 96.4 | 3.2 | 53.7 | 10.8 | 136.3 |
| MT17M02510 | 25.3 | 169 | 96.9 | 2.8 | 53.7 | 11.6 | 129.7 |
| MT17M04801 | 28.9 | 172 | 95.2 | 4.1 | 53.8 | 11.8 | 144.6 |
| MT17M04808 | 30.6 | 174 | 93.2 | 5.7 | 53.4 | 11.2 | 124.3 |
| MT17M04904 | 28.1 | 176 | 95.0 | 4.4 | 53.1 | 12.0 | 134.0 |
| MT17M05106 | 31.4 | 172 | 89.5 | 9.0 | 54.0 | 11.9 | 140.4 |
| MT17M05201 | 27.3 | 170 | 95.1 | 4.3 | 51.3 | 13.3 | 110.2 |
| MT17M05312 | 31.1 | 175 | 94.1 | 5.2 | 52.7 | 11.7 | 147.4 |
| MT17M05416 | 27.8 | 174 | 92.4 | 6.3 | 52.3 | 11.7 | 116.2 |
| MT17M05502 | 31.2 | 174 | 96.2 | 3.4 | 53.8 | 11.8 | 139.3 |
| MT17M05508 | 32.3 | 172 | 95.7 | 3.8 | 53.9 | 11.3 | 140.3 |
| MT17M05609 | 31.9 | 173 | 95.1 | 4.3 | 52.6 | 11.8 | 122.7 |
| MT17M05808 | 28.3 | 171 | 93.7 | 5.2 | 53.0 | 12.0 | 117.9 |
| MT17M05812 | 31.5 | 171 | 95.1 | 4.2 | 53.8 | 13.0 | 127.4 |
| MT17M06010 | 25.6 | 168 | 97.8 | 2.1 | 53.8 | 12.6 | 136.3 |
| MT17M07605 | 25.7 | 169 | 91.0 | 7.0 | 53.0 | 11.9 | 129.6 |
| MT17M07704 | 29.3 | 170 | 94.3 | 5.0 | 54.0 | 12.3 | 141.9 |
| MT17M07901 | 28.6 | 173 | 91.7 | 6.3 | 51.9 | 11.0 | 133.6 |
| MT17M07902 | 29.9 | 172 | 91.2 | 7.6 | 53.3 | 12.0 | 129.5 |
| MT17M07904 | 29.3 | 172 | 89.5 | 8.9 | 53.1 | 11.4 | 140.2 |
| MT17M08001 | 27.0 | 169 | 96.3 | 3.2 | 54.0 | 12.8 | 127.0 |
| MT17M08016 | 29.5 | 169 | 96.6 | 3.0 | 53.5 | 12.6 | 133.7 |

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Evaluation of Early Yield of Barley - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Plump >6/64 (%) | Regular 5/64 (%) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|------------------------------|-----------------------|------------------------|----------------------------|----------------|----------------------------|
| MT17M08208 | 24.7 | 174 | 92.1 | 7.0 | 52.7 | 13.9 | 123.2 |
| MT17M08213 | 27.3 | 175 | 97.1 | 2.6 | 54.0 | 12.3 | 137.8 |
| MT17M08403 | 29.4 | 175 | 91.7 | 7.2 | 53.2 | 12.6 | 147.8 |
| MT17M08404 | 28.9 | 176 | 92.5 | 6.2 | 53.7 | 12.3 | 131.6 |
| MT17M08501 | 25.2 | 171 | 93.5 | 5.4 | 54.5 | 11.8 | 126.3 |
| MT17M08509 | 28.5 | 174 | 95.4 | 4.2 | 54.2 | 12.8 | 124.0 |
| MT17M08702 | 27.6 | 171 | 92.3 | 6.0 | 53.6 | 11.0 | 130.0 |
| MT17M08804 | 26.0 | 168 | 96.3 | 3.1 | 53.5 | 12.5 | 123.2 |
| MT17M08806 | 26.8 | 169 | 98.3 | 1.5 | 53.9 | 11.9 | 133.6 |
| MT17M08808 | 28.0 | 169 | 96.7 | 2.9 | 53.4 | 11.1 | 144.7 |
| MT17M09010 | 30.1 | 175 | 95.6 | 3.7 | 53.3 | 10.9 | 135.3 |
| MT17M09011 | 30.3 | 174 | 95.5 | 4.1 | 53.8 | 11.8 | 135.4 |
| MT17M09602 | 28.6 | 172 | 94.1 | 5.1 | 52.7 | 10.5 | 132.8 |
| Odyssey | 25.3 | 175 | 96.5 | 3.1 | 51.9 | 11.5 | 130.7 |
| Mean | 28.6 | 172 | 94.9 | 4.4 | 52.9 | 12.7 | 131 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0014 | 0.56 | 0.02 |
| CV (%) | 6.57 | 0.63 | 1.83 | 31.1 | 3.74 | 73.7 | 9.22 |
| LSD (0.05) | 3.04 | 1.75 | 2.81 | 2.19 | 3.20 | 15.2 | 19.5 |

Planted: 4/16/2019

Harvested: 8/8/2019

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 39

N added (lb/ac): 60

Previous crop: Fallow

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 31

P₂O₅ added (lb/ac): 20

Forage Barley Evaluation - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|------------|------------------------|------------------------------|----------------------------|----------------|-------------------------|
| Hays | | 174 | 49.4 | 13.1 | 119 |
| Lavina | 26.8 | 171 | 48.6 | 13.6 | 134 |
| MT16F01601 | 27.6 | 171 | 48.6 | 14.2 | 132 |
| MT16F01602 | 28.6 | 169 | 46.8 | 12.3 | 127 |
| MT16F01603 | 26.6 | 171 | 46.4 | 14.2 | 130 |
| MT16F02406 | 31.0 | 172 | 49.7 | 13.2 | 132 |
| MT16F02408 | 29.0 | 172 | 50.5 | 14.7 | 140 |
| MT16F02410 | 28.3 | 171 | 49.4 | 14.1 | 133 |
| MT16F02902 | 30.7 | 172 | 49.9 | 13.6 | 140 |
| MT16F02903 | 33.1 | 171 | 50.6 | 13.5 | 125 |
| MT16F02910 | 34.0 | 171 | 47.3 | 14.0 | 129 |
| MT17F01606 | 29.0 | 171 | 46.3 | 12.6 | 230 |
| MT17F01616 | 28.3 | 171 | 47.0 | 14.3 | 124 |
| MT17F02401 | 30.4 | 172 | 47.3 | 13.5 | 117 |
| MT17F02902 | 33.9 | 172 | 51.5 | 13.5 | 136 |
| MT17F02908 | 29.4 | 174 | 51.8 | 13.6 | 135 |
| Mean | 29.6 | 172 | 48.8 | 13.6 | 137 |
| P-Val | <0.0001 | 0.0027 | <0.0001 | 0.0006 | 0.39 |
| CV (%) | 4.61 | 0.64 | 1.48 | 3.95 | 31.0 |
| LSD | 2.27 | 1.82 | 1.21 | 0.90 | 71.0 |

Planted: 4/16/19

Harvested: 8/14/19

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 22

N added (lb/ac): 60

Previous crop: Pea

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 29

P₂O₅ added (lb/ac): 20

Dryland Hulless Barley Evaluation - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|-------------|---------------------|---------------------------|----------------------|-------------|----------------------|
| 09WA-265.12 | 27.1 | 175 | 62.4 | 11.1 | 99.1 |
| Havener | 26.8 | 176 | 62.4 | 11.5 | 92.8 |
| MT16H09210 | 26.6 | 174 | 59.1 | 11.7 | 92.7 |
| MT16H09302 | 30.4 | 174 | 60.4 | 12.3 | 101.4 |
| MT16H09308 | 29.1 | 171 | 60.9 | 11.8 | 88.1 |
| MT16H21503 | 27.7 | 175 | 62.9 | 13.1 | 64.1 |
| MT16H22201 | 27.1 | 169 | 61.8 | 12.9 | 72.8 |
| MT17H09304 | 29.0 | 171 | 61.1 | 12.4 | 84.2 |
| MT17H09402 | 30.3 | 173 | 58.5 | 13.9 | 54.4 |
| OR23-B | 28.3 | 173 | 60.9 | 11.8 | 89.3 |
| OR27-1-C | 29.0 | 178 | 62.8 | 12.0 | 92.7 |
| OR29-2-B | 26.8 | 176 | 59.8 | 12.3 | 97.2 |
| OR29-3-C | 24.8 | 172 | 63.2 | 13.6 | 86.5 |
| OR29-4-B | 25.7 | 172 | 63.0 | 13.0 | 89.4 |
| OR33-3-A | 27.4 | 175 | 62.5 | 12.7 | 88.5 |
| OR45-1-B | 31.2 | 176 | 61.8 | 11.6 | 86.7 |
| Mean | 27.9 | 174 | 61.5 | 12.3 | 86.9 |
| P-Value | 0.0012 | <0.0001 | <0.0001 | 0.0006 | 0.007 |
| CV (%) | 5.77 | 0.71 | 0.97 | 5.20 | 13.5 |
| LSD (0.05) | 2.69 | 2.07 | 1.0 | 1.09 | 19.9 |

Planted: 4/16/19

Harvested: 8/9/19

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac):22

N added (lb/ac): 60

Previous crop: Pea

Soil Type: William Clay Loam

Plot Width: 5 ft

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 29

P₂O₅ added (lb/ac): 20

Irrigated Hulless Barley Evaluation

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|-------------|---------------------|---------------------------|----------------------|-------------|----------------------|
| 09WA-265.12 | 34.5 | 178 | 61.7 | 13.9 | 145 |
| Havener | 30.3 | 179 | 62.4 | 13.4 | 129 |
| MT16H09210 | 32.5 | 177 | 58.9 | 14.3 | 127 |
| MT16H09302 | 33.5 | 178 | 59.5 | 13.4 | 125 |
| MT16H09308 | 31.1 | 174 | 60.7 | 12.1 | 118 |
| MT16H21503 | 29.5 | 180 | 62.5 | 15.0 | 116 |
| MT16H22201 | 28.6 | 172 | 59.7 | 14.3 | 97 |
| MT17H09304 | 33.3 | 173 | 61.5 | 13.1 | 133 |
| MT17H09402 | 34.6 | 177 | 58.4 | 16.0 | 104 |
| OR23-B | 35.4 | 178 | 58.4 | 14.8 | 115 |
| OR27-1-C | 34.4 | 183 | 61.5 | 14.7 | 116 |
| OR29-2-B | 30.3 | 178 | 59.0 | 13.8 | 137 |
| OR29-3-C | 33.6 | 176 | 61.0 | 16.3 | 121 |
| OR29-4-B | 29.8 | 175 | 62.7 | 15.3 | 125 |
| OR33-3-A | 35.6 | 177 | 61.5 | 15.2 | 115 |
| OR45-1-B | 35.6 | 179 | 61.9 | 15.1 | 118 |
| Mean | 32.7 | 177 | 60.7 | 14.4 | 122 |
| P-Value | 0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 5.78 | 0.60 | 1.30 | 2.40 | 7.05 |
| LSD (0.05) | 3.15 | 1.78 | 1.31 | 0.58 | 14.6 |

Planted: 4/26/19

Harvested: 8/16/19

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 25

N added (lb/ac): 60

Previous crop: Sugarbeet

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 22.5"

Irrigation (sprinkler): 1.8"

Soil Test P₂O₅ (ppm): 25

P₂O₅ added (lb/ac): 20

Recrop Barley Evaluation - MSU

EARC, Sidney, MT 2019

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Plump >6/64 (%) | Regular 5/64 (%) | Test Weight† (lb/bu) | Protein (%) | Grain Yield† (bu/ac) |
|----------------|--------------------------------|--------------------------------------|-------------------------------|-----------------------------|---------------------------------|------------------------|---------------------------------|
| Balster | 26.2 | 176 | 97.2 | 2.5 | 51.2 | 12.0 | 100 |
| Champion | 30.4 | 174 | 93.3 | 5.9 | 52.6 | 11.5 | 105 |
| Conrad | 24.3 | 177 | 97.1 | 2.7 | 51.4 | 13.1 | 101 |
| Copeland | 31.9 | 178 | 96.5 | 3.1 | 51.8 | 12.1 | 108 |
| Craft | 28.3 | 175 | 96.5 | 3.2 | 52.4 | 13.5 | 74 |
| Expedition | 24.1 | 176 | 97.7 | 2.1 | 52.2 | 11.6 | 105 |
| Fraser | 25.3 | 176 | 98.1 | 1.8 | 49.8 | 12.1 | 90 |
| Genie | 24.7 | 175 | 92.0 | 6.7 | 52.2 | 11.9 | 120 |
| Growler | 27.2 | 177 | 96.8 | 3.0 | 50.8 | 11.9 | 105 |
| Haxby | 29.5 | 174 | 95.3 | 4.2 | 53.8 | 12.7 | 112 |
| Haybet | 31.5 | 174 | 68.4 | 27.7 | 47.6 | 14.6 | 59 |
| Hays | 29.5 | 175 | 79.6 | 15.9 | 48.0 | 13.1 | 82 |
| Hockett | 25.5 | 174 | 96.6 | 3.0 | 53.1 | 12.0 | 108 |
| Lavina | 30.4 | 174 | 79.1 | 18.5 | 46.9 | 13.7 | 89 |
| Merit 57 | 27.6 | 177 | 91.7 | 7.0 | 50.8 | 12.0 | 104 |
| Metcalfe | 29.7 | 175 | 95.5 | 4.0 | 51.9 | 13.6 | 103 |
| MT124112 | 25.5 | 175 | 97.0 | 2.8 | 50.4 | 11.4 | 74 |
| MT124113 | 27.3 | 169 | 97.9 | 1.9 | 51.1 | 11.8 | 82 |
| MT124128 | 24.8 | 169 | 97.8 | 1.9 | 51.3 | 11.8 | 82 |
| MT124134 | 25.5 | 171 | 98.0 | 1.7 | 51.5 | 11.9 | 78 |
| MT124664 | 26.2 | 174 | 98.0 | 1.8 | 51.5 | 12.6 | 81 |
| Odyssey | 25.2 | 178 | 96.6 | 3.0 | 50.0 | 11.3 | 104 |
| Opera | 23.4 | 180 | 95.6 | 3.8 | 48.7 | 10.9 | 98 |
| Synergy | 30.2 | 177 | 96.7 | 3.1 | 51.2 | 13.0 | 92 |
| Voyager | 27.3 | 174 | 98.0 | 1.8 | 50.5 | 12.9 | 82 |
| Mean | 27.3 | 175 | 93.9 | 5.33 | 50.9 | 12.4 | 93.6 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.02 |
| CV (%) | 7.09 | 0.81 | 2.6 | 34.1 | 1.48 | 5.94 | 19.0 |
| LSD (0.05) | 3.17 | 2.31 | 3.97 | 2.98 | 1.24 | 1.21 | 29.5 |

Planted: 4/19/19

Harvested: 8/14/19

(Julian*) is a continuous count of days since January 1

† Test weight and grain yield adjusted to 12.0% moisture

Soil Test N Avail (lb/ac): 22

N added (lb/ac): 60

Previous crop: Pea

Soil Type: William Clay Loam

Plot Width: 5 ft.

Precipitation (2019): 21.5"

Soil Test P₂O₅ (ppm): 29

P₂O₅ added (lb/ac): 20

OAT VARIETY DESCRIPTIONS

| VARIETY | ORIGIN ¹ | YEAR RELEASED | GRAIN COLOR | HEIGHT | MATURITY | RESISTANCE TO ² | | | | QUALITY FACTORS | |
|--------------|---------------------|---------------|-------------|--------|----------|----------------------------|-----------|------------|---------------------|-----------------|---------------|
| | | | | | | LODGING | STEM RUST | CROWN RUST | BARLEY YELLOW DWARF | TEST WEIGHT | GRAIN PROTEIN |
| AC PINNACLE | CANADA | 1999 | WHITE | TALL | LATE | MS | R | R | S | MEDIUM | LOW |
| BEACH | NDSU | 2004 | WHITE | TALL | M LATE | MR | S | MR/MS | MS | MEDIUM | M HIGH |
| CDC DANCER | CANADA | 2000 | WHITE | TALL | LATE | MR | S | MS | S | HIGH | MEDIUM |
| CDC MINSTREL | CANADA | 2006 | WHITE | TALL | LATE | MR | S | S | S | M HIGH | MEDIUM |
| CS CAMDEN | CANTERRA | 2016 | WHITE | MEDIUM | MED | R | S | MS | NA | NA | NA |
| DEON | MN | 2013 | YELLOW | TALL | LATE | R | S | R | T | V HIGH | NA |
| HAYDEN | SDSU | 2014 | WHITE | MEDIUM | MED | M | S | MR/MS | MR | M HIGH | MEDIUM |
| HiFi | NDSU | 2001 | WHITE | TALL | LATE | MR | MR | R | T | M HIGH | MEDIUM |
| HYTEST | SDSU | 1986 | WHITE | TALL | EARLY | MS | S | MS | S | V HIGH | HIGH |
| JURY | NDSU | 2012 | WHITE | TALL | LATE | MS | R | R | MR | M HIGH | MEDIUM |
| KILLDEER | NDSU | 2000 | WHITE | MED | MED | MR | S | MS | MR | M HIGH | MEDIUM |
| LEGGETT | CANADA | 2005 | WHITE | TALL | LATE | MR | MR | R | S | MEDIUM | MEDIUM |
| NEWBURG | NDSU | 2011 | WHITE | TALL | LATE | MS | R | R | MR | MEDIUM | MEDIUM |
| OTANA | MT | 1977 | WHITE | TALL | LATE | S | S | S | S | HIGH | MEDIUM |
| ORE3541M | CANADA | 2018 | WHITE | MEDIUM | LATE | R | S | R | MS | HIGH | M HIGH |
| ORE3542M | CANADA | 2019 | WHITE | MEDIUM | LATE | R | S | R | S | M HIGH | MEDIUM |
| PAUL | NDSU | 1994 | HULLESS | V TALL | LATE | MS | R | MR | T | V HIGH | HIGH |
| ROCKFORD | NDSU | 2008 | WHITE | TALL | LATE | R | S | R | MR | M HIGH | MEDIUM |
| SOURIS | NDSU | 2006 | WHITE | MED | MED | R | MS | R | MS | HIGH | MEDIUM |
| STALLION | SDSU | 2006 | WHITE | TALL | LATE | M | S | MR | NA | HIGH | MEDIUM |

¹Refers to developer: CANADA represents developers from that country; MN = Minnesota; MT = Montana State University; NDSU = North Dakota State University; SDSU = South Dakota State University.

²M = Intermediate; MR = Moderately resistant; MS = Moderately susceptible; NA = Not available; R = Resistant; S = Susceptible; T = Tolerant; VS = Very susceptible.



EARC Postdoc Research Associate, Fatemeh Etemadi speaking at EARC field day

Oats Dryland Variety Trial - NDSU WREC, Williston, ND 2019

| Variety | Days to heading (DAP ¹) | Plant height (in) | Test weight [‡] (lb/bu) | Yield [#] (bu/a) | | |
|--------------|--|----------------------|-------------------------------------|------------------------------|----------|----------|
| | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| Killdeer | 54 | 34.6 | 42.2 | 194.7 | 136.5 | 113.5 |
| CS Camden | 56 | 37.8 | 40.5 | 195.0 | 136.2 | 113.4 |
| Jury | 57 | 36.0 | 42.2 | 183.5 | 135.3 | 112.2 |
| Legget | 55 | 38.6 | 43.9 | 190.7 | 136.7 | 112.2 |
| CDC Dancer | 55 | 38.3 | 44.6 | 186.1 | 134.1 | 111.5 |
| Deon | 56 | 38.6 | 43.4 | 176.7 | 128.7 | 109.4 |
| AC Pinnacle | 54 | 42.8 | 44.8 | 166.3 | 125.0 | 107.6 |
| Hayden | 55 | 37.4 | 44.6 | 176.3 | 124.1 | 106.7 |
| Otana | 56 | 38.3 | 42.7 | 171.0 | 125.5 | 106.5 |
| Rockford | 55 | 38.2 | 45.0 | 184.6 | 128.1 | 106.3 |
| CDC Minstrel | 56 | 36.5 | 42.7 | 172.8 | 124.0 | 104.1 |
| HiFi | 56 | 37.3 | 43.5 | 164.0 | 121.1 | 101.3 |
| Souris | 54 | 36.1 | 44.2 | 162.2 | 117.4 | 100.0 |
| Newburg | 55 | 40.0 | 43.7 | 147.7 | 116.6 | 99.4 |
| Stallion | 55 | 38.6 | 42.9 | 156.6 | 120.3 | 97.0 |
| Beach | 54 | 36.7 | 45.3 | 138.0 | 110.7 | 92.6 |
| Hyttest | 54 | 37.3 | 45.7 | 127.1 | 92.5 | 78.3 |
| Paul | 57 | 41.9 | 51.8 | 120.1 | 87.7 | 72.7 |
| ORe3542M | 55 | 33.6 | 41.7 | 164.4 | - | - |
| ORe3541M | 54 | 33.3 | 44.1 | 146.8 | - | - |
| Warrior | 55 | 32.7 | 43.4 | 166.0 | - | - |
| Mean | 55 | 37.9 | 44.3 | 163.4 | - | - |
| CV (%) | 1.5 | 6.6 | 1.4 | 10.8 | - | - |
| LSD (5%) | 1.4 | 4.1 | 1.0 | 28.8 | - | - |
| LSD (10%) | 1.1 | 3.4 | 0.8 | 24.1 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft. Previous crop: soybeans
 Planted: 5-7-2019 Harvested: 8-21-2019
 Soil test to 6" in ppm: OM=2.0% pH=5.2 Soil type: Williams-Bowbells loam.
 Soil test to 24" in lb/a:
 Applied fertilizers in lb/a:
[‡]Protein adjusted to 12% moisture.
[#]Yield reported on a 13.5% moisture basis.
¹DAP = Days after planting.
 Herbicide Application: Bison @ 1.5 pts/a (6/13/2019)

Oat Irrigated Variety Trial - NDSU WREC, Nesson Valley, ND 2019

| Variety | Plant Height (in) | Days to Head (DAP*) | Lodging (0 - 9 ⁺) | Test Weight (lb/bu) | Yield (bu/a) | | |
|-----------|----------------------|------------------------|----------------------------------|------------------------|-----------------|----------|----------|
| | | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| Deon | 46 | 71 | 7 | 42.5 | 175.4 | 199.3 | 170.4 |
| Hayden | 47 | 70 | 5 | 42.2 | 182.1 | 185.7 | 164.5 |
| Killdeer | 42 | 69 | 8 | 37.6 | 148.3 | 170.3 | 150.4 |
| Rockford | 47 | 71 | 9 | 42.5 | 165.9 | 168.2 | 149.4 |
| Jury | 47 | 73 | 9 | 39.7 | 150.3 | 168.4 | 148.2 |
| Beach | 47 | 69 | 7 | 43.7 | 154.1 | 163.4 | 146.0 |
| CS Camden | 44 | 69 | 2 | 38.3 | 187.8 | 188.3 | - |
| ORe3541M | 46 | 70 | 6 | 41.7 | 183.9 | - | - |
| ORe3542M | 46 | 70 | 3 | 36.6 | 169.9 | - | - |
| Hyttest | 45 | 68 | 7 | 42.8 | 142.7 | - | - |
| Paul | 50 | 72 | 5 | 49.5 | 112.2 | - | - |
| MEAN | 46.1 | 70.1 | 6.2 | 41.55 | 161.15 | 177.66 | 154.83 |
| C.V. (%) | 3.6 | 2.0 | - | 7.02 | 15.68 | - | - |
| LSD (5%) | 2.4 | 2.0 | 3.7 | ns | 36.21 | - | - |
| LSD (10%) | 2.0 | 1.7 | 3.0 | 3.49 | 30.10 | - | - |

* Days after planting * 0: no lodging - 9: plants lying flat on the ground
 Location: Latitude 48 9.9222N; Longitude 103 6.132W Elevation: 1902 ft
 Soil test (0-6 in.): P=22 ppm; K=177 ppm; pH=7.9 ; OM=2.2% Previous crop: Field Pea
 (0-24 in.): NO3-N=25 lb/a Planted: 4/24/2019
 Yield goal: 200 bu/a Harvested: 8/19/2019
 Planting population: 1.25 million seeds/a Soil type: Lihen Loamy Fine Sand
 Applied fertilizer: 208 lb/a of Urea (46-0-0) [4/18] Plot size: 92 ft^2
 Herbicides applied: Aim 0.5 oz/a, Rhonox 1 pt/a, and Moxy 1 pt/a (6/5) Rainfall: 9.6 in (4/24 - 8/19)
 Fungicides applied: None applied

Flax Variety Descriptions

| Variety ¹ | ORIGIN ² | YEAR RELEASED | RELATIVE MATURITY ³ | SEED COLOR | PLANT HEIGHT ³ | RESISTANCE TO WILT ⁴ |
|----------------------|---------------------|---------------|--------------------------------|------------|---------------------------|---------------------------------|
| ACC Bright | Canada | 2016 | LATE | YELLOW | M TALL | MR |
| Bison | NDSU | 1926 | MEDIUM | BROWN | MEDIUM | MR |
| Carter | NDSU | 2004 | MEDIUM | YELLOW | MEDIUM | MR |
| CDC Bethume | Canada | 1999 | M LATE | BROWN | M TALL | MR |
| CDC Glas | Canada | 2012 | M LATE | BROWN | M TALL | MR |
| CDC Melyn | Canada | 2016 | M LATE | YELLOW | MEDIUM | MR |
| CDC Neela | Canada | 2013 | M LATE | BROWN | MEDIUM | MR |
| CDC Plava | Canada | 2015 | MEDIUM | BROWN | MEDIUM | MR |
| CDC Sanctuary | Canada | 2012 | MEDIUM | BROWN | M TALL | MR |
| CDC Sorrel | Canada | 2007 | M LATE | BROWN | M TALL | MR |
| Gold ND | NDSU | 2014 | MEDIUM | YELLOW | M TALL | MR/R |
| ND Hammond | NDSU | 2018 | NA | BROWN | NA | MS |
| Nekoma | NDSU | 2002 | LATE | BROWN | MEDIUM | MR |
| Omega | NDSU | 1989 | MEDIUM | YELLOW | MEDIUM | MS |
| Pembina | NDSU | 1998 | MEDIUM | BROWN | MEDIUM | MR |
| Prairie Blue | Canada | 2003 | M LATE | BROWN | MEDIUM | NA |
| Prairie Grande | Canada | 2008 | M EARLY | BROWN | MEDIUM | MR |
| Prairie Sapphire | Canada | 2012 | MEDIUM | BROWN | MEDIUM | MR |
| Prairie Thunder | Canada | 2006 | MEDIUM | BROWN | SHORT | NA |
| Webster | SDSU | 1998 | LATE | BROWN | TALL | MR |
| York | NDSU | 2002 | LATE | BROWN | MEDIUM | R |

²Refers to developer:

³M = Medium. ⁴MR = Moderately resistant; MS = Moderately susceptible; NA = Data not available; R = Resistant; S = Susceptible.

Flax Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Stand (%) | Days to Flowering (DAP) | Days to Maturity (DAP) | Plant height (in) | Oil [†] (%) | Test weight (lb/bu) | Yield | | |
|-----------------|-----------|-------------------------|------------------------|-------------------|----------------------|---------------------|-------------|-----------------|-----------------|
| | | | | | | | 2019 (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg (bu/a) |
| OMEGA | 64 | 56 | 94 | 27.3 | 43.4 | 53.2 | 21.8 | 21.2 | 17.4 |
| CDC GLAS | 69 | 55 | 94 | 28.0 | 44.4 | 47.8 | 21.3 | 18.3 | 16.4 |
| CDC NEELA | 40 | 56 | 97 | 24.4 | 43.0 | 51.3 | 16.2 | 16.6 | 15.0 |
| YORK | 70 | 54 | 94 | 27.2 | 43.7 | 51.0 | 16.2 | 17.1 | 14.6 |
| PRAIRIE THUNDER | 58 | 55 | 95 | 27.7 | 43.1 | 51.1 | 19.3 | 15.2 | 14.0 |
| GOLD ND | 59 | 55 | 95 | 28.1 | 44.7 | 52.2 | 14.0 | 15.1 | 13.6 |
| BISON | 66 | 54 | 94 | 27.6 | 43.1 | 52.1 | 12.6 | 14.1 | 13.5 |
| CARTER | 63 | 53 | 95 | 25.3 | 42.9 | 51.9 | 13.9 | 14.9 | 13.3 |
| WEBSTER | 66 | 54 | 97 | 28.2 | 44.4 | 51.5 | 13.2 | 13.4 | 12.2 |
| ND HAMMOND | 63 | 54 | 96 | 25.9 | 42.3 | 50.3 | 15.9 | 13.8 | - |
| CDC BURYU | 76 | 53 | 94 | 27.0 | 43.4 | 52.3 | 26.8 | - | - |
| CDC MELYN | 60 | 56 | 94 | 26.4 | 45.3 | 46.0 | 15.3 | - | - |
| CDC PLAVA | 73 | 55 | 95 | 26.5 | 44.7 | 47.7 | 28.8 | - | - |
| CDC BRIGHT | 76 | 54 | 94 | 25.9 | 45.9 | 45.3 | 21.5 | - | - |
| Mean | 63 | 55 | 95 | 27.1 | 44.0 | 51.2 | 17.4 | - | - |
| CV (%) | 23 | 2 | 2 | 6.2 | 0.8 | 1.3 | 21.4 | - | - |
| LSD (5%) | 21 | 2 | 3 | 2.3 | 0.5 | 1.0 | 5.2 | - | - |
| LSD (10%) | 17 | 1 | 2 | 2.0 | 0.4 | 0.8 | 4.4 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft

Previous crop: German Foxtail Millet

Planted: 5-3-2019

Harvested: 09-23-2019

[†]Oil adjusted to 9% moisture

Soil type: Williams-Bowbells loam

Soil test to 6" in ppm: P=26 ppm K=301 ppm OM=1.8% pH=5.9

Soil test to 24" in lb/a: N=106 lb/a

Applied fertilizers in lb/a: N=21; P=24; K=0; S=6; Zn=0.6 (60 lbs/a MESZ applied with seed , 30 lbs of Urea broadcast)

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18) ; Bison @ 0.9pt/a with Secure EC @ 12 oz/a (6/24/2019)

Flax Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Days to Flower (DAP*) | Days to Maturity (DAP*) | Lodging (0 - 9 ⁺) | Plant Height (in) | Oil† | | | Yield | | | |
|-----------------|--------------------------|----------------------------|----------------------------------|----------------------|----------|--------------|--------------|------------------------|-------------|-----------------|-----------------|
| | | | | | 2019 (%) | 2-Yr Avg (%) | 3-Yr Avg (%) | Test Weight (lb/bu) | 2019 (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg (bu/a) |
| Bison | 60 | 94 | 1 | 29 | 38.2 | 38.2 | 39.0 | 52.6 | 38.7 | 30.2 | 33.1 |
| CDC Sanctuary | 59 | 94 | 0 | 28 | 38.6 | 38.1 | 38.7 | 51.9 | 36.6 | 29.8 | 32.4 |
| York | 59 | 95 | 0 | 26 | 39.0 | 38.4 | 38.9 | 52.4 | 32.8 | 27.9 | 30.8 |
| Gold ND | 59 | 97 | 0 | 28 | 40.3 | 39.2 | 39.6 | 53.3 | 31.2 | 26.7 | 30.6 |
| CDC Sorrel | 58 | 95 | 0 | 29 | 38.6 | 38.7 | 39.1 | 52.5 | 33.9 | 27.6 | 29.6 |
| CDC Glas | 58 | 94 | 0 | 25 | 39.9 | 39.2 | 39.7 | 51.8 | 21.2 | 22.5 | 27.5 |
| ND Hammond | 58 | 94 | 0 | 28 | 38.5 | 38.0 | - | 52.5 | 35.2 | 29.2 | - |
| Prairie Thunder | 60 | 95 | 0 | 31 | 37.4 | 37.3 | - | 52.7 | 38.0 | 28.8 | - |
| CDC Melyn | 58 | 92 | 0 | 26 | 39.0 | 39.5 | - | 53.3 | 25.2 | 28.5 | - |
| Pembina | 59 | 95 | 1 | 28 | 38.6 | 38.5 | - | 52.7 | 29.9 | 26.5 | - |
| Rahab 94 | 60 | 94 | 0 | 28 | 38.7 | 38.3 | - | 52.1 | 29.6 | 26.2 | - |
| CDC Bethume | 58 | 96 | 0 | 28 | 38.7 | - | - | 52.7 | 29.2 | - | - |
| MEAN | 58.7 | 94.3 | 0.2 | 27.8 | 38.80 | 38.49 | 39.18 | 52.51 | 32.02 | 27.63 | 30.67 |
| C.V. (%) | 2.2 | 2.6 | 214.8 | 6.9 | 1.77 | - | - | 1.42 | 19.26 | - | - |
| LSD (5%) | 1.9 | 3.5 | ns | 2.8 | 0.99 | - | - | 1.08 | 8.81 | - | - |
| LSD (10%) | 1.5 | 2.9 | 0.5 | 2.3 | 0.82 | - | - | 0.89 | 7.33 | - | - |

* Days after planting † 0: no lodging - 9: plants lying flat on the ground ‡ Oil content adjusted to 9% moisture

Location: Latitude 48 9.9222 N; Longitude 103 6.132 W

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6; OM=3.1%

(0-24 in.): NO3-N=15 lb/a

Yield goal: 50 bu/a

Planting population: 1 million seeds/a

Applied fertilizer: 141 lb/a of Urea (46-0-0)

Herbicides applied: Spartan Charge 2 oz/a and Preference 7 oz/a (5/10),

Section 3EC 5.33 oz/a, 28-0-0 2 at/a, Destiny HC 1.5 pt/a (6/24), Gramaxone SL 2.0 2 pt/a and Destiny HC 2 qt/100 gal (8/28)

Fungicides applied: Priaxor D 8 oz/a (7/12)

Elevation: 1902 ft

Previous crop: Corn

Planted: 5/6/2019

Harvested: 8/30/2019

Soil type: Lihen Loamy Fine Sand

Plot size: 61 ft²

Rainfall: 9.4 in. (5/6 - 8/30)

Safflower Variety Descriptions

| VARIETY | ORIGIN ¹ | PVP ² | HULL TYPE ³ | OIL TYPE ⁴ | IRRIGATED YIELD ⁵ | DRYLAND YIELD ⁵ | TWT ⁵ | OIL ⁵ | MATURITY | TOLERANCE ⁶ | |
|--------------|---------------------|------------------|------------------------|-----------------------|------------------------------|----------------------------|------------------|------------------|----------|------------------------|----|
| | | | | | | | | | | ALT | BB |
| BALDY | MT | YES | N | HIGH LINO | GOOD | GOOD | V HIGH | LOW | MED | NA | NA |
| CARDINAL | MT/NDSU | YES | N | HIGH LINO | V GOOD | V GOOD | HIGH | FAIR | MED | T | MT |
| FINCH | MT/NDSU | NO | N | HIGH LINO | GOOD | V GOOD | V HIGH | FAIR | M EARLY | MS | T |
| HYBRID 200 | STI | YES | N | HIGH OLEIC | V GOOD | V GOOD | V HIGH | FAIR | MED | MT | NA |
| HYBRID 300 | STI | YES | N | HIGH OLEIC | V GOOD | V GOOD | V HIGH | FAIR | MED | MT | NA |
| HYBRID 446 | STI | YES | N | HIGH OLEIC | V GOOD | V GOOD | V HIGH | FAIR | MED | MT | NA |
| HYBRID 528 | STI | YES | STP | HIGH OLEIC | GOOD | GOOD | M HIGH | GOOD | MED | MT | NA |
| HYBRID 621 | STI | YES | STP | HIGH OLEIC | GOOD | GOOD | M HIGH | GOOD | MED | MT | NA |
| 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 | MT/NDSU | YES | N | HIGH OLEIC | GOOD | V GOOD | HIGH | FAIR | M EARLY | T | MT |
| MONTOLA 2000 | MT/NDSU | YES | N | HIGH OLEIC | M GOOD | GOOD | MED | GOOD | EARLY | MS | MS |
| MONTOLA 2001 | MT/NDSU | YES | STP | HIGH OLEIC | GOOD | FAIR | MED | GOOD | MED | MT | MT |
| MONTOLA 2003 | MT/NDSU | YES | N | HIGH OLEIC | V GOOD | V GOOD | M HIGH | GOOD | M EARLY | MT | MT |
| MONTOLA 2004 | MT/NDSU | YES | N | HIGH OLEIC | GOOD | GOOD | M HIGH | GOOD | M EARLY | MS | MT |
| MORLIN | MT/NDSU | YES | STP | HIGH LINO | V GOOD | GOOD | MED | GOOD | M LATE | T | T |
| NUTRASAFF | MT/NDSU | YES | RED | HIGH LINO | GOOD | GOOD | MED | HIGH | MED | T | MT |
| RUBIS RED | MT | YES | N | HIGH LINO | GOOD | GOOD | V HIGH | LOW | MED | NA | NA |
| STI 1201 | STI | YES | STP | HIGH OLEIC | GOOD | GOOD | M HIGH | GOOD | MED | MT | NA |
| STI 1401 | STI | YES | STP | HIGH OLEIC | GOOD | GOOD | M HIGH | HIGH | MED | MT | NA |

¹Refers to developer: MT = Montana State University; NDSU = North Dakota State University; STI = Safflower Technologies International.

²PVP = Plant Variety Protection. "YES" indicates that the variety is protected, and the seed may be sold for planting purposes only as a class of certified seed (Title V option) and/or exclusive licensed variety. ³N = Normal; RED = Reduced; STP = Striped. ⁴Lino = Linoleic.

⁵Relative ratings of yield, test weight, and oil will vary under conditions of moderate-severe disease infestation.

⁶Alt = Alternaria leaf spot disease; BB = Bacterial blight; MS = Moderately susceptible; MT = Moderately tolerant; S = Susceptible; T = Tolerant. NA = Not Available

Safflower Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Oil Type | Stand | Days to heading | Plant Height | Oil [†] | Test weight | Yield | | |
|--------------|------------|-------|-----------------|--------------|------------------|-------------|-------|----------|----------|
| | | | | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| Chickadee | High Lino | 65 | 83.0 | 21.2 | 40.3 | 40.7 | 1865 | 1501 | 1321 |
| Cardinal | High Lino | 71 | 84.8 | 23.2 | 38.4 | 37.0 | 1583 | 1412 | 1257 |
| Hybrid 1601 | High Oleic | 59 | 83.8 | 25.3 | 37.3 | 32.1 | 1375 | 1324 | 1244 |
| Hybrid 446 | High Oleic | 53 | 82.8 | 22.6 | 39.9 | 39.8 | 1375 | 1340 | 1221 |
| Hybrid 528 | High Oleic | 59 | 82.5 | 24.4 | 38.1 | 31.7 | 1500 | 1380 | 1218 |
| Hybrid 300 | High Oleic | 54 | 82.3 | 23 | 40.8 | 40.0 | 1400 | 1281 | 1208 |
| Hybrid 200 | High Oleic | 22 | 88.0 | 23.2 | 38.3 | 37.7 | 1239 | 1270 | 1205 |
| Montola 2003 | High Oleic | 48 | 86.3 | 21.1 | 40.2 | 37.3 | 1216 | 1289 | 1057 |
| MonDak | High Oleic | 49 | 85.3 | 22.8 | 41.8 | 37.3 | 1360 | 1137 | 1054 |
| Morlin | High Lino | 81 | 85.0 | 20.2 | 38.2 | 34.8 | 1442 | 1215 | 1028 |
| Hybrid 570 | High Oleic | 56 | 83.5 | 23.5 | 39.4 | 33.9 | 1109 | 1074 | 1002 |
| Rubis Red | High Lino | 43 | 82.5 | 21.4 | 36.7 | 40.6 | 1143 | 1051 | 966 |
| Hybrid 621 | High Oleic | 51 | 83.8 | 21.9 | 40.6 | 29.0 | 856 | 928 | 959 |
| Finch | High Lino | 68 | 82.0 | 22.5 | 42.0 | 36.3 | 934 | 930 | 834 |
| NutraSaff | High Lino | 59 | 83.5 | 22.6 | 41.1 | 31.0 | 986 | 1040 | 825 |
| STI 1201 | High Oleic | 55 | 84.3 | 19.6 | 39.3 | 31.8 | 938 | 912 | 821 |
| Baldy | High Lino | 44 | 82.5 | 22.0 | 38.8 | 37.1 | 741 | 893 | 818 |
| Montola 2000 | High Oleic | 58 | 83.0 | 21.2 | 38.7 | 36.2 | 1452 | - | - |
| Mean | | 55 | 83.8 | 22.3 | 39.4 | 35.8 | 1251 | - | - |
| CV (%) | | 16.1 | 1.2 | 7.9 | 6.7 | 2.5 | 18 | - | - |
| LSD (5%) | | 12.6 | 1.4 | 2.5 | 3.8 | 1.2 | 314 | - | - |
| LSD (10%) | | 10.5 | 1.2 | 2.1 | 3.1 | 1.0 | 262 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Previous crop: German Millet

Planted: 05/02/2019

Harvested: 09/19/2019

Soil test to 6" in ppm: P=26 ppm K=301 ppm OM=1.8% pH=5.9

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=106 lb/a

Applied fertilizers in lb/a: N=21; P=24; K=0; S=6; Zn=0.6

(60 lbs/a MESZ applied with seed , 30 Ins of Urea broadcast)

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18)

[†]Oil adjusted to 10% moisture.

¹DAP = Days after planting.

Safflower Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Plant Height (in) | Oil† | | Test Weight (lb/bu) | Yield | |
|--------------|----------------------|-------------|-----------------|------------------------|----------------|--------------------|
| | | 2019 (%) | 3-Yr Avg (%) | | 2019 (lb/a) | 3-Yr Avg (lb/a) |
| Hybrid 446 | 32 | 38.3 | 31.5 | 37.6 | 1623 | 1886 |
| Montola 2003 | 30 | 42.2 | 36.5 | 35.3 | 1187 | 1838 |
| MonDak | 31 | 41.3 | 34.9 | 36.9 | 1463 | 1820 |
| Hybrid 200 | 31 | 38.7 | 31.6 | 35.7 | 1528 | 1819 |
| Hybrid 300 | 33 | 39.7 | 31.9 | 39.0 | 1869 | 1796 |
| Hybrid 1601 | 33 | 42.9 | 35.3 | 29.4 | 1104 | 1793 |
| Cardinal | 32 | 40.9 | 34.9 | 34.5 | 1292 | 1629 |
| Rubis Red | 33 | 37.7 | 30.7 | 40.7 | 1133 | 1607 |
| STI 1201 | 29 | 43.7 | 40.7 | 31.2 | 1183 | 1433 |
| Baldy | 31 | 36.9 | 29.8 | 34.7 | 973 | 1432 |
| Finch | 32 | 40.4 | 35.1 | 32.2 | 987 | 1244 |
| Morlin | 30 | 38.1 | 35.7 | 31.9 | 944 | 1222 |
| STI1401 | 31 | 46.6 | 44.4 | 27.7 | 842 | 996 |
| NutraSaff | 33 | 45.1 | 44.5 | 28.4 | 773 | 887 |
| Chickadee | 28 | 42.3 | - | 38.6 | 1350 | - |
| Montola 2000 | 27 | 42.5 | - | 34.0 | 1394 | - |
| Montola 2001 | 32 | 34.9 | - | 28.4 | 1006 | - |
| MEAN | 31.1 | 40.70 | 35.54 | 33.90 | 1214.8 | 1528.8 |
| C.V. (%) | 5.7 | 1.27 | - | 2.11 | 15.9 | - |
| LSD (5%) | 3.0 | 0.86 | - | 1.19 | 320.8 | - |
| LSD (10%) | 2.5 | 0.72 | - | 0.99 | 266.8 | - |

* Days after planting * 0: no lodging - 9: plants lying flat on the ground † oil content reported on oven dried basis
 Location: Latitude 48 9.9222°N; Longitude 103 6.132°W Elevator: 1902 ft
 Soil test (0-6 in.): P=17 ppm; K=182 ppm; pH=7.6 ; OM=1.6% Previous Crop: Durum
 (0-24 in.): NO3-N=48 lb/a Planted: 5/7/2019
 Yield goal: 2,000 lb/a Harvested: 10/8/2019
 Planting population: Conventional 20 lb/a PLS, Hybrid 18 lb/a PLS Soil type: Lihen Loamy Fine Sand
 Applied fertilizer: 68 lb/a of Urea (46-0-0) [5/13] Plots size: 40 ft^2
 Herbicides applied: Prowl H2O 1 pt/a (5/10) Rainfall: 20.0 inches (5/7 - 10/8)
 Fungicides applied: Priaxor D 8 oz/a (7/17), and Priaxor D 8 oz/a (7/30)

Safflower Irrigated Variety Trial - EARC

EARC, Sidney, MT 2019

| Variety | Stand (%) | Days to Flowering (DAP ¹) | Plant height (in) | Oil (%) | Test weight (lb/bu) | Yield |
|--------------|--------------|--|----------------------|------------|------------------------|----------------|
| | | | | | | 2019 (lb/a) |
| Montola 2003 | 99 | 77 | 30 | 41.1 | 34.3 | 3193 |
| Hybrid 300 | 96 | 73 | 31 | 38.0 | 36.0 | 3135 |
| MonDak | 97 | 77 | 31 | 40.9 | 32.6 | 3011 |
| Chickadee | 99 | 76 | 28 | 41.3 | 33.4 | 2652 |
| Hybrid 200 | 89 | 75 | 30 | 37.6 | 35.8 | 2521 |
| Rubis Red | 98 | 73 | 29 | 36.0 | 34.6 | 2442 |
| Hybrid 1601 | 99 | 76 | 32 | 42.0 | 28.7 | 2363 |
| Hybrid 446 | 95 | 74 | 31 | 36.4 | 32.5 | 2360 |
| STI 1201 | 99 | 76 | 28 | 41.5 | 30.2 | 2204 |
| STI 1401 | 97 | 77 | 31 | 45.6 | 28.3 | 2187 |
| Morlin | 100 | 77 | 30 | 36.8 | 32.1 | 2115 |
| Montola 2000 | 98 | 75 | 28 | 38.7 | 27.5 | 2100 |
| NutraSaff | 98 | 66 | 32 | 45.6 | 29.1 | 1799 |
| Cardinal | 100 | 76 | 31 | 38.5 | 30.3 | 1710 |
| Montola 2001 | 97 | 76 | 29 | 34.9 | 26.0 | 1707 |
| Finch | 88 | 74 | 31 | 39.6 | 29.5 | 1365 |
| Baldy | 99 | 71 | 30 | 35.1 | 32.0 | 927 |
| Mean | 97 | 75 | 30 | 39.4 | 30.9 | 2146 |
| CV (%) | 3.5 | 4.3 | 3.9 | 5.1 | 6.4 | 10.2 |
| LSD (5%) | 5.6 | 5.3 | 1.9 | 3.3 | 3.3 | 360.4 |
| LSD (10%) | 4.7 | 4.4 | 1.6 | 2.8 | 2.7 | 300.4 |

Location: EARC, Sidney, MT Previous crop: sugar beets
 Planted: 5/15/2019 Harvested: 10/16/2019
 Soil test (0-6"): P=25 ppm; K=350 ppm; pH=5.9; OM=2.6%. Soil type: Savage Silty Clay
 (0-24"): NO3-N=25 lb/a.
 Applied fertilizers in lb/a: N=100; P₂O₅=38; K₂O=0.
¹Oil adjusted to 0% moisture. ¹DAP = Days after planting.
 Precipitation: 22.5" Irrigation (sprinkler): 5.99"
 Herbicide applications: Sonalin & Eptam (3 pints/ac) on 5/8/2019.
 Fungicide applications: Priaxor (8 oz/ac) on 7/26/2019 and 8/14/2019.

Sunflower Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Company | Hybrid Type | Oil Type | Days to Flowering | Days to Maturity | Height | Oil [†] | Test Weight | Yield | | |
|----------------|-----------|--------------|------------|---------------------|---------------------|--------|------------------|-------------|--------|----------|----------|
| | | | | | | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| | | | | (DAP ¹) | (DAP ¹) | (in) | (%) | (lb/bu) | (lb/a) | (lbs/a) | (lbs/a) |
| N4HM354 | Nuseed | Clearfield | Nusun | 70 | 130 | 46 | 42.3 | 32.59 | 1002 | 1743 | 1868 |
| Camaro II | Nuseed | Clearfield | Nusun | 67 | 131 | 44 | 42.9 | 32.49 | 1052 | 1782 | 1856 |
| Falcon | Nuseed | Express | Nusun | 70 | 131 | 45 | 42.3 | 32.37 | 987 | 1765 | 1803 |
| E-362436 | Proseed | Conventional | Nusun | 69 | 133 | 52 | 41.7 | 34.65 | 1196 | - | - |
| E-91 E | Proseed | Express | Nusun | 69 | 131 | 52 | 37.0 | 29.23 | 862 | - | - |
| E-92 E | Proseed | Express | Nusun | 73 | 132 | 59 | 40.2 | 29.99 | 923 | - | - |
| N4H470 CL Plus | Nuseed | Clearfield | High Oleic | 71 | 133 | 46 | 48.3 | 33.85 | 1428 | - | - |
| N4H302 E | Nuseed | Express | High Oleic | 69 | 132 | 46 | 44.7 | 30.45 | 1138 | - | - |
| H42HO18CL | Dyna-Gro | Clearfield | High Oleic | 68 | 130 | 39 | 45.2 | 31.86 | 807 | - | - |
| H44HO12CL | Dyna-Gro | Clearfield | High Oleic | 66 | 133 | 44 | 43.5 | 32.51 | 1340 | - | - |
| H45HO10EX | Dyna-Gro | Express | High Oleic | 70 | 133 | 46 | 42.1 | 30.80 | 686 | - | - |
| H45NS16CL | Dyna-Gro | Clearfield | Nusun | 67 | 132 | 43 | 43.9 | 34.70 | 1397 | - | - |
| H48HO15CL | Dyna-Gro | Clearfield | High Oleic | 72 | 133 | 49 | 48.4 | 31.68 | 1329 | - | - |
| H49HO19CL | Dyna-Gro | Clearfield | High Oleic | 71 | 131 | 48 | 46.2 | 32.05 | 1294 | - | - |
| H49NS14CL | Dyna-Gro | Clearfield | Nusun | 70 | 133 | 45 | 43.5 | 33.86 | 1247 | - | - |
| CP450E | Windfield | Express | High Oleic | 71 | 133 | 42 | 37.9 | 30.56 | 1189 | - | - |
| CP455E | Windfield | Express | High Oleic | 70 | 133 | 43 | 42.3 | 32.27 | 989 | - | - |
| Mean | | | | 69 | 131.8 | 47.0 | 41.8 | 31.9 | 1127 | - | - |
| CV (%) | | | | 1.5 | 0.7 | 4.4 | 4.4 | 2.1 | 14.5 | - | - |
| LSD (5%) | | | | 1.4 | 1.3 | 2.9 | 2.6 | 1.0 | 231.7 | - | - |
| LSD (10%) | | | | 1.2 | 1.1 | 2.4 | 2.2 | 0.8 | 193.5 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Previous crop: Cover Crop

Planted: 5/28/2019

Harvested: 10/8/2019

Soil test to 6" in ppm: P=26 ppm; K=301 ppm; OM=1.8%; pH=5.9

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=106 lb/a

Applied fertilizers in lb/a: N=36; P₂O₅=26; K₂O=0.

[†] Oil adjusted to 10% moisture.

¹DAP = Days after planting.

Sunflower Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Company / Brand | Hybrid Type | Oil Type | Days to Flower | Plant Height | Oil [†] | Test Weight | Harvest Moisture | Yield [‡] |
|----------------|-----------------|--------------|------------|----------------|--------------|------------------|-------------|------------------|--------------------|
| | | | | | | | | | |
| Falcon | Nuseed | Express | Nusun | 75 | 46 | 40.3 | 32.3 | 12.4 | 3078 |
| N4H470 CL Plus | Nuseed | Clearfield | High Oleic | 76 | 45 | 41.8 | 28.2 | 15.2 | 2830 |
| H49NS14CL | Dyna-Gro | Clearfield | Nusun | 76 | 41 | 38.2 | 31.2 | 15.8 | 2674 |
| Camaro II | Nuseed | Clearfield | Nusun | 75 | 46 | 40.0 | 31.3 | 13.7 | 2605 |
| N4H302 E | Nuseed | Express | High Oleic | 73 | 51 | 38.2 | 26.2 | 12.6 | 2513 |
| H48HO15CL | Dyna-Gro | Clearfield | High Oleic | 76 | 46 | 43.0 | 29.0 | 15.1 | 2379 |
| H45NS16CL | Dyna-Gro | Clearfield | Nusun | 70 | 47 | 38.6 | 31.3 | 12.2 | 2365 |
| H49HO19CL | Dyna-Gro | Clearfield | High Oleic | 76 | 42 | 38.1 | 28.3 | 15.9 | 2358 |
| H42HO18CL | Dyna-Gro | Clearfield | High Oleic | 71 | 44 | 38.8 | 30.8 | 12.4 | 2289 |
| H45HO10EX | Dyna-Gro | Express | High Oleic | 73 | 49 | 39.5 | 28.5 | 12.7 | 2241 |
| E-362436 | Proseed | Conventional | Nusun | 71 | 51 | 36.5 | 31.2 | 13.6 | 2154 |
| H44HO12CL | Dyna-Gro | Clearfield | High Oleic | 68 | 46 | 40.1 | 30.3 | 12.8 | 2109 |
| E-91 E | Proseed | Express | Nusun | 75 | 56 | 35.6 | 30.0 | 11.8 | 2095 |
| E-31 CL | Proseed | Clearfield | Nusun | 75 | 49 | 33.6 | 29.0 | 12.3 | 1954 |
| N4HM354 | Nuseed | Clearfield | Nusun | 71 | 46 | 40.0 | 31.8 | 12.1 | 1870 |
| E-92 E | Proseed | Express | Nusun | 77 | 62 | 35.8 | 26.5 | 12.4 | 1755 |
| MEAN | | | | 73.5 | 47.9 | 38.63 | 29.74 | 13.30 | 2329.3 |
| C.V. (%) | | | | 1.1 | 10.0 | 4.35 | 5.33 | 6.17 | 19.5 |
| LSD (5%) | | | | 1.2 | 6.8 | 2.40 | 2.26 | 1.17 | 648.2 |
| LSD (10%) | | | | 5.7 | 5.7 | 2.00 | 1.88 | 0.97 | 540.5 |

* Days after planting † 0: no lodging - 9: plants lying flat on the ground ‡ Oil content adjusted to 10% moisture † Yield adjusted to harvest moisture

Location: Latitude 48 9.9222N; Longitude 103 6.132W

Elevation: 1902 ft

Soil test (0-6 in.): P=20 ppm; K=191 ppm; pH=7.7 ; OM=2%

Previous crop: Soybean

(0-24 in.): NO3-N=34 lb/a

Planted: 5/21/2019

Planting population: 26,000 seeds/a

Harvested: 11/26/2019

Applied fertilizer: 265 lb/a of Urea (46-0-0) [5/8]

Soil type: Lihen Loamy Fine Sand

Herbicides applied: Prowl H2O 1.5 pt/a (5/23) and Section 3EC 5.33 oz/a (6/24)

Plot size: 260 ft^2

Fungicides applied: none applied

Rainfall: 19.5 inches (5/21 - 11/26)

Canola-Clearfield Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Company/ Brand | Flower Duration | Days to Maturity | Plant height | Lodging | Oil [†] | Test weight | Yield [#] | |
|-----------|-------------------|--------------------|---------------------|-----------------|---------|------------------|-------------|--------------------|--|
| | | | | | | | | 2019 | |
| | | (days) | (DAP ¹) | (in) | (0-9) | (%) | (lb/bu) | (bu/a) | |
| CS2500 CL | Canterra Seeds | 28 | 103.0 | 36.0 | 5.5 | 45.5 | 51.7 | 1423.6 | |
| 5545 CL | BrettYoung | 29 | 103.0 | 41.0 | 3.0 | 45.9 | 51.3 | 1339.1 | |
| Mean | | 28 | 102.2 | 36.3 | 3.7 | 45.3 | 51.5 | 1333.8 | |
| CV (%) | | 4.9 | 1.9 | 6.8 | 28.7 | 4.1 | 0.5 | 14.2 | |
| LSD (5%) | | 2.2 | 3.1 | 4.0 | 1.7 | 3.0 | 0.4 | 303.4 | |
| LSD (10%) | | 1.8 | 2.5 | 3.2 | 1.4 | 2.4 | 0.3 | 245.9 | |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Previous crop: soybeans

Planted: 05/07/2019

Harvested: 08/28/2019

Soil test to 6" in ppm: P=24 ppm K=363 OM=2.0 pH=5.7

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=37.5 lb/a

Applied fertilizers in lb/a: N=90; P=24; K=0; S=46; Zn=0.6

[†]Seed Oil Content = Oils are reported on a oven dried basis, 120 ° F for 4 hours.

[#]Yield reported on a 13.5% moisture basis.

¹DAP = Days after planting.

Canola-Roundup Ready Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Company/ Brand | Flower Duration | Days to Maturity | Plant height | Lodging | Oil [†] | Test Weight | Yield [#] | | |
|-------------|-------------------|--------------------|---------------------|-----------------|---------|------------------|----------------|--------------------|----------|----------|
| | | | | | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| | | (days) | (DAP ¹) | (in) | (0-9) | (%) | (lb/bu) | ------(bu/a)----- | | |
| 6074 RR | BrettYoung | 28 | 102.3 | 37.6 | 1.5 | 48.4 | 51.2 | 1471.3 | 1343.7 | 1126.8 |
| CP930RR | Croplan | 29 | 101.0 | 33.7 | 3.8 | 48.3 | 51.3 | 1235.3 | 1147.1 | 1096.4 |
| 300 Mag | Proseed | 28 | 101.8 | 34.4 | 4.8 | 46.4 | 51.7 | 1048.5 | 1107.2 | 1025.5 |
| CP955RR | Croplan | 28 | 102.5 | 34.1 | 3.0 | 47.7 | 51.5 | 976.9 | 973.9 | 994.3 |
| Star 402 | Star | 29 | 102.5 | 34.5 | 2.8 | 50.1 | 51.0 | 1015.2 | 982.1 | 969.4 |
| PS 5000 | Proseed | 28 | 99.5 | 34.0 | 5.3 | 44.9 | 52.0 | 878.3 | 939.7 | 928.1 |
| 4187 RR | BrettYoung | 27 | 103.3 | 35.4 | 2.3 | 48.2 | 51.2 | 1083.0 | 1032.0 | - |
| 6090 RR | BrettYoung | 28 | 103.0 | 36.5 | 4.3 | 48.0 | 47.2 | 974.5 | 828.7 | - |
| CS2100 | Canterra Seeds | 29 | 102.0 | 36.4 | 3.5 | 45.6 | 52.0 | 1173.6 | - | - |
| CS2300 | Canterra Seeds | 29 | 104.5 | 39.1 | 2.3 | 47.4 | 50.2 | 925.0 | - | - |
| CS2600 CR-T | Canterra Seeds | 30 | 102.8 | 31.0 | 3.5 | 46.9 | 51.5 | 882.0 | - | - |
| CP9982RR | Croplan | 29 | 104.8 | 39.9 | 3.0 | 44.8 | 50.9 | 930.1 | - | - |
| CP9919RR | Croplan | 31 | 100.8 | 26.3 | 6.3 | 44.9 | 35.9 | 255.0 | - | - |
| CP9978TF | Croplan | 28 | 103.5 | 35.3 | 2.5 | 46.2 | 51.9 | 1339.5 | - | - |
| Starflex | Star | 27 | 101.3 | 33.2 | 2.8 | 49.0 | 51.6 | 1109.8 | - | - |
| Mean | | 28 | 102.4 | 34.7 | 3.4 | 47.2 | 50.2 | 1019.6 | - | - |
| CV (%) | | 7.2 | 1.7 | 11.2 | 48.0 | 3.7 | 3.7 | 24.1 | - | - |
| LSD (5%) | | 2.9 | 2.5 | 5.5 | 2.3 | 2.5 | 2.6 | 350.5 | - | - |
| LSD (10%) | | 2.4 | 2.1 | 4.6 | 1.9 | 2.1 | 2.2 | 292.3 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Previous crop: soybeans

Planted: 05/07/2019

Harvested: 08/28/2019

Soil test to 6" in ppm: P=24 ppm K=363 OM=2.0 pH=5.7

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=37.5 lb/a

Applied fertilizers in lb/a: N=90; P=24; K=0; S=46; Zn=0.6

[†]Seed Oil Content = Oils are reported on a oven dried basis, 120 ° F for 4 hours.

[#]Yield reported on a 13.5% moisture basis.

¹DAP = Days after planting.

RR Canola Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Company / Brand | Days to Flower (DAP*) | Flower Duration (days) | Days to Maturity (DAP*) | Lodging (0 - 9*) | Oil† | | | Test | | | Yield | | |
|-----------|-----------------|-----------------------|------------------------|-------------------------|------------------|----------|--------------|--------------|----------------|-------------|-----------------|-----------------|-------------|-----------------|
| | | | | | | 2019 (%) | 2-Yr Avg (%) | 3-Yr Avg (%) | Weight (lb/bu) | 2019 (lb/a) | 2-Yr Avg (lb/a) | 3-Yr Avg (lb/a) | 2019 (lb/a) | 2-Yr Avg (lb/a) |
| CP930RR | CROPLAN | 58 | 11 | 100 | 0 | 43.6 | 43.0 | 42.4 | 48.4 | 1979 | 2246 | 2805 | | |
| CP955RR | CROPLAN | 57 | 14 | 100 | 0 | 44.1 | 42.8 | 42.2 | 48.4 | 2081 | 2172 | 2771 | | |
| 6074 RR | BrettYoung | 60 | 12 | 97 | 0 | 43.8 | 41.6 | 41.3 | 48.7 | 2208 | 2118 | 2693 | | |
| Star 402 | Santerra Seed | 56 | 13 | 99 | 0 | 44.4 | 43.0 | 43.0 | 48.9 | 1821 | 2125 | 2662 | | |
| 300 Mag | Proseed | 56 | 16 | 101 | 0 | 42.9 | 41.8 | - | 48.9 | 1959 | 2882 | - | | |
| PS 5000 | Proseed | 58 | 13 | 99 | 0 | 41.3 | 40.6 | - | 49.4 | 1913 | 2545 | - | | |
| 4187 RR | BrettYoung | 59 | 14 | 98 | 0 | 43.3 | 42.1 | - | 48.6 | 2131 | 2191 | - | | |
| 6090 RR | BrettYoung | 60 | 10 | 98 | 0 | 42.4 | 41.1 | - | 49.5 | 1967 | 2110 | - | | |
| CP9978TF | CROPLAN | 58 | 12 | 100 | 0 | 41.7 | - | - | 49.2 | 1995 | - | - | | |
| Starflex | Santerra Seed | 56 | 13 | 98 | 0 | 42.6 | - | - | 49.2 | 1851 | - | - | | |
| CP9982RR | CROPLAN | 60 | 13 | 100 | 0 | 42.1 | - | - | 48.3 | 1654 | - | - | | |
| CP9919RR | CROPLAN | 55 | 13 | 96 | 0 | 40.5 | - | - | 48.9 | 1631 | - | - | | |
| MEAN | | 57.8 | 12.6 | 99.0 | 0.0 | 42.93 | 42.01 | 42.22 | 48.87 | 1959.9 | 2298.6 | 2732.8 | | |
| C.V. (%) | | 4.0 | 19.1 | 2.5 | - | 2.41 | - | - | 2.19 | 13.2 | - | - | | |
| LSD (5%) | | 3.3 | 3.4 | 3.6 | ns | 1.48 | - | - | ns | 366.2 | - | - | | |
| LSD (10%) | | 2.7 | 2.9 | 3.0 | ns | 1.23 | - | - | ns | 304.6 | - | - | | |

* Days after planting † 0: no lodging - 9: plants lying flat on the ground † Oil content adjusted to 8.5% moisture

Location: Latitude 48.9, 92.22'N; Longitude 103.6, 132'W

Elevation: 1902 ft

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6; OM=3.1%

Previous crop: Corn

(0-24 in.): NO3-N=15 lb/a

Planted: 5/6/2019

Yield goal: 2,500 lb/a

Harvested: 8/28/2019

Planting population: 260,000 seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: 125 lb/a of AMS (21-0-0-24S) and 171 lb/a of Urea (46-0-0)

Plot size: 61 ft²

Herbicides applied: Sonolan HFP 1.5 pt/a (5/10), Cornerstone 5 Plus 24 oz/a and Class Act 24 oz/a (6/13),

Rainfall: 9.4 in. (5/6 - 8/28)

Section 3EC 5.33 oz/a, 28-0-0 2 qt/a, and Destiny HC 1.5 pt/a (6/24)

Fungicides applied: Praxor D 8 oz/a (7/12)

Soybean Dryland Conventional Variety Trial -NDSU

WREC, Williston, ND 2019

| Variety | Company/Brand | Relative Maturity | Height (in.) | Days to Maturity (DAP) | Protein (%) | Test Weight (lb/bu) | Yield (bu/a) | 2-YR Avg Yield (bu/a) |
|---------------------|---------------|-------------------|--------------|------------------------|-------------|---------------------|--------------|-----------------------|
| ND Stutsman | NDSU | 0.7 | 25.8 | 124 | 31.8 | 56.7 | 42.4 | - |
| AG 00835 (RR check) | Asgrow | 0.08 | 21.5 | 119 | 31.1 | 56.3 | 40.8 | - |
| AG 00937 (RR check) | Asgrow | 0.09 | 23.0 | 119 | 33.4 | 55.2 | 39.4 | - |
| AG 0835 (RR check) | Asgrow | 0.8 | 26.0 | 129 | 30.6 | 54.7 | 37.8 | - |
| AG 00632 (RR check) | Asgrow | 0.06 | 23.2 | 119 | 33.1 | 56.7 | 36.9 | 28.0 |
| ND Henson | NDSU | 0.00 | 20.3 | 119 | 33.1 | 56.3 | 36.5 | 31.7 |
| ND Benson | NDSU | 0.4 | 23.0 | 129 | 34.3 | 56.6 | 36.0 | - |
| MEAN | | | 22.6 | 122.1 | 33.0 | 56.2 | 38.6 | - |
| C.V.(%) | | | 9.5 | 0.8 | 2.3 | 1.2 | 6.2 | - |
| LSD (5%) | | | 3.0 | 1.3 | 1.1 | 0.9 | 3.4 | - |
| LSD (10%) | | | 2.5 | 1.1 | 0.9 | 0.8 | 2.8 | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft

Previous crop: German Foxtail Millet

Planted: 5-14-2019

Harvested: 10-07-2019

Planting population: 140,000 seeds/a

Soil type: Williams-Bowbells loam

Soil test to 6" in ppm: P=26 ppm K=301 ppm OM=1.8% pH=5.9

Soil test to 24" in lb/a: N=106 lb/a

Applied fertilizers in lb/a: None

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18) ; Roundup @32oz/a (6/27/19)

Soybean Dryland Roundup Ready Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Company/Brand | Relative Maturity | Height (in.) | Days to Mature (DAP) | Protein (%) | Oil (%) | Test Weight (lb/bu) | Yield (bu/a) |
|---------------|---------------|-------------------|--------------|----------------------|-------------|---------|---------------------|--------------|
| 50309N | Integra | 0.3 | 22.9 | 119 | 32.1 | 19.1 | 56.6 | 43.8 |
| S03XT29 | Dyna-Gro | 0.3 | 24.6 | 119 | 31.8 | 19.3 | 56.2 | 43.5 |
| 19X03 | PFS | 0.3 | 22.8 | 119 | 31.9 | 19.1 | 56.6 | 42.6 |
| LGS0111RX | LG Seeds | 0.1 | 23.8 | 119 | 33.3 | 20.3 | 56.9 | 42.1 |
| 30-20 | Proseed | 0.2 | 25.1 | 120 | 33.8 | 19.7 | 56.3 | 42.0 |
| S02-F9X | Syngenta NK | 0.2 | 21.6 | 121 | 30.9 | 19.7 | 57.2 | 42.0 |
| RX00810 | REA hybrids | 00.8 | 17.8 | 119 | 32.9 | 20.4 | 55.7 | 41.0 |
| S01-C4X | Syngenta NK | 0.1 | 24.2 | 119 | 31.7 | 19.5 | 56.9 | 40.5 |
| XT 60-09 | Proseed | 00.9 | 24.8 | 119 | 32.8 | 18.4 | 56.9 | 40.0 |
| S009XT68 | Dyna-Gro | 00.9 | 25.1 | 119 | 32.9 | 18.5 | 57.3 | 39.8 |
| ND14-6120 | NDSU | 0.1 | 23.7 | 119 | 32.5 | 19.7 | 57.8 | 39.7 |
| RX0520 | REA hybrids | 0.5 | 25.2 | 129 | 32.4 | 19.3 | 56.1 | 39.1 |
| S007-Y4 | Syngenta NK | 00.7 | 21.9 | 119 | 31.8 | 20.1 | 57.1 | 39.0 |
| RX0330 | REA hybrids | 0.3 | 24.6 | 125 | 32.8 | 19.2 | 56.4 | 38.5 |
| ND17009GT | NDSU | 00.9 | 25.6 | 119 | 34.4 | 20.4 | 58.1 | 38.5 |
| EL 80-093 | Proseed | 00.9 | 21.3 | 119 | 30.9 | 20.4 | 56.4 | 38.4 |
| 16R01 | PFS | 0.1 | 26.1 | 119 | 33.5 | 20.4 | 56.4 | 38.3 |
| S006-R7X | Syngenta NK | 00.6 | 19.2 | 119 | 33.4 | 20.3 | 55.9 | 37.4 |
| ND18008GT | NDSU | 00.8 | 21.9 | 119 | 33.2 | 20.3 | 57.0 | 37.3 |
| LGS00899RX | LG Seeds | 00.8 | 23.5 | 119 | 31.9 | 20.3 | 56.9 | 36.9 |
| M06R-614008GT | UM | 00.8 | 18.4 | 120 | 32.5 | 20.4 | 56.5 | 36.9 |
| 40209 E3 | Integra | 0.3 | 22.3 | 122 | 32.0 | 19.5 | 56.0 | 36.4 |
| RX00749 | REA hybrids | 00.7 | 20.0 | 119 | 31.5 | 19.8 | 56.0 | 34.2 |
| 20EN02 | PFS | 0.2 | 20.4 | 124 | 31.3 | 19.5 | 55.9 | 33.3 |
| Mean | | | 22.9 | 120.0 | 32.5 | 19.7 | 56.7 | 39.0 |
| CV % | | | 8.3 | 0.8 | 1.9 | 1.3 | 0.8 | 7.8 |
| LSD 0.05 | | | 2.7 | 1.4 | 0.9 | 0.4 | 0.7 | 4.3 |
| LSD 0.1 | | | 2.2 | 1.2 | 0.7 | 0.3 | 0.6 | 3.6 |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft

Previous crop: German Foxtail Millet

Planted: 5-14-2019

Harvested: 10-07-2019

Planting population: 140,000 seeds/a

Soil type: Williams-Bowbells loam

Soil test to 6" in ppm: P=26 ppm K=301 ppm OM=1.8% pH=5.9

Soil test to 24" in lb/a: N=106 lb/a

Applied fertilizers in lb/a: None

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18) ; Roundup @32oz/a (6/27/19)

Soybeans Roundup Ready Dryland Off-Station Variety Trial-NDSU

Divide County, ND 2019

| Variety | Company/ Brand | Relative Maturity | Protein† | Test Weight (lb/bu) | Yield 2019 (bu/a) |
|---------------|-------------------|----------------------|----------|------------------------|----------------------|
| S03XT29 | Dyna-Gro | 0.3 | 36.2 | 55.8 | 47.8 |
| 30-20 | Proseed | 0.2 | 37.2 | 52.6 | 41.5 |
| S009XT68 | Dyna-Gro | 00.9 | 37.8 | 56.3 | 41.3 |
| LGS0111RX | LG Seeds | 0.1 | 36.9 | 54.0 | 40.5 |
| S01-C4X | Syngenta NK | 0.1 | 35.1 | 56.0 | 40.2 |
| ND14-6120 | NDSU | 0.1 | 37.1 | 57.2 | 35.0 |
| 40209 E3 | Integra | 0.3 | 36.9 | 51.9 | 35.0 |
| M06R-614008GT | UM | 00.8 | 36.6 | 53.5 | 34.9 |
| ND17009GT | NDSU | 00.9 | 37.7 | 56.6 | 34.9 |
| ND18008GT | NDSU | 00.8 | 36.2 | 55.9 | 34.1 |
| 20EN02 | PFS | 0.2 | 36.8 | 52.7 | 29.1 |
| RX0330 | REA Hybrids | 0.3 | 36.9 | 52.3 | 27.2 |
| Mean | | | 36.8 | 54.6 | 36.8 |
| CV % | | | 1.1 | 1.7 | 13.8 |
| LSD 0.05 | | | 0.7 | 1.6 | 8.6 |
| LSD 0.1 | | | 0.6 | 1.3 | 7.1 |

Location: Crosby, ND; Latitude 48° 8' N; Longitude 103° 18' W; Elevation 2044 ft.

Planted: 05/06/2019

Harvested: 10/16/2019

Soil test (0-6"): P=14 ppm; K=362 ppm; OM=3.0%.

Previous crop: spring wheat

(0-24"): NO3-N=14 lb/a.

Soil type: Farnuf-Alkabo

Applied fertilizers in lb/a: none

†Protein adjusted to 13% moisture.

Herbicide Applications: Spartan Charge @ 4oz/a with RT3 @ 32 oz/a (5/6/2019);

Basagran @ 1pt/a with Secure @ 8 oz/a (6/25/2019)

Soybeans Roundup Ready Dryland Off-Station Variety Trial-NDSU

McKenzie County, ND 2019

| Variety | Company/ Brand | Relative Maturity | Protein† | Test Weight (lb/bu) | Yield 2019 (bu/a) |
|---------------|-------------------|----------------------|----------|------------------------|----------------------|
| LGS0111RX | LG Seeds | 0.1 | 34.9 | 54.7 | 33.0 |
| S01-C4X | Syngenta NK | 0.1 | 34.3 | 55.9 | 29.7 |
| RX0330 | REA Hybrids | 0.3 | 32.7 | 53.2 | 28.3 |
| 30-20 | Proseed | 0.2 | 35.4 | 54.2 | 26.8 |
| ND14-6120 | NDSU | 0.1 | 35.7 | 55.3 | 24.9 |
| S009XT68 | Dyna-Gro | 00.9 | 35.2 | 55.6 | 24.6 |
| S03XT29 | Dyna-Gro | 0.3 | 34.1 | 54.7 | 24.1 |
| ND17009GT | NDSU | 00.9 | 35.9 | 56.1 | 23.6 |
| 20EN02 | PFS | 0.2 | 34.5 | 55.1 | 22.5 |
| 40209 E3 | Integra | 0.3 | 34.8 | 54.1 | 21.5 |
| M06R-614008GT | UM | 00.8 | 34.1 | 55.3 | 20.5 |
| ND18008GT | NDSU | 00.8 | 35.6 | 54.8 | 17.5 |
| Mean | | | 34.8 | 54.9 | 24.8 |
| CV % | | | 2.0 | 1.0 | 12.0 |
| LSD 0.05 | | | 1.2 | 0.9 | 5.0 |
| LSD 0.1 | | | 1.0 | 0.8 | 4.2 |

Location: Arnegard, ND; Elevation 2254 ft.

Previous crop: spring wheat

Planted: 05/13/2019

Harvested: 10/15/2019

†Protein adjusted to 13% moisture.

Soil type: Dooley-Zahl complex

Applied Fertilizer in lb/a: none

Herbicide Applications: Spartan Charge @ 4 oz/a with RT3 @ 32 oz/a (5/13/2019);

Basagran @ 1 pt/a with Secure @ 10 oz/a (6/18/2019)

Conventional Soybean Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Company / Brand | Relative Maturity | Plant Height (in) | Days to Maturity (DAP*) | Protein† | | Oil‡ | | Test Weight (lb/bu) | Yield | |
|-------------|-----------------|-------------------|-------------------|-------------------------|----------|--------------|----------|--------------|---------------------|-------------|-----------------|
| | | | | | 2019 (%) | 3-Yr Avg (%) | 2019 (%) | 3-Yr Avg (%) | | 2019 (bu/a) | 3-Yr Avg (bu/a) |
| ND Benson | NDSU | 0.4 | 24 | 128 | 35.4 | 36.0 | 15.3 | 14.5 | 57.5 | 49.3 | 56.0 |
| ND Rolette | NDSU | 00.9 | 21 | 122 | 36.1 | 35.7 | 14.8 | 14.5 | 57.8 | 44.8 | 51.2 |
| ND Henson | NDSU | 0.0 | 18 | 122 | 37.5 | 36.2 | 15.3 | 14.8 | 58.4 | 38.9 | 50.6 |
| ND Stutsman | NDSU | 0.7 | 22 | 129 | 36.6 | - | 15.4 | - | 58.4 | 47.8 | - |
| MEAN | | | 21.1 | 125.4 | 36.41 | 35.95 | 15.19 | 14.62 | 58.02 | 45.22 | 52.61 |
| C.V. (%) | | | 9.2 | 1.2 | 3.11 | - | 3.74 | - | 1.62 | 10.76 | - |
| LSD (5%) | | | 3.1 | 2.3 | 1.81 | - | ns | - | ns | 7.78 | - |
| LSD (10%) | | | 2.5 | 1.9 | 1.47 | - | ns | - | ns | 6.31 | - |

* Days after planting † Protein content adjusted to 13% moisture ‡ Oil content adjusted to 13% moisture

Lodging not reported for 2019 as no lodging was noted in the trial.

Location: Latitude 48 9.9222N; Longitude 103 6.132W

Elevation: 1902 ft

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6 ; OM=3.1% (0-24 in.): NO3-N=15 lb/a

Previous crop: Corn

Planted: 5/15/2019

Yield goal: 50 bu/a

Harvested: 10/8/2019

Planting population: 200,000 seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: none applied / seed inoculated

Plot size: 61 ft^2

Herbicides applied: Prowl H2O 1.5 pt/a (5/23), Section 3EC 5.33 oz/a, Destiny HC 1.5 pt/a, 28-0-0 2 qt/a (6/24), and Basagran 1 pt/a, Destiny HC 2 pt/a, Varisto 21 oz/a (6/26)

Rainfall: 20.0 in. (5/15 - 10/8)

Fungicides applied: Priaxor D 8 oz/a (7/12)

RR Soybean Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Company / Brand | Relative Maturity | Plant Height (in) | Days to Maturity (DAP*) | Protein† | | Oil‡ | | Test Weight (lb/bu) | Yield | |
|---------------|--------------------|-------------------|-------------------|-------------------------|----------|--------------|----------|--------------|---------------------|-------------|-----------------|
| | | | | | 2019 (%) | 3-Yr Avg (%) | 2019 (%) | 3-Yr Avg (%) | | 2019 (bu/a) | 3-Yr Avg (bu/a) |
| ND17009GT | NDSU | 00.9 | 16 | 120 | 36.7 | 37.7 | 15.3 | 14.6 | 58.0 | 29.3 | 51.3 |
| ND18008GT | NDSU | 00.8 | 14 | 119 | 37.9 | 37.7 | 14.5 | 14.4 | 58.5 | 21.4 | 44.1 |
| RX00749 | REA | 00.7 | 17 | 119 | 36.4 | - | 14.5 | - | 58.3 | 30.8 | - |
| RX0520 | REA | 0.5 | 19 | 131 | 36.2 | - | 14.5 | - | 57.8 | 43.9 | - |
| 50309N | Integra | 0.3 | 18 | 123 | 36.3 | - | 14.8 | - | 58.2 | 42.1 | - |
| 30-20 | Proseed | 0.2 | 20 | 126 | 36.6 | - | 14.7 | - | 57.9 | 41.6 | - |
| S02-F9X | NK | 0.2 | 18 | 121 | 36.2 | - | 15.2 | - | 57.9 | 41.6 | - |
| 19EN02 | Peterson Farm Seed | 0.2 | 18 | 129 | 37.1 | - | 14.8 | - | 57.8 | 41.2 | - |
| 16R01 | Peterson Farm Seed | 0.1 | 22 | 121 | 36.9 | - | 15.1 | - | 58.6 | 40.8 | - |
| S03XT29 | Dyna-Gro | 0.3 | 16 | 122 | 36.9 | - | 15.2 | - | 58.4 | 39.6 | - |
| RX0330 | REA | 0.3 | 19 | 127 | 36.0 | - | 15.0 | - | 58.0 | 38.5 | - |
| M06R-614008GT | U of M | 00.8 | 17 | 130 | 36.5 | - | 15.8 | - | 57.9 | 38.4 | - |
| S009XT68 | Dyna-Gro | 00.9 | 20 | 123 | 36.8 | - | 15.2 | - | 57.9 | 38.2 | - |
| 40209 E3 | Integra | 0.2 | 19 | 127 | 37.0 | - | 15.0 | - | 57.9 | 37.1 | - |
| GH0308X | Golden Harvest | 0.3 | 17 | 125 | 44.8 | - | 15.0 | - | 57.6 | 37.1 | - |
| 19X03 | Peterson Farm Seed | 0.3 | 18 | 121 | 36.6 | - | 15.5 | - | 58.5 | 36.5 | - |
| EL 80-093 | Proseed | 00.9 | 17 | 120 | 35.8 | - | 14.7 | - | 57.4 | 35.7 | - |
| XT 60-09 | Proseed | 00.9 | 20 | 119 | 35.9 | - | 15.4 | - | 57.8 | 34.7 | - |
| S01-C4X | NK | 0.1 | 18 | 124 | 37.3 | - | 14.9 | - | 58.1 | 34.0 | - |
| GH0145X | Golden Harvest | 0.1 | 20 | 121 | 36.4 | - | 15.0 | - | 57.6 | 33.2 | - |
| S007-Y4 | NK | 00.5 | 18 | 121 | 36.5 | - | 14.9 | - | 58.3 | 32.1 | - |
| RX00810 | REA | 00.8 | 17 | 120 | 37.4 | - | 14.4 | - | 57.9 | 30.3 | - |
| S0006-R7X | NK | 00.6 | 16 | 120 | 36.7 | - | 15.0 | - | 58.2 | 26.1 | - |
| MEAN | | | 18.0 | 122.9 | 37.00 | 37.70 | 14.98 | 14.50 | 58.02 | 35.82 | 47.70 |
| C.V. (%) | | | 9.5 | 1.9 | 9.64 | - | 4.68 | - | 1.00 | 13.42 | - |
| LSD (5%) | | | 2.4 | 3.3 | 5.04 | - | 0.99 | - | 0.82 | 9.51 | - |
| LSD (10%) | | | 2.0 | 2.7 | 4.21 | - | 0.83 | - | 0.68 | 5.67 | - |

* Days after planting † 0: no lodging - 9: plants lying flat on the ground † Protein content adjusted to 13% moisture ‡ Oil content adjusted to 13% moisture

Location: Latitude 48 9.9222N; Longitude 103 6.132W

Elevation: 1902 ft

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6 ; OM=3.1% (0-24 in.): NO3-N=15 lb/a

Previous crop: Corn

Planted: 5/15/2019

Yield goal: 50 bu/a

Harvested: 10/8/2019

Planting population: 200,000 seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: none applied

Plot size: 61 ft^2

Herbicides applied: Prowl H2O 1.5 pt/a and Spartan Charge 2 oz/a (5/23), Cornerstone 5 Plus 26 oz/a and Class Act 24 oz/a (6/13), and Section 3 EC 5.33 oz/a, Destiny HC 1.5 pt/a, and 28-0-0 2 qt/a (6/24),

Rainfall: 20.0 in. (5/15 - 10/8)

Fungicides applied: Priaxor D 8 oz/a (7/12)

Navy Bean Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Canopy Height (in) | Days to Maturity (DAP*) | Hundred Seed Weight (g) | Seeds / Pound | Test Weight (lb/bu) | Yield | |
|--------------|-----------------------|----------------------------|----------------------------|---------------|------------------------|----------------|--------------------|
| | | | | | | 2019 (lb/a) | 2-Yr Avg (lb/a) |
| HMS Medalist | 13 | 122 | 77 | 589 | 63.9 | 1447 | 1353 |
| T9905 | 11 | 124 | 79 | 580 | 61.9 | 1303 | 1318 |
| Blizzard | 12 | 122 | 78 | 580 | 62.4 | 1221 | 1221 |
| MEAN | 12.1 | 122.3 | 78.1 | 583.1 | 62.75 | 1323.8 | 1297.4 |
| C.V. (%) | 13.3 | 1.5 | 5.6 | 5.6 | 1.32 | 17.4 | - |
| LSD (5%) | ns | ns | ns | ns | 1.44 | ns | - |
| LSD (10%) | ns | ns | ns | ns | 1.14 | ns | - |

* Days after planting 0: no lodging - 9: plants lying flat on the ground

Location: Latitude 48 9.9222°N; Longitude 103 6.132°W

Elevation: 1902 ft

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6 ; OM=3.1%

Previous crop: Corn

(0-24 in.): NO3-N=15 lb/a

Planted: 5/21/2019

Yield goal: 2,500 lb/a

Harvested: 10/7/2019

Planting population: 125,000 seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: 265 lb/a of Urea (46-0-0) [6/4]

Plot size: 53 ft²

Herbicides applied: Prowl H2O 1.5 pt/a (5/23), Section 3EC 5.33 oz/a, Destiny HC 1.5 pt/a, 28-0-0 2 qt/a (6/24),

Rainfall: 19.5 in. (5/21 - 10/7)

Basagran 1 pt/a, Destiny HC 2 pt/a, Varisto 21 oz/a (6/26), Gramoxone 2.0 SL 2 pt/a, and Destiny HC 1 qt/ 100 gal (9/24)

Fungicides applied: Priaxor D 8 oz/a (7/12)

Pinto Bean Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Canopy Height (in) | Days to Maturity (DAP*) | Hundred Seed Weight (g) | Seeds / Pound | Test Weight (lb/bu) | Yield | | |
|----------------|-----------------------|----------------------------|----------------------------|---------------|------------------------|----------------|--------------------|--------------------|
| | | | | | | 2019 (lb/a) | 2-Yr Avg (lb/a) | 3-Yr Avg (lb/a) |
| Monterrey | 14 | 122 | 36 | 1256 | 57.2 | 1689 | 2185 | 3087 |
| LaPaz | 14 | 123 | 36 | 1244 | 55.9 | 1426 | 1974 | 2717 |
| Lariat | 12 | 121 | 37 | 1230 | 57.5 | 1702 | 2055 | 2641 |
| ND-Palomino | 15 | 123 | 35 | 1312 | 59.7 | 1663 | 1809 | 2364 |
| Stampede | 13 | 123 | 35 | 1316 | 58.4 | 1539 | 1776 | 2362 |
| Windbreaker | 13 | 122 | 36 | 1251 | 58.6 | 1942 | 1912 | 2299 |
| ND121315-Pinto | 11 | 123 | 36 | 1254 | 59.0 | 1896 | - | - |
| Torreón | 13 | 123 | 37 | 1229 | 58.6 | 1893 | - | - |
| Vibrant | 15 | 125 | 36 | 1261 | 57.3 | 1873 | - | - |
| ND-Falcon | 15 | 125 | 37 | 1245 | 57.1 | 1569 | - | - |
| MEAN | 13.5 | 122.8 | 36.1 | 1259.7 | 57.94 | 1719.3 | 1951.9 | 2578.5 |
| C.V. (%) | 15.2 | 1.8 | 5.7 | 6.1 | 2.96 | 13.7 | - | - |
| LSD (5%) | 3.5 | 3.3 | ns | ns | 2.49 | 341.2 | - | - |
| LSD (10%) | 2.9 | 2.7 | ns | ns | 2.07 | 283.2 | - | - |

* Days after planting 0: no lodging - 9: plants lying flat on the ground

Location: Latitude 48 9.9222°N; Longitude 103 6.132°W

Elevation: 1902 ft

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6 ; OM=3.1%

Previous crop: Corn

(0-24 in.): NO3-N=15 lb/a

Planted: 5/21/2019

Yield goal: 2,500 lb/a

Harvested: 10/7/2019

Planting population: 125,000 seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: 265 lb/a of Urea (46-0-0) [6/4]

Plot size: 53 ft²

Herbicides applied: Prowl H2O 1.5 pt/a (5/23), Section 3EC 5.33 oz/a, Destiny HC 1.5 pt/a, 28-0-0 2 qt/a (6/24),

Rainfall: 19.5 in. (5/21 - 10/7)

Basagran 1 pt/a, Destiny HC 2 pt/a, Varisto 21 oz/a (6/26), Gramoxone 2.0 SL 2 pt/a, and Destiny HC 1 qt/ 100 gal (9/24)

Fungicides applied: Priaxor D 8 oz/a (7/12)

Faba Bean Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Days to Maturity | Protein† | | Test Weight (lb/bu) | Yield | | |
|--------------|------------------|----------|---------------|---------------------|-------------|-----------------|-----------------|
| | | 2019 (%) | 2-Yr Avg‡ (%) | | 2019 (lb/a) | 2-Yr Avg (lb/a) | 3-Yr Avg (lb/a) |
| Laura | 93 | 26.7 | 24.8 | 62.9 | 2105 | 1476 | 2677 |
| Fabelle | 94 | 26.4 | 24.1 | 63.1 | 2566 | 1740 | 2457 |
| Boxer | 93 | 26.6 | 24.5 | 62.7 | 2043 | 3509 | - |
| FanFare | 96 | 26.5 | 24.3 | 62.5 | 2049 | 3308 | - |
| LG Cartouche | 94 | 26.7 | 26.7 | 62.0 | 2282 | - | - |
| MEAN | 93.9 | 26.58 | 24.87 | 62.65 | 2209.1 | 2508.2 | 2566.7 |
| C.V. (%) | 1.8 | 2.52 | - | 1.07 | 11.5 | - | - |
| LSD (5%) | ns | ns | - | 1.03 | 391.7 | - | - |
| LSD (10%) | 2.2 | ns | - | 0.84 | 320.4 | - | - |

* Days after planting 0: no lodging - 9: plants lying flat on the ground † Protein content adjusted to 16% moisture

‡ 2-Yr average from 2017 and 2019

Location: Latitude 48 9.9222°N; Longitude 103 6.132°W

Elevation: 1902 ft

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6 ; OM=3.1%

Previous crop: Corn

(0-24 in.): NO3-N=15 lb/a

Planted: 5/6/2019

Yield goal: 2,500 lb/a

Harvested: 9/4/2019

Planting population: 195,000 seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: none / seed inoculated

Plot size: 53 ft²

Herbicides applied: Prowl H2O 2 pt/a and Sharpen 0.5 oz/a (5/10), Section 3EC 5.33 oz/a, Destiny HC 1.5 pt/a,

Rainfall: 10.3 inches (5/6 - 9/4)

and 28-0-0 2 qt/a (6/24), Basag Basagran 1 pt/a, and Destiny HC 1 pt/a (6/26), and Gramoxone 2.0SL 2 pt/a, and Destiny HC 1 qt/100 gal (8/28)

Fungicides applied: Priaxor D 8 oz/a (7/12)

Insecticides applied: Mustang Maxx 4 oz/a (7/2)

Misc. Bean Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Market Class‡ | Canopy Height (in) | Days to Maturity (DAP*) | Hundred Seed Weight (g) | Seeds / Pound | Test Weight (lb/bu) | Yield | |
|-----------------|---------------|--------------------|-------------------------|-------------------------|---------------|---------------------|-------------|-----------------|
| | | | | | | | 2019 (lb/a) | 2-Yr Avg (lb/a) |
| Zorro | BL | 10 | 121 | 101 | 490 | 60.0 | 1424 | 2060 |
| Powderhorn | GN | 11 | 123 | 111 | 455 | 60.0 | 2194 | 1893 |
| Eclipse | BL | 12 | 121 | 134 | 338 | 57.9 | 1542 | 1669 |
| Loreto | BL | 11 | 125 | 91 | 542 | 60.5 | 1403 | 1558 |
| Rosetta | PK | 13 | 124 | 96 | 502 | 59.2 | 1505 | 1467 |
| Merlot | SR | 13 | 123 | 77 | 588 | 59.6 | 1980 | - |
| ND112929-Pink | PK | 14 | 120 | 113 | 426 | 58.3 | 1927 | - |
| ND-Pegasus | GN | 16 | 123 | 111 | 452 | 60.8 | 1799 | - |
| NDF120287-Black | BL | 11 | 121 | 104 | 474 | 60.0 | 1798 | - |
| Black Tails | BL | 12 | 124 | 100 | 487 | 56.4 | 1788 | - |
| Viper | SR | 15 | 122 | 99 | 492 | 60.4 | 1739 | - |
| MEAN | | 12.4 | 122.4 | 103.3 | 477.0 | 59.37 | 1736.4 | 1729.4 |
| C.V. (%) | | 14.5 | 1.7 | 31.3 | 30.4 | 3.91 | 24.9 | - |
| LSD (5%) | | 3.0 | 2.9 | 46.7 | 208.0 | 3.35 | 536.0 | - |
| LSD (10%) | | 2.5 | 2.4 | 38.9 | 173.1 | 2.78 | 445.9 | - |

* Days after planting 0: no lodging - 9: plants lying flat on the ground

‡ Market class: BL = Black, GN = Great Northern, SR = Small Red, PK = Pink

Location: Latitude 48 9.9222°N; Longitude 103 6.132°W

Elevation: 1902 ft

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6 ; OM=3.1%

Previous crop: Corn

(0-24 in.): NO3-N=15 lb/a

Planted: 5/21/2019

Yield goal: 2,500 lb/a

Harvested: 10/7/2019

Planting population: 125,000 seeds/a

Soil type: Lihen Loamy Fine Sand

Applied fertilizer: 265 lb/a of Urea (46-0-0) [6/4]

Plot size: 53 ft²

Herbicides applied: Prowl H2O 1.5 pt/a (5/23), Section 3EC 5.33 oz/a, Destiny HC 1.5 pt/a, 28-0-0 2 qt/a (6/24),

Rainfall: 19.5 in. (5/21 - 10/7)

Basagran 1 pt/a, Destiny HC 2 pt/a, Varisto 21 oz/a (6/26), Gramoxone 2.0 SL 2 pt/a, and Destiny HC 1 qt/ 100 gal (9/24)

Fungicides applied: Priaxor D 8 oz/a (7/12)

Corn Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Company | Days to Silk (DAP ¹) | Plant Height (in) | Bird Damage‡ (%) | Test Weight† (lb/bu) | Yield# |
|---------------|---------------------|-------------------------------------|----------------------|---------------------|-------------------------|----------------|
| | | | | | | 2019 (bu/a) |
| 1974 | Proseed | 74 | 26.6 | 51.4 | 54.4 | 107.0 |
| 2B862 | REA Hybrids | 74 | 29.3 | 24.9 | 49.7 | 98.6 |
| 1980 | Proseed | 72 | 29.4 | 45.0 | 53.1 | 95.6 |
| 3009 VT2P | Wilbur Ellis | 72 | 27.7 | 44.8 | 54.2 | 95.0 |
| 73S84 | Peterson Farms Seed | 73 | 29.3 | 26.7 | 52.0 | 92.0 |
| 71D83 | Peterson Farms Seed | 73 | 29.2 | 42.5 | 52.2 | 91.9 |
| 71V81 | Peterson Farms Seed | 75 | 27.1 | 17.7 | 52.0 | 91.3 |
| NK8005-3110A | Syngenta | 73 | 26.8 | 11.6 | 54.2 | 90.8 |
| 1480VT2P | Proseed | 74 | 29.5 | 32.2 | 53.2 | 89.6 |
| 2A872 | REA Hybrids | 75 | 30.6 | 25.1 | 49.4 | 88.3 |
| 1B780 | REA Hybrids | 73 | 29.5 | 33.6 | 51.1 | 87.6 |
| 1B720 | REA Hybrids | 71 | 25.1 | 52.1 | 56.2 | 87.4 |
| 3718 VT2P RIB | Wilbur Ellis | 75 | 27.7 | 12.6 | 47.8 | 86.1 |
| 3282 VT2P RIB | Wilbur Ellis | 75 | 33.2 | 18.7 | 52.7 | 85.6 |
| IC2862 | Rob-See-Co | 73 | 31.7 | 30.0 | 55.5 | 84.0 |
| NK7837-3220 | Syngenta | 74 | 29.0 | 6.9 | 53.4 | 82.8 |
| 3537 VT2P RIB | Wilbur Ellis | 74 | 31.2 | 19.7 | 49.6 | 76.2 |
| NK8204-3220 | Syngenta | 78 | 31.0 | 12.4 | 51.2 | 73.9 |
| RC3240 | Rob-See-Co | 74 | 29.7 | 25.8 | 56.1 | 72.4 |
| NK8519-3220 | Syngenta | 80 | 32.7 | 18.5 | 48.8 | 66.6 |
| Mean | | 74 | 29.3 | 27.6 | 52.3 | 87.6 |
| CV (%) | | 2.0 | 12.7 | 32.9 | 1.8 | 18.3 |
| LSD (5%) | | 2.1 | 5.3 | 19.0 | 1.3 | 22.7 |
| LSD (10%) | | 1.8 | 4.4 | 15.7 | 1.1 | 18.9 |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft. Previous crop: soybeans
 Planted: Repls 1 & 2- 5/15/2019, Repls 3 & 4- 5/20/2019 Soil type: Williams-Bowbells loam.
 Soil test to 6" in ppm: P=26 ppm; K=301 ppm; OM=1.8%; pH=5.9 Harvested: 10/21/2019
 Soil test to 24" in lb/a: N=106 lb/a
 Applied fertilizers in lb/a: N=36; P₂O₅=26; K₂O=0.
 ‡Bird Damage: % of cobs with damage from birds
 †Yield adjusted for bird damage
¹DAP = Days after planting.

Corn Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Company / Brand | Relative Maturity | Days to Silk (DAP*) | Ear Height (in) | Harvest Moisture (%) | Test Weight (lb/bu) | Yield | | |
|-----------------|--------------------|-------------------|------------------------|--------------------|-------------------------|------------------------|-----------------|--------------------|--------------------|
| | | | | | | | 2019‡ (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg (bu/a) |
| 2B861 | REA | 86 | 78 | 30 | 23.0 | 49.1 | 168.9 | 196.4 | 208.1 |
| 3718 VT2P RIB | Integra | 87 | 82 | 31 | 24.3 | 46.3 | 154.3 | 182.9 | - |
| 1B780 | REA | 79 | 77 | 30 | 20.7 | 49.6 | 160.1 | 179.2 | - |
| 3537 VT2P RIB | Integra | 85 | 82 | 31 | 20.3 | 49.6 | 135.8 | 161.5 | - |
| 3282 VT2P RIB | Integra | 82 | 82 | 32 | 20.7 | 50.2 | 133.4 | 161.2 | - |
| 1980 | Proseed | 80 | 75 | 29 | 19.8 | 52.1 | 184.3 | - | - |
| 73S84 | Peterson Farm Seed | 84 | 78 | 32 | 21.1 | 50.4 | 168.9 | - | - |
| 1978 | Proseed | 78 | 77 | 32 | 18.3 | 53.4 | 164.2 | - | - |
| G85Z56-3220-EZ1 | Golden Harvest | 85 | 83 | 35 | 21.7 | 48.1 | 162.1 | - | - |
| 1974 | Proseed | 74 | 75 | 25 | 19.5 | 53.5 | 161.5 | - | - |
| NK8519-3220 | NK | 85 | 83 | 35 | 20.6 | 48.5 | 159.3 | - | - |
| 2B862 | REA | 86 | 79 | 28 | 23.2 | 48.6 | 158.1 | - | - |
| 71V81 | Peterson Farm Seed | 81 | 78 | 29 | 20.1 | 52.6 | 155.9 | - | - |
| NK8005-3110A | NK | 80 | 76 | 29 | 21.0 | 54.6 | 152.3 | - | - |
| D22QH42 | Dyna-Gro | 82 | 76 | 29 | 21.9 | 54.2 | 149.0 | - | - |
| NK7837-3220 | NK | 78 | 78 | 31 | 20.8 | 53.7 | 145.4 | - | - |
| 71D83 | Peterson Farm Seed | 83 | 76 | 30 | 20.0 | 52.1 | 145.1 | - | - |
| G78C29-3220-EZ1 | Golden Harvest | 78 | 75 | 32 | 21.5 | 53.5 | 142.3 | - | - |
| G82M47-3220-EZ1 | Golden Harvest | 82 | 82 | 32 | 19.9 | 49.3 | 140.0 | - | - |
| NK8204-3220 | NK | 82 | 81 | 33 | 19.9 | 50.0 | 138.7 | - | - |
| 1B720 | REA | 72 | 73 | 25 | 23.2 | 55.5 | 137.9 | - | - |
| G80Q01-3110A | Golden Harvest | 80 | 75 | 29 | 20.9 | 54.7 | 132.0 | - | - |
| MEAN | | | 78.0 | 30.4 | 21.00 | 51.36 | 152.25 | 176.24 | 208.13 |
| C.V. (%) | | | 1.6 | 9.2 | 7.80 | 2.07 | 11.54 | - | - |
| LSD (5%) | | | 1.8 | 3.9 | 2.32 | 1.50 | 23.47 | - | - |
| LSD (10%) | | | 1.5 | 3.3 | 1.94 | 1.26 | 19.61 | - | - |

* Days after planting † Yield adjusted to harvest moisture
 Location: Latitude 48.9222°N; Longitude 103.6132°W Elevation: 1902 ft
 Soil test to (0-6 in.): P=20 ppm; K=191 ppm; pH=7.7; OM=2.0% Previous crop: Soybean
 (0-24 in.): NO3-N= 34 lb/a Planted: 5/14/2019
 Yield goal: 190 bu/a Harvested: 11/26/2019
 Planting population: 38,000 seeds/a Soil type: Lihen Loamy Fine Sand
 Applied fertilizer in lb/a broadcast: 265 lbs of Urea (46-0-0)[5/8], and 146 lbs of Urea (46-0-0) [7/12] Plot size: 130 ft*2
 Herbicides applied: Cornerstone 5 Plus 26 oz/a and Class Act 21 oz/a (6/12) Rainfall: 20.0 inches (5/14 - 11/26)
 Fungicides applied: none applied
 ‡ Heavy rains during growing season caused nitrate leaching. Supplemental N was applied on 7/12.
 Yielding leaves indicated low N levels and negatively impacted yields.

LENTIL VARIETY DESCRIPTIONS

| VARIETY | ORIGIN ¹ | SEED COLOR | RELATIVE MATURITY | RELATIVE HEIGHT | SEED SIZE | RESISTANCE TO ² | |
|----------------|---------------------|------------|-------------------|-----------------|-------------|----------------------------|-------------|
| | | | | | | ASCOCHYTA | ANTHRACNOSE |
| AVONDALE | USDA | GREEN | MEDIUM | TALL | MEDIUM | NA | NA |
| CDC DAZIL* | CANADA | RED | M EARLY | NA | SMALL | R | R |
| CDC GREENLAND | CANADA | GREEN | EARLY | MEDIUM | V LARGE | R | S |
| CDC IMIGREEN* | CANADA | GREEN | MEDIUM | MEDIUM | LARGE | R | S |
| CDC IMPALA* | CANADA | RED | EARLY | SHORT | EXTRA SMALL | R | R |
| CDC IMPACT* | CANADA | RED | LATE | SHORT | SMALL | NA | NA |
| CDC IMPRESS* | CANADA | GREEN | M LATE | SHORT | LARGE | R | NA |
| CDC INVINCIBLE | CANADA | GREEN | EARLY | MEDIUM | SHORT | R | R |
| CDC LEMAY | CANADA | GREEN | EARLY | SHORT | SMALL | MS | S |
| CDC MAXIM* | CANADA | RED | M EARLY | MEDIUM | SMALL | R | R |
| CDC PERIDOT* | CANADA | GREEN | EARLY | NA | SMALL | R | NA |
| CDC PROCLAIM* | CANADA | RED | M EARLY | NA | SMALL | R | R |
| CDC REDBERRY | CANADA | RED | MEDIUM | MEDIUM | SMALL | R | R |
| CDC REDCOAT | CANADA | RED | M LATE | TALL | LARGE | R | R |
| CDC RED RIDER | CANADA | RED | M EARLY | MEDIUM | SMALL | MR | MS |
| CDC RICHLEA | CANADA | GREEN | M LATE | MEDIUM | MEDIUM | S | S |
| CDC ROSETOWN | CANADA | RED | EARLY | SHORT | SMALL | MR | MR |
| CDC ROULEAU | CANADA | RED | MEDIUM | MEDIUM | SMALL | MR | MS |
| CDC VICEROY | CANADA | GREEN | M EARLY | MEDIUM | SMALL | R | MR |
| CRIMSON | USDA | RED | EARLY | M SHORT | SMALL | S | S |
| ESSEX | USDA | GREEN | MEDIUM | M TALL | MEDIUM | NA | S |
| ESTON | CANADA | GREEN | EARLY | MEDIUM | SMALL | S | S |
| MERRITT | USDA | GREEN | M LATE | MEDIUM | LARGE | NA | NA |
| MORENA | USDA | BROWN | EARLY | TALL | SMALL | NA | S |
| ND EAGLE | NDSU | GREEN | EARLY | MEDIUM | SMALL | NA | NA |
| PARDINA | SPAIN | BROWN | EARLY | SHORT | SMALL | NA | NA |
| PENNELL | USDA | GREEN | MEDIUM | MEDIUM | LARGE | NA | S |
| RIVELAND | USDA | GREEN | M LATE | TALL | V LARGE | NA | S |

¹Refers to developer: NDSU = North Dakota State University; USDA = United States Department of Agriculture; CANADA and SPAIN represent developers from respective countries.

²MR = Moderately resistant; NA= Data not available; R = Resistant; S = Susceptible.

*Clearfield lentil with imidazolinone tolerance.



EARC Research Scientist Bill Frank, and MSU/Richland County Extension Agent Tim Fine speaking at EARC Field Day

Lentils Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Days to Flowering (DAP ¹) | Days to Maturity (DAP ¹) | Plant height (in) | 1000 Kernel Weight (g) | Protein [†] (%) | Test weight (lb/bu) | Yield [#] | | |
|----------------------|--|---|----------------------|---------------------------|-----------------------------|------------------------|--------------------|----------|----------|
| | | | | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| French Green | | | | | | | | | |
| CDC LEMAY | 58 | 94 | 10.1 | 31.0 | 24.5 | 63.0 | 1828 | 1379 | 1095 |
| Medium Green | | | | | | | | | |
| AVONDALE | 55 | 95 | 13.6 | 47.6 | 27.0 | 61.1 | 2661 | 1799 | 1547 |
| CDC RICHLEA | 56 | 95 | 13.7 | 46.8 | 26.0 | 61.3 | 2600 | 1862 | 1513 |
| Large Green | | | | | | | | | |
| CDC GREENLAND | 57 | 95 | 11.3 | 60.9 | 23.7 | 58.1 | 2277 | 1790 | 1445 |
| RIVELAND | 54 | 95 | 14.1 | 70.0 | 25.2 | 58.4 | 2379 | 1625 | 1360 |
| PENNELL | 57 | 95 | 12.1 | 56.3 | 25.4 | 59.4 | 1537 | 1124 | 968 |
| Small Green | | | | | | | | | |
| CDC VICEROY | 56 | 94 | 11.8 | 31.0 | 25.5 | 62.7 | 2580 | 1865 | 1485 |
| ND EAGLE | 54 | 94 | 12.0 | 36.2 | 24.1 | 62.6 | 2583 | 1745 | 1463 |
| Small Red | | | | | | | | | |
| CDC RED RIDER | 57 | 94 | 12.8 | 42.7 | 25.3 | 62.0 | 2783 | 2037 | 1640 |
| CDC REDBERRY | 57 | 94 | 14.0 | 40.1 | 25.2 | 62.1 | 2376 | 1862 | 1485 |
| CDC ROULEAU | 58 | 94 | 12.4 | 33.2 | 25.1 | 61.6 | 2491 | 1704 | 1417 |
| CDC ROSETOWN | 58 | 94 | 11.4 | 26.6 | 24.7 | 63.1 | 2259 | 1681 | 1345 |
| Spanish Brown | | | | | | | | | |
| PARDINA | 53 | 94 | 9.7 | 39.5 | 25.0 | 63.8 | 2389 | 1307 | 1137 |
| Mean | 55.19 | 94.38 | 12.02 | 46.91 | 25.1 | 61.59 | 2403 | - | - |
| CV (%) | 1.13 | 0.53 | 10.70 | 4.46 | 5.6 | 1.19 | 11 | - | - |
| LSD (5%) | 0.88 | 0.70 | 1.81 | 2.95 | 2.0 | 1.03 | 388 | - | - |
| LSD (10%) | 0.74 | 0.58 | 1.51 | 2.47 | 1.6 | 0.86 | 324 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft.

Pervious crop: German Foxtail Millet

Planted: 05/03/2019

Harvested: 8/16/2019

Soil test to 6" in ppm: P=26 ppm K=301 ppr OM=1.8% pH=5.9

Soil type: Williams-Bowbells loam.

Soil test to 24" in lb/a: N=106 lb/a

Applied fertilizers in lb/a: none

[†]Protein adjusted to 0% moisture.

[#]Yield reported on a 13.5% moisture basis.

¹DAP = Days after planting.

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18) ; Secure EC @ 12 oz/a (6/24/2019)



WREC Field Day
Events

Dryland Lentil Variety Evaluation - MSU

Richland, MT 2019

| Variety | Plant Height (cm) | Test Weight (lb/bu) | 1000 Seed Weight (g) | Adjusted Grain Yield (lb/a) |
|----------------|----------------------|------------------------|----------------------------|-----------------------------------|
| Avondale | 33.0 | 62.5 | 49.0 | 2299 |
| CDC Impress | 32.4 | 62.2 | 50.4 | 2332 |
| CDC Invincible | 30.5 | 64.9 | 30.0 | 2076 |
| CDC Maxim | 30.5 | 64.4 | 38.4 | 2366 |
| CDC Richlea | 31.1 | 61.8 | 53.5 | 2355 |
| CDC Viceroy | 33.0 | 65.0 | 30.8 | 2371 |
| NDL090185R | 34.9 | 62.8 | 37.4 | 2536 |
| NDL090204R | 32.4 | 63.9 | 40.6 | 2271 |
| NDL090170L | 33.0 | 61.1 | 67.8 | 2283 |
| Sage | 26.7 | 64.6 | 37.0 | 1943 |
| Mean | 31.8 | 63.3 | 43.5 | 2283 |
| P-Value | 0.0002 | <0.0001 | 0.0 | <0.0001 |
| LSD | 2.87 | 0.3 | 17.3 | 167.0 |
| CV (%) | 6.3 | 0.3 | 27.3 | 5.0 |

Location: Richland, MT

Previous crop: Spring Wheat

Planted: May 9, 2019

Harvested: Aug. 21, 2019

Applied fertilizers in lb/a: None

Soil type: Farnuf Loam

Yield adjusted to 13% moisture content

Herbicide: Valor at 3 fl oz/a fall applied; Sharpen at 0.75 fl oz/a.

Irrigated Lentil Variety Evaluation - MSU

EARC, Sidney, MT 2019

| Variety | Days to Flower DAP ¹ | Plant Height (cm) | Test Weight (lb/bu) | 1000 Seed Weight (g) | Adjusted Grain Yield (lb/a) |
|----------------|------------------------------------|----------------------|------------------------|----------------------------|-----------------------------------|
| Avondale | 54 | 38.3 | 61.1 | 44.9 | 2751 |
| CDC Impress | 56 | 34.8 | 59.7 | 51.8 | 2371 |
| CDC Invincible | 58 | 35.0 | 63.0 | 33.8 | 2753 |
| CDC Maxim | 54 | 28.5 | 63.4 | 37.5 | 2864 |
| CDC Richlea | 58 | 32.0 | 59.6 | 47.6 | 2488 |
| CDC Viceroy | 57 | 33.5 | 63.5 | 33.3 | 2729 |
| NDL090185R | 56 | 34.5 | 60.1 | 46.6 | 2531 |
| NDL090204R | 54 | 30.8 | 61.7 | 50.9 | 2273 |
| NDL090170L | 54 | 33.3 | 59.0 | 60.0 | 2110 |
| Sage | 54 | 29.3 | 63.2 | 35.8 | 2758 |
| Mean | 55.5 | 33.0 | 61.4 | 44.2 | 2563 |
| P-Value | <0.0001 | 0.0086 | <0.0001 | <0.0001 | 0.4 |
| LSD | 0 | 4.73 | 0.6 | 2.6 | 692.0 |
| CV (%) | 0 | 9.89 | 0.7 | 4.0 | 18.6 |

Location: EARC; Sidney, MT

Previous crop: Sugarbeet

Planted: April 24, 2019

Harvested: Aug. 14, 2019

Applied fertilizers in lb/a: None

Soil type: Williams Clay Loam

Yield adjusted to 13% moisture content

Rain fall (Apr-Aug) = 10.1"

Irrigation = 1.8"

Herbicide: Durango and Outlook at 24 oz/ac and 12 oz/ac, respectively.

DAP¹ = Days after planting

FIELD PEA VARIETY DESCRIPTIONS

| VARIETY | ORIGIN OR SUPPLIER | VINE HABIT ¹ | GROWTH HABIT ² | VINE LENGTH | RELATIVE MATURITY | SEED SIZE | RESISTANCE ³ TO POWDERY MILDEW |
|-------------------------|--------------------|-------------------------|---------------------------|-------------|-------------------|-----------|---|
| YELLOW COTYLEDON | | | | | | | |
| AAC CARVER | CANADA | NA | NA | MEDIUM | EARLY | MEDIUM | R |
| AAC CHROME | LEGUME LOGIC | SL | NA | MEDIUM | MEDIUM | M LARGE | R |
| AAC PROFIT | BIRDSALL GRAIN | NA | NA | NA | M LATE | MEDIUM | R |
| AGASSIZ | CANADA | SL | SD | TALL | MEDIUM | MEDIUM | R |
| BRIDGER | LEGUME LOGIC | SL | SD | MEDIUM | MEDIUM | MEDIUM | MS |
| CDC AMARILLO | CANADA | SL | SD | MEDIUM | MEDIUM | MEDIUM | R |
| CDC INCA | MERIDIAN SEEDS | NA | NA | NA | MEDIUM | MEDIUM | R |
| CDC LEROY | CANADA | SL | SD | M SHORT | MED LATE | SMALL | R |
| CDC MEADOW | CANADA | SL | SD | MEDIUM | EARLY | MEDIUM | R |
| CDC SAFFRON | CANADA | SL | SD | MEDIUM | MEDIUM | MEDIUM | R |
| CDC TREASURE | BIRDSALL GRAIN | SL | SD | MEDIUM | EARLY | SMALL | R |
| DELTA | LIMAGRAIN | SL | SD | MEDIUM | MEDIUM | MEDIUM | MR |
| DS ADMIRAL | DANISCO | SL | SD | TALL | MEDIUM | LARGE | R |
| DURWOOD | PULSE USA | SL | SD | M SHORT | M LATE | MEDIUM | NA |
| EARLYSTAR | MERIDIAN SEEDS | SL | SD | TALL | EARLY | MEDIUM | R |
| HAMPTON | NDCIA | NA | NA | M SHORT | MEDIUM | MEDIUM | R |
| HYLINE | LEGUME LOGIC | SL | NA | NA | MEDIUM | MEDIUM | R |
| JETSET | MERIDIAN | SL | SD | MEDIUM | MEDIUM | M SMALL | R |
| KORANDO | PULSE USA | SL | SD | MEDIUM | EARLY | MEDIUM | R |
| LG AMIGO | PULSE USA | SL | NA | NA | M EARLY | MEDIUM | R |
| LG SUNRISE | PULSE USA | SL | NA | TALL | MEDIUM | S MEDIUM | R |
| LGPN4909 | LIMAGRAIN | NA | NA | NA | NA | NA | NA |
| LGPN4913 | LIMAGRAIN | NA | NA | NA | NA | NA | NA |
| LGPN4915 (LG STUNNER) | LIMAGRAIN | NA | NA | NA | NA | NA | NA |
| MONTECH 4152 | MONTECH | SL | SD | MEDIUM | EARLY | LARGE | NA |
| MYSTIQUE | PULSE USA | SL | SD | M SHORT | M LATE | M SMALL | MR |
| NAVARRO | GREAT NORTHERN AG | SL | NA | M TALL | EARLY | LARGE | MS |
| NDP121587 | NDSU | NA | NA | M SHORT | MEDIUM | M SMALL | R |
| NETTE 2010 | PULSE USA | SL | NA | SHORT | M EARLY | M SMALL | NA |
| PSTSP27 | PHOTOSYNTECH | NA | NA | NA | NA | NA | NA |
| PSTSP34 | PHOTOSYNTECH | NA | NA | NA | NA | NA | NA |
| PSTSP32 | PHOTOSYNTECH | NA | NA | NA | NA | NA | NA |
| SALAMANCA | GREAT NORTHERN AG | SL | NA | MEDIUM | EARLY | MEDIUM | MS |
| SPIDER | NICKERSON | SL | SD | MEDIUM | MEDIUM | LARGE | R |
| SW MIDAS | SWEDEN | SL | SD | SHORT | M LATE | SMALL | R |
| SW TRAPEZE | SWEDEN | SL | SD | M SHORT | MEDIUM | MEDIUM | NA |
| VEGAS | PULSE USA | SL | SD | SHORT | M LATE | LARGE | NA |
| GREEN COTYLEDON | | | | | | | |
| AAC COMFORT | MERIDIAN SEEDS | NA | NA | MEDIUM | MEDIUM | LARGE | R |
| ARAGORN | PROGENE | SL | SD | M SHORT | M EARLY | M LARGE | NA |
| ARCADIA | PULSE USA | SL | SD | MEDIUM | EARLY | SMALL | MS |
| CDC GREENWATER | MERIDIAN SEEDS | NA | NA | M TALL | LATE | MEDIUM | R |
| CDC STRIKER | CANADA | SL | SD | MEDIUM | MEDIUM | M LARGE | S |
| CRUISER | WA | SL | SD | MEDIUM | MEDIUM | M SMALL | S |
| DAYTONA | MERIDIAN | SL | SD | MEDIUM | LATE | MEDIUM | R |
| GINNY | PROGENE | NA | NA | M SHORT | MEDIUM | SMALL | NA |
| GREENWOOD | PROGENE | NA | NA | MEDIUM | MEDIUM | SMALL | MR |
| K-2 | LEGUME LOGIC | SL | SD | MEDIUM | EARLY | M SMALL | S |
| LG KODA | PULSE USA | SL | NA | MEDIUM | MEDIUM | MEDIUM | R |
| MAJORET | SWEDEN | SL | SD | MEDIUM | M LATE | MEDIUM | S |
| SHAMROCK | GREAT NORTHERN AG | SL | NA | NA | LATE | NA | S |
| STIRLING | WA | SL | SD | SHORT | EARLY | MEDIUM | R |
| VIPER | PULSE USA | SL | SD | M SHORT | M EARLY | MEDIUM | MR |

¹NA = Data not available; SL = Semi-leafless; ²SD = Semi-dwarf; ³MR = Moderately resistant; MS = Moderately susceptible; R = Resistant, S = Susceptible.

Dryland Field Pea Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Flowering Date (DAP) | Maturity Date (DAP) | Height (in.) | Protein (%) | 1000 Seed Weight (g) | Test Weight (lb/bu) | Yield (bu/a) | 2-YR Avg (bu/a) | 3-YR Avg (bu/a) |
|-------------------------------------|----------------------|---------------------|--------------|-------------|----------------------|---------------------|--------------|-----------------|-----------------|
| <u>Yellow Cotyledon Type</u> | | | | | | | | | |
| AAC Carver | 57 | 93 | 24 | 20.9 | 260.3 | 65.1 | 67.6 | 49.1 | 39.8 |
| Agassiz | 57 | 93 | 23 | 21.8 | 267.2 | 64.9 | 62.3 | 47.9 | 38.9 |
| Jetset | 58 | 95 | 23 | 24.5 | 260.9 | 65.4 | 62.4 | 45.4 | 37.2 |
| CDC Inca | 60 | 94 | 27 | 22.5 | 239.5 | 65.3 | 65.9 | 46.8 | 36.9 |
| Hyline | 58 | 94 | 23 | 22.7 | 267.4 | 65.4 | 62.5 | 44.9 | 36.8 |
| CDC Saffron | 59 | 94 | 22 | 21.9 | 266.4 | 65.5 | 60.7 | 48.5 | 36.5 |
| Salamanca | 57 | 92 | 25 | 23.2 | 266.0 | 64.8 | 58.0 | 43.6 | 36.4 |
| Durwood | 57 | 96 | 28 | 22.9 | 258.9 | 65.2 | 61.5 | 44.0 | 36.2 |
| Korando | 54 | 95 | 23 | 24.7 | 287.1 | 65.4 | 57.1 | 44.7 | 35.9 |
| DS Admiral | 58 | 94 | 22 | 21.9 | 247.0 | 65.3 | 54.6 | 42.8 | 34.8 |
| SW Midas | 59 | 92 | 21 | 20.5 | 219.8 | 65.1 | 53.4 | 43.1 | 34.6 |
| Spider | 59 | 96 | 26 | 23.0 | 253.2 | 65.2 | 60.6 | 46.6 | 34.4 |
| LG Amigo | 57 | 94 | 21 | 24.5 | 240.4 | 64.7 | 54.3 | 39.0 | 34.1 |
| CDC Amarillo | 60 | 95 | 26 | 22.0 | 249.0 | 65.3 | 59.3 | 43.0 | 33.0 |
| AAC Chrome | 59 | 95 | 23 | 21.5 | 273.8 | 65.8 | 75.0 | 54.5 | - |
| AAC Profit | 61 | 95 | 26 | 22.9 | 257.2 | 65.1 | 66.1 | 50.2 | - |
| Bridger | 55 | 94 | 21 | 23.4 | 243.8 | 65.7 | 64.2 | 49.4 | - |
| LG Sunrise | 55 | 94 | 28 | 20.3 | 247.0 | 66.3 | 57.5 | 44.3 | - |
| LGPN4915 | 55 | 94 | 23 | 26.7 | 235.4 | 65.2 | 56.6 | 44.2 | - |
| Navarro | 53 | 93 | 21 | 22.6 | 270.2 | 65.3 | 55.8 | 44.0 | - |
| LGPN4909 | 54 | 92 | 20 | 22.6 | 228.8 | 64.9 | 55.2 | 41.4 | - |
| LGPN4913 | 56 | 92 | 22 | 23.5 | 259.8 | 65.8 | 53.2 | 40.7 | - |
| AC Earlystar | 57 | 93 | 24 | 20.2 | 230.3 | 65.3 | 64.6 | - | - |
| CDC Spectrum | 59 | 96 | 25 | 23.7 | 263.8 | 64.7 | 63.9 | - | - |
| CDC Treasure | 56 | 93 | 26 | 21.1 | 223.8 | 65.9 | 61.9 | - | - |
| DL Apollo | 58 | 92 | 20 | 22.8 | 233.9 | 65.6 | 60.0 | - | - |
| Hampton | 60 | 94 | 20 | 25.5 | 244.2 | 64.9 | 55.8 | - | - |
| N13022-7 | 54 | 94 | 22 | 23.4 | 276.7 | 65.8 | 62.0 | - | - |
| N13029-10 | 54 | 94 | 23 | 21.3 | 275.2 | 65.8 | 60.3 | - | - |
| N13057-4 | 54 | 92 | 21 | 23.4 | 239.5 | 65.1 | 50.1 | - | - |
| N13057-5 | 58 | 95 | 27 | 25.0 | 254.3 | 65.0 | 58.7 | - | - |
| N13068-1 | 57 | 93 | 24 | 22.4 | 287.3 | 65.0 | 64.8 | - | - |
| NDP121587 | 58 | 94 | 23 | 20.7 | 243.8 | 65.1 | 55.4 | - | - |
| Nette 2010 | 54 | 93 | 24 | 20.2 | 239.7 | 66.3 | 57.4 | - | - |
| PSTSP27 | 54 | 91 | 22 | 23.7 | 275.5 | 65.4 | 56.9 | - | - |
| PSTSP34 | 58 | 92 | 27 | 22.5 | 219.3 | 65.5 | 59.5 | - | - |
| PSTSPS32 | 59 | 93 | 25 | 22.5 | 287.1 | 65.9 | 68.3 | - | - |
| <u>Green Cotyledon Type</u> | | | | | | | | | |
| Arcadia | 57 | 95 | 21 | 20.6 | 219.7 | 65.3 | 61.4 | 46.7 | 38.6 |
| CDC Striker | 57 | 94 | 19 | 20.3 | 226.8 | 65.2 | 64.3 | 47.8 | 38.2 |
| AAC Comfort | 62 | 96 | 23 | 23.6 | 270.6 | 65.2 | 66.5 | 44.9 | 34.1 |
| CDC Greenwater | 60 | 96 | 27 | 21.7 | 252.3 | 65.3 | 56.8 | 42.0 | 33.2 |
| Viper | 56 | 93 | 23 | 22.5 | 235.8 | 64.5 | 53.5 | 40.3 | 33.0 |
| Shamrock | 60 | 93 | 22 | 22.3 | 258.1 | 65.4 | 62.7 | 43.0 | 32.6 |
| Cruiser | 56 | 92 | 21 | 21.6 | 209.9 | 64.9 | 48.2 | 36.5 | 30.3 |
| Banner | 54 | 91 | 20 | 17.6 | 210.5 | 65.5 | 54.6 | 40.3 | - |
| Empire | 58 | 95 | 30 | 22.4 | 234.1 | 66.0 | 55.9 | - | - |
| LN1131 | 55 | 90 | 19 | 23.3 | 262.0 | 64.4 | 50.4 | - | - |
| N13073-17 | 59 | 93 | 24 | 23.0 | 288.1 | 64.7 | 59.9 | - | - |
| N13073-19 | 54 | 94 | 23 | 23.6 | 281.2 | 64.9 | 55.8 | - | - |
| 12CP3032 | 59 | 94 | 22 | 21.2 | 308.6 | 65.2 | 57.4 | - | - |
| Mean | 57 | 93 | 23 | 22.4 | 252.6 | 65.3 | 59.4 | - | - |
| CV % | 2 | 1 | 12 | 3.6 | 4.0 | 0.6 | 8.3 | - | - |
| LSD 0.05 | 1 | 2 | 4 | 1.1 | 13.9 | 0.6 | 6.9 | - | - |
| LSD 0.1 | 1 | 2 | 3 | 0.9 | 11.7 | 0.5 | 5.8 | - | - |

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft

Previous crop: German Foxtail Millet

Planted: 4/26/2019

Harvested: 08/01/2019

Soil test to 6" in ppm: P=26 ppm; K=301 ppm; OM=1.8%; pH= 5.9

Soil type: Williams-Bowels loam

Soil test to 24" in lb/a: N=106 lbs/a

Applied fertilizers in lb/a: none

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18) ; Secure EC @ 12 oz/a (6/24/2019)

Peas Dryland Off-Station Variety Trial - NDSU **Divide County, ND 2019**

| Variety | 1000 Kernel Weight | Protein [†] | Test weight | Yield [#] | | |
|------------------------------|--------------------|----------------------|-------------|--------------------|----------|----------|
| | | | | 2019 | 2-Yr Avg | 3-Yr Avg |
| | (g) | (%) | (lb/bu) | ------(bu/a)----- | | |
| <u>Yellow Cotyledon Type</u> | | | | | | |
| Agassiz | 221.0 | 26.3 | 62.4 | 61.8 | 53.5 | 46.0 |
| Nette 2010 | 227.0 | 24.0 | 63.9 | 53.1 | 43.2 | 37.0 |
| NDP 121587 | 221.1 | 23.6 | 63.2 | 53.7 | - | - |
| CDC Saffron | 233.5 | 26.2 | 63.3 | 61.2 | - | - |
| CDC Treasure | 205.2 | 24.0 | 64.4 | 51.7 | - | - |
| SW Midas | 201.3 | 24.7 | 63.3 | 51.2 | - | - |
| Hampton | 216.6 | 26.9 | 61.8 | 49.3 | - | - |
| <u>Green Cotyledon Type</u> | | | | | | |
| Arcadia | 206.2 | 23.7 | 62.7 | 52.2 | 47.4 | 42.5 |
| Majoret | 226.7 | 26.7 | 63.4 | 56.9 | 42.5 | - |
| CDC Striker | 232.2 | 26.6 | 63.7 | 47.4 | - | - |
| Aragorn | 197.9 | 25.6 | 62.4 | 46.1 | - | - |
| Cruiser | 185.2 | 25.1 | 63.0 | 45.2 | - | - |
| Mean | 214.5 | 25.3 | 63.1 | 52.5 | - | - |
| CV (%) | 3.7 | 1.9 | 0.7 | 11.7 | - | - |
| LSD (5%) | 13.4 | 0.8 | 0.8 | 10.4 | - | - |
| LSD (10%) | 11.1 | 0.7 | 0.6 | 8.6 | - | - |

Location: Crosby, ND; Latitude 48° 8' N; Longitude 103° 18' W; Elevation 2044 ft.

Planted: 05/06/2019

Previous crop: spring wheat

Soil test (0-6"): P=14 ppm; K=362 ppm; OM=3.0%.

Harvested: 8/21/2019

(0-24"): NO3-N=14 lb/a.

Soil type: Farnuf-Alkabo

Applied fertilizers in lb/a: none

[†]Protein adjusted to 0% moisture.

[#]Yield reported on a 13.5% moisture basis.

¹DAP = Days after planting.

Herbicide Applications: Spartan Charge @ 4oz/a with RT3 @ 32 oz/a (5/6/2019);

Basagran @ 1pt/a with Secure @ 8 oz/a (6/25/2019)

Peas Dryland Off-Station Variety Trial - NDSU **McKenzie County, ND 2019**

| Variety | 1000 Kernel Weight | Protein [†] | Test weight | Yield [#] |
|------------------------------|--------------------|----------------------|-------------|--------------------|
| | | | | 2019 |
| | (g) | (%) | (lb/bu) | (bu/a) |
| <u>Yellow Cotyledon Type</u> | | | | |
| Agassiz | 230.3 | 25.8 | 61.3 | 54.7 |
| CDC Saffron | 235.6 | 25.6 | 62.7 | 53.6 |
| NDP 121587 | 213.8 | 23.8 | 62.0 | 49.4 |
| CDC Treasure | 206.1 | 24.5 | 63.2 | 47.5 |
| Nette 2010 | 222.9 | 24.2 | 63.3 | 46.5 |
| Hampton | 219.6 | 28.3 | 61.6 | 43.2 |
| SW Midas | 200.7 | 24.8 | 61.7 | 43.0 |
| <u>Green Cotyledon Type</u> | | | | |
| Arcadia | 205.1 | 23.4 | 61.7 | 50.1 |
| Cruiser | 180.2 | 24.8 | 61.7 | 37.7 |
| Majoret | 232 | 26.6 | 62.6 | 36.8 |
| Aragorn | 191.6 | 23.6 | 61.4 | 36.6 |
| CDC Striker | 226.2 | 27.6 | 62.6 | 33.2 |
| Mean | 213.7 | 25.2 | 62.1 | 44.4 |
| CV (%) | 2.3 | 3.8 | 0.7 | 8.7 |
| LSD (5%) | 8.5 | 1.6 | 0.8 | 6.5 |
| LSD (10%) | 7.0 | 1.4 | 0.7 | 5.4 |

Location: Arnegard, ND; Elevation 2254 ft.

Previous crop: spring wheat

Planted: 05/13/2019

Harvested: 08/21/2019

[†]Protein adjusted to 0% moisture.

Soil type: Dooley-Zahl complex

[#]Yield reported on a 13.5% moisture basis.

Applied Fertilizer in lb/a: none

Herbicide Applications: Spartan Charge @ 4 oz/a with RT3 @ 32 oz/a (5/13/2019);

Basagran @ 1 pt/a with Secure @ 10 oz/a (6/18/2019)

Field Pea Irrigated Variety Trial - NDSU

WREC, Nesson Valley, ND 2019

| Variety | Canopy Height (in) | Vine Length (in) | Height Index† (%) | Days to Flower (DAP*) | Days to Maturity (DAP*) | Lodging (0 - 9*) | Protein† (%) | Test Weight (lb/bu) | Yield | | | |
|-------------------------|--------------------|------------------|-------------------|-----------------------|-------------------------|------------------|--------------|---------------------|-------------|-----------------|-----------------|--|
| | | | | | | | | | 2019 (bu/a) | 2-Yr Avg (bu/a) | 3-Yr Avg (bu/a) | |
| YELLOW COTYLEDON | | | | | | | | | | | | |
| Agassiz | 22 | 31 | 69 | 58 | 92 | 5 | 25.9 | 61.9 | 53.4 | 56.7 | 55.5 | |
| Spider | 21 | 35 | 61 | 60 | 94 | 6 | 27.4 | 62.5 | 50.8 | - | - | |
| DS Admiral | 25 | 30 | 82 | 58 | 91 | 6 | 24.2 | 62.2 | 45.1 | - | - | |
| GREEN COTYLEDON | | | | | | | | | | | | |
| CDC Striker | 17 | 29 | 56 | 57 | 90 | 6 | 25.1 | 61.4 | 50.5 | 52.6 | 51.1 | |
| Cruiser | 11 | 29 | 36 | 57 | 91 | 8 | 25.2 | 61.0 | 48.2 | - | - | |
| Arcadia | 12 | 29 | 41 | 60 | 90 | 8 | 24.9 | 60.6 | 47.8 | - | - | |
| MEAN | 22.4 | 31.9 | 70.8 | 58.4 | 92.1 | 5.7 | 25.80 | 62.20 | 49.77 | 56.68 | 55.45 | |
| C.V. (%) | 23.1 | 5.8 | 24.2 | 5.4 | 2.0 | 20.0 | 2.12 | 1.03 | 13.64 | - | - | |
| LSD (5%) | 6.1 | 2.7 | 20.9 | 4.7 | 2.7 | 1.9 | 0.81 | 0.96 | ns | - | - | |
| LSD (10%) | 5.0 | 2.2 | 17.2 | ns | 2.3 | 1.6 | 0.67 | 0.79 | ns | - | - | |

* Days after planting † 0: no lodging - 9: plants lying flat on the ground † Protein content adjusted to 12% moisture

‡ Percentage of how lodged the plant is. 100% - Plant is standing straight, 0% - Plant is lying flat.

Location: Latitude 48.9, 92.22N; Longitude 103.6, 1.32W

Soil test (0-6 in.): P=13 ppm; K=313 ppm; pH=7.6 ; OM=3.1%

(0-24 in.): NO3-N=15 lb/a

Yield goal: 50 bu/a

Planting population: 400,000 seeds/a

Applied fertilizer: none applied

Herbicides applied: Prowl H2O 2 p/a and Sharpen 0.5 oz/a (5/10), Section 3EC 5.33 oz/a, 28-0-0 2 qt/a, and Destiny HC 1.5 p/a (6/24),

Basagran 1 p/a and Destiny HC 1.5 p/a (6/26), and Gramoxone SL 2.0 2 p/a and Destiny HC 1 qt/ 100 gal (8/28)

Fungicides applied: Priaxor D 8 oz/a (7/12)

Elevation: 1902 ft

Previous crop: Corn

Planted: 5/3/2019

Harvested: 9/4/2019

Soil type: Lihen Loamy Fine Sand

Plot size: 61 ftx2

Rainfall: 10.4 in. (5/3 - 9/4)

Dryland Green Dry Pea Variety Evaluation - MSU

Richland, MT 2019

| Variety | Plant Height (cm) | Test Weight (lb/bu) | Protein (%) | Adjusted Grain Yield (lb/a) |
|----------------|----------------------|------------------------|----------------|-----------------------------------|
| AAC Comfort | 67.3 | 64.7 | 24.6 | 2696 |
| Aragorn | 64.8 | 62.5 | 23.1 | 2858 |
| Bluemoon | 64.1 | 64.4 | 22.9 | 3153 |
| CDC Greenwater | 76.8 | 65.6 | 23.4 | 2938 |
| Ginny | 59.7 | 64.0 | 23.3 | 2941 |
| Hampton | 62.2 | 64.4 | 26.2 | 2441 |
| Keystone | 61.6 | 65.6 | 25.2 | 2105 |
| Majoret | 64.8 | 64.8 | 24.7 | 2764 |
| MT457 | 65.4 | 64.6 | 25.4 | 2757 |
| Pro 121-7126 | 55.9 | 63.9 | 23.7 | 2651 |
| Pro 141-6258 | 55.9 | 63.8 | 21.2 | 2671 |
| PS0877MT076 | 57.2 | 63.8 | 25.8 | 2133 |
| SW Arcadia | 62.9 | 63.9 | 23.7 | 2930 |
| Mean | 63.0 | 64.3 | 24.1 | 2695 |
| P-Value | 0.0003 | <.0001 | <.0001 | <.0001 |
| LSD | 7.6 | 0.6 | 0.7 | 227.4 |
| CV (%) | 8.4 | 0.6 | 1.9 | 5.9 |

Dryland Yellow Dry Pea Variety Evaluation - MSU

Richland, MT 2019

| Variety | Plant Height (cm) | Test Weight (lb/bu) | Protein (%) | Adjusted Grain Yield (lb/a) |
|--------------|----------------------|------------------------|----------------|-----------------------------------|
| 124-7146 | 60.3 | 65.8 | 28.6 | 2358 |
| 154-7207 | 56.5 | 65.2 | 25.3 | 2091 |
| 154-7225 | 56.5 | 65.4 | 29.3 | 1940 |
| AAC Asher | 64.8 | 64.7 | 23.5 | 3531 |
| AAC Carver | 72.4 | 64.7 | 22.1 | 3175 |
| AAC Chrome | 68.6 | 64.2 | 24.0 | 3597 |
| AAC Profit | 71.1 | 65.0 | 25.8 | 2953 |
| AC Agassiz | 68.6 | 63.9 | 25.2 | 2939 |
| AC Earlystar | 71.8 | 64.1 | 23.3 | 3130 |
| Astronoute | 69.2 | 65.0 | 25.0 | 3448 |
| Bridger | 66.7 | 64.3 | 22.9 | 3084 |
| CDC Amarillo | 78.7 | 65.5 | 24.5 | 2793 |
| CDC Dakota | 74.3 | 65.4 | 26.6 | 3359 |
| CDC Inca | 81.3 | 65.4 | 24.6 | 3207 |
| CDC Saffron | 70.5 | 65.2 | 24.1 | 3516 |
| CDC Spectrum | 80.0 | 64.9 | 25.5 | 3062 |
| Delta | 59.1 | 64.2 | 24.1 | 3287 |
| DL Apollo | 80.0 | 65.4 | 25.5 | 3103 |
| DS-Admiral | 71.1 | 64.3 | 23.5 | 3236 |
| Durwood | 71.1 | 64.2 | 24.1 | 2823 |
| Hyline | 70.5 | 64.4 | 24.0 | 3114 |
| Jetset | 64.8 | 63.9 | 23.8 | 3640 |
| Korando | 66.7 | 64.6 | 24.2 | 3412 |
| LG Amigo | 69.2 | 63.9 | 23.5 | 3359 |
| LG Sunrise | 66.7 | 64.8 | 22.4 | 2845 |
| Majestic | 73.7 | 64.8 | 23.9 | 3155 |
| Navarro | 67.9 | 64.0 | 25.2 | 3215 |
| NDP121587 | 64.1 | 63.7 | 22.3 | 3436 |
| Nette 2010 | 61.6 | 64.7 | 23.0 | 2946 |
| Pro 093-7410 | 59.7 | 64.7 | 21.8 | 3059 |
| Pro 133-6243 | 66.0 | 64.8 | 24.3 | 3287 |
| Pro 143-6236 | 56.5 | 63.9 | 22.7 | 2538 |
| PS07100925 | 62.2 | 64.5 | 24.2 | 3277 |
| PS08101022 | 51.4 | 64.4 | 23.3 | 3896 |
| PS0877MT632 | 62.2 | 64.7 | 25.9 | 2567 |
| Salamanca | 68.6 | 64.1 | 24.8 | 3132 |
| Spider | 71.8 | 65.4 | 24.9 | 2773 |
| Mean | 67.5 | 64.6 | 24.4 | 3089 |
| P-Value | <.0001 | <.0001 | <.0001 | <.0001 |
| LSD | 9.4 | 0.5 | 0.8 | 279.4 |
| CV (%) | 9.9 | 0.6 | 2.2 | 6.5 |

Location: Richland, MT

Previous crop: Spring Wheat

Planted: May 9, 2019

Harvested: Aug. 20, 2019

Applied fertilizers in lb/a: None

Soil type: Farnuf Loam

Yield adjusted to 13% moisture content

Herbicide: Valor at 3 fl oz/a fall applied; Sharpen at 0.75 fl oz/a.

Irrigated Green Dry Pea Variety Evaluation - MSU

Sidney, MT 2019

| Variety | Days to Flower | Plant Height | Test Weight | 1000 Seed Weight | Protein | Adjusted Grain Yield |
|-------------|------------------|--------------|-------------|------------------|---------|----------------------|
| | DAP ¹ | | | | | |
| | | (cm) | (lb/bu) | (g) | (%) | (lb/a) |
| Aragorn | 56 | 66.5 | 63.4 | 204.6 | 21.5 | 4874 |
| Hampton | 59 | 65.5 | 64.8 | 214.3 | 21.5 | 4731 |
| Majoret | 56 | 69.8 | 65.3 | 234.5 | 21.1 | 5050 |
| MT457 | 56 | 71.5 | 64.1 | 233.1 | 25.0 | 4691 |
| PS0877MT076 | 59 | 61.8 | 63.9 | 175.6 | 21.9 | 3414 |
| Mean | 57 | 67.0 | 64.3 | 212.4 | 22.2 | 4552 |
| P-Value | <0.0001 | 0.0845 | <0.0001 | <0.0001 | <0.0001 | 0.0002 |
| LSD | 0 | 7.2 | 0.5 | 8.3 | 0.8 | 544.5 |
| CV (%) | 0 | 7.0 | 0.6 | 2.5 | 2.3 | 7.8 |

Irrigated Yellow Dry Pea Variety Evaluation - MSU

Sidney, MT 2019

| Variety | Days to Flower | Plant Height | Test Weight | 1000 Seed Weight | Protein | Adjusted Grain Yield |
|-------------|------------------|--------------|-------------|------------------|---------|----------------------|
| | DAP ¹ | | | | | |
| | | (cm) | (lb/bu) | (g) | (%) | (lb/a) |
| Delta | 56 | 64.0 | 65.7 | 236.0 | 20.6 | 4994 |
| DS-Admiral | 56 | 78.0 | 64.8 | 234.6 | 20.6 | 5114 |
| NDP121587 | 54 | 76.8 | 65.1 | 236.4 | 20.1 | 5333 |
| PS07100925 | 58 | 64.0 | 64.7 | 261.1 | 20.4 | 5123 |
| PS08101022 | 54 | 65.3 | 64.4 | 240.0 | 20.1 | 5313 |
| PS0877MT632 | 54 | 70.5 | 64.0 | 205.9 | 22.2 | 4305 |
| Mean | 55 | 69.8 | 64.8 | 236.0 | 20.6 | 5030 |
| P-Value | <0.0001 | 0.044 | 0.005 | <0.0001 | 0.007 | 0.029 |
| LSD | 0 | 11.1 | 0.8 | 6.4 | 1.1 | 615.7 |
| CV (%) | 0 | 10.5 | 0.8 | 1.8 | 3.5 | 8.1 |

Location: EARC; Sidney, MT

Previous crop: Sugarbeet

Planted: April 24, 2019

Harvested: Aug. 9, 2019

Applied fertilizers in lb/a: None

Soil type: Williams Clay Loam

Yield adjusted to 13% moisture content

Herbicide: Durango and Outlook at 24 oz/ac and 12 oz/ac, respectively.

DAP¹ = Days after planting

Chickpea Dryland Variety Trial - NDSU

WREC, Williston, ND 2019

| Variety | Brand/ Company | Days to Flower | Days to Mature | Plant height | Seed Size | | | | 1000 Seed Weight | Test weight | Yield | | | | |
|---------------|----------------|---------------------|---------------------|--------------|-----------|-------|--------|-------|------------------|-------------|--------------------|----------|----------|--|--|
| | | | | | <8mm | 8-9mm | 9-10mm | >10mm | | | 2019 | 2-Yr Avg | 3-Yr Avg | | |
| | | (DAP ¹) | (DAP ¹) | (in) | (%) | (%) | (%) | (%) | (g) | (lb/bu) | ----- (lb/a) ----- | | | | |
| Desi | | | | | | | | | | | | | | | |
| CDC ANNA | Meridian Seeds | 58 | 111 | 18.3 | 100.0 | 0.0 | 0.0 | 0.0 | 182.4 | 62.3 | 2449 | 2112 | 1678 | | |
| Kabuli | | | | | | | | | | | | | | | |
| CDC ORION | Meridian Seeds | 57 | 111 | 18.0 | 40.8 | 46.7 | 12.4 | 0.1 | 400.4 | 61.4 | 2466 | 2115 | 1701 | | |
| CDC LUNA | Meridian Seeds | 57 | 112 | 18.0 | 74.4 | 22.2 | 3.2 | 0.3 | 338.7 | 62.2 | 2228 | 2079 | 1585 | | |
| CDC FRONTIER | Meridian Seeds | 58 | 107 | 17.8 | 78.8 | 19.4 | 1.7 | 0.0 | 333.2 | 61.9 | 2140 | 1826 | 1458 | | |
| SAWYER | | 58 | 109 | 17.4 | 72.1 | 22.2 | 5.6 | 0.1 | 366.2 | 60.4 | 1987 | 1825 | 1411 | | |
| SIERRA | | 58 | 109 | 17.7 | 39.5 | 47.1 | 12.3 | 1.1 | 431.7 | 61.3 | 1903 | 1571 | 1242 | | |
| CDC Leader | Meridian Seeds | 56 | 111 | 18.0 | 67.6 | 29.7 | 2.7 | 0.0 | 351.2 | 62.2 | 2772 | 2364 | - | | |
| CDC Palmer | Meridian Seeds | 56 | 112 | 18.1 | 47.1 | 47.3 | 5.6 | 0.0 | 387.1 | 61.8 | 2921 | 2405 | - | | |
| BGC090017 | | 57 | 112 | 20.1 | 48.6 | 44.6 | 6.9 | 0.0 | 394.8 | 62.6 | 2555 | - | - | | |
| MS-19CP1 | Meridian Seeds | 56 | 111 | 16.9 | 99.2 | 0.8 | 0.0 | 0.0 | 269.5 | 63.0 | 2861 | - | - | | |
| MS-19CP2 | Meridian Seeds | 59 | 110 | 20.1 | 98.7 | 1.3 | 0.0 | 0.0 | 238.6 | 60.0 | 2785 | - | - | | |
| Mean | | 57 | 111 | 19 | 57.3 | 30.7 | 11.3 | 0.7 | 367.4 | 61.2 | 2340.0 | - | - | | |
| CV (%) | | 1.9 | 2.4 | 8.4 | 8.4 | 12.1 | 27.1 | 125.9 | 3.6 | 1.3 | 11.0 | - | - | | |
| LSD (5%) | | 1.5 | 3.8 | 2.2 | 6.9 | 5.3 | 4.3 | 1.2 | 19.0 | 1.1 | 365.3 | - | - | | |
| LSD (10%) | | 1.3 | 3.1 | 1.9 | 5.7 | 4.4 | 3.6 | 1.0 | 15.8 | 0.9 | 304.8 | - | - | | |

Location of the WREC: Latitude 48 8'; Longitude 103 44'W; Elevation 2105 ft

Previous Crop: German Foxtail Millet

Planting Date: 5/3/19

Harvest Date: 9/4/19

Soil type: Williams-Bowbells loam

Soil test to 6" in ppm: P=26 ppm; K=301 ppm; OM=1.8%; pH=5.9

Soil test to 24" in lb/a: N=106 lb/a

Applied fertilizers in lb/a: none

Herbicide Applications: Valor @ 3 oz/a with LV6 @ 1pt/a (10/22/18); Secure EC @ 12 oz/a (6/24/2019)

¹DAP = days after planting

Irrigated Chickpea Variety Evaluation - MSU**Sidney, MT 2019**

| Variety | Seed sizes greater than 22/64 inches | Adjusted Grain Yield |
|--------------|---|----------------------|
| | (%) | (lb/a) |
| BGC090017 | 57.9 | 3965 |
| CDC Alma | 33.5 | 1249 |
| CDC Frontier | 24.0 | 2605 |
| CDC Leader | 49.4 | 4371 |
| CDC Orion | 47.7 | 2830 |
| Myles | 0.0 | 2573 |
| Nash | 51.9 | 361 |
| Royal | 46.1 | 662 |
| Sawyer | 21.7 | 1585 |
| Sierra | 59.2 | 922 |
| Mean | 39.1 | 2112 |
| P-Value | <0.0001 | <0.0001 |
| LSD | 0.1 | 532.8 |
| CV (%) | 15.8 | 17.4 |

Location: EARC; Sidney, MT

Previous crop: Sugarbeet

Planted: April 23, 2019

Harvested: Sept. 5, 2019

Applied fertilizers in lb/a: None

Soil type: Williams Clay Loam

Yield adjusted to 13% moisture content

Rain fall (Apr-Aug) = 10.1"

Irrigation = 1.8"

Herbicide: Durango and Outlook at 24 oz/ac and 12 oz/ac, respectively.

Fungicide: Proline at 5.7 fl oz/a on 6/27/19, Priaxor @ 8 fl oz/a on 7/13/19, Delaro at 12 fl oz/a on 7/30/19.

Note: Conditions were favorable for development of Ascochyta blight at this location in 2019 and as a result, those varieties lacking resistance to Ascochyta performed poorly

Dryland Chickpea Variety Evaluation - MSU**Richland, MT 2019**

| Variety | Seed sizes greater than 22/64 inches | Adjusted Grain Yield |
|--------------|---|----------------------|
| | (%) | (lb/a) |
| BGC090017 | 82.0 | 1713 |
| CDC Alma | 48.8 | 2245 |
| CDC Frontier | 62.4 | 2391 |
| CDC Leader | 66.3 | 2193 |
| CDC Orion | 70.7 | 1705 |
| CDC Palmer | 67.0 | 1811 |
| GNC-18011 | 4.3 | 1011 |
| Myles | 0.0 | 1168 |
| Nash | 88.9 | 802 |
| Royal | 77.5 | 924 |
| Sawyer | 63.9 | 1854 |
| Sierra | 87.8 | 996 |
| Mean | 60.0 | 1568 |
| P-Value | <0.0001 | <0.0001 |
| LSD | 0.1 | 142.8 |
| CV (%) | 14.7 | 6.3 |

Location: Richland, MT

Previous crop: Spring Wheat

Planted: May 9, 2019

Harvested: Sept. 4, 2019

Applied fertilizers in lb/a: None

Soil type: Farnuf Loam

Yield adjusted to 13% moisture content

Herbicide: Valor at 3 fl oz/a fall applied; Sharpen at 0.75 fl oz/a.

Dryland Crop Performance Comparisons – Williston, ND 2019

Gautam Pradhan, Jerald Bergman, Kyle Dragseth

| Crop | Type | Variety | Yield | Market | Gross | + or - |
|-----------------|----------------|----------|----------------|---------------|--------|-----------------|
| | | | 3 Year Avg* | Price† | Return | spring wheat |
| | | | (bu/a) | (\$/bu) | (\$/a) | (\$/a) |
| HR Spring Wheat | | Bolles | 43.00 | 4.87 | 209.41 | 0.00 |
| HR Winter Wheat | | Jerry | 47.47 | 3.68 | 174.68 | -34.73 |
| Durum Wheat | | Joppa | 44.51 | 6.00 | 267.03 | 57.62 |
| Flax | | Average‡ | 17.00 | 9.00 | 152.97 | -56.44 |
| Soybeans | (Conventional) | Average‡ | 28.62 | 7.56 | 216.39 | 6.98 |
| Field Peas | (Green) | Arcadia | 41.07 | 5.00 | 205.36 | -4.05 |
| | (Yellow) | Agassiz | 42.63 | 3.75 | 159.85 | -49.56 |
| | | | lb/a | \$/CWT | | |
| Canola | | Star 402 | 1398.73 | 14.91 | 208.55 | -0.86 |
| Safflower | | MonDak | 1499.46 | 18.00 | 269.90 | 60.49 |
| Lentils | (Medium green) | Avondale | 1982.00 | 14.00‡ | 277.48 | 68.07 |

*The average yield of a crop, except durum wheat, was based on three-year average yield (2016, 2017, 2019) from dryland varietal trials. The average yield of durum wheat was based on 2017 and 2019. There were several episodes of high wind, heavy rain, and hailstorm that affected crops in 2018. So, the data from 2018 was not included.

†The market price was obtained in the second week of December 2019 from different grain elevators in and around Williston.

‡Average of several varieties and/or types within the crop.

‡Very limited market in 2019



WREC staff prepare for harvest

Drone Based High Throughput Phenotyping in Support of Cereal Breeding for Drought Tolerance

Gautam P. Pradhan¹, Joel K. Ransom², Jerald W. Bergman¹

¹NDSU Williston Research Extension Center, Williston, ND

²NDSU Department of Plant Sciences, Fargo, ND

Funding Agency: ND Agricultural Experiment Station – Precision Ag Grant Program

Introduction

In North Dakota, about 99% of field crops are non-irrigated, and drought is the single most important abiotic factor affecting yield and quality of dryland crops. In 2000, drought caused ~223 million dollars of economic losses in North Dakota (Jossi, 2002), and the loss in 2006 was estimated at 425 million dollars (NDDA, 2007). It is imperative to develop stress tolerant varieties to mitigate the effect of drought stress on field crops. Plant physiological traits such as the normalized difference vegetation index (NDVI), normalized difference red edge (NDRE), and canopy temperature (CT) are directly related to crop growth and yield; a stress tolerant crop usually has higher NDVI/NDRE and low CT as compared to susceptible crop. These traits, when measured frequently during the growing season, may help in the identification of high yielding drought tolerant genotypes. However, breeders seldom use these traits in their breeding programs; because it is highly resource demanding (time and labor). Also, due to time constraints, breeders have been collecting plant height data only once in a season. Thus, to identify drought tolerant cereal genotypes rapidly and accurately from standing crops, there is a need of an application of PRECISION AGRICULTURE, i.e., an application of high throughput phenotyping system comprising of geographic information systems, remote sensing, and geographic positioning system, which enable the measurement of physiological/canopy data from thousands of plots quickly (within minutes), frequently (6-7 times during the growing season), and accurately (georeferenced). The objective of this project is to evaluate the usefulness of high-resolution geotagged data collected by using an unmanned aircraft system (UAS, drone) equipped with multispectral, thermal, and RGB cameras/sensors in quantifying plant stand; plant height, plant health (NDVI, NDRE, CT) and heading date of cereal breeding nursery plots efficiently and accurately.

Materials and Methods

In 2018, a newly purchased drone (DJI MATRICE 600 PRO, Picture 1), a multispectral camera (MicaSense RedEdge-M, Picture 3), and an RGB camera (DJI Zenmuse X3, Picture 4) were assembled, calibrated, and tested. The UAS system, thus built, was flown over the barley and durum breeding nurseries using the Pix4D Capture App installed on an iPad. The images (~1000 photos) thus collected were processed in Agisoft Photoscan to generate Digital Elevation Model (DEM) and Orthophotos; which were subsequently used in QGIS to create raster images of Normalized Difference Vegetative Index (NDVI), Normalized Difference Red Edge (NDRE), and canopy height. Ultimately, the ArcGIS software along with Python Scripts was used to calculate and quantify plot-wise mean NDVI, NDRE, and Maximum canopy height plot.

In 2019, a drone (DJI MATRICE 600 PRO) equipped with a multispectral camera (MicaSense RedEdge-M) or a thermal camera (DJI Zenmuse XT2, Picture 5) and a newly acquired DJI Mavic 2 PRO (Picture 2) drone equipped with an RGB camera was flown frequently over the barley and winter wheat breeding nurseries and once over the durum nurseries. Altogether, we flew 20 times in the season. Software like DJI Ground Station Pro, DJI GO, DJI GO4, and Atlas Flight in an iPad was used to fly drones based on the type of camera and/or drone. The images were processed in Agisoft Metashape Professional to generate Digital Elevation Model (DEM) and orthophotos. The ArcGIS along with Python Scripts were used to quantify plot-wise canopy height from DEM and mean NDVI, NDRE from orthophotos.

Results

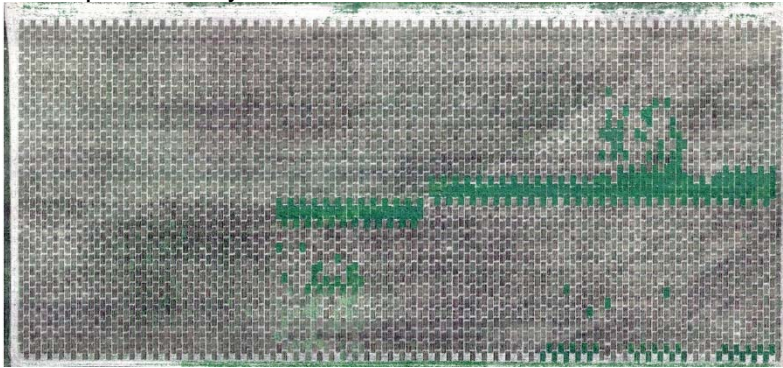
We successfully generated RGB, DEM, NDVI, NDRE, and canopy temperature orthomosaic (raster images) from our flights and quantified plot-wise plant height, NDVI, and NDRE. Figures 1-7 show outcomes of the project from selected dates and nurseries. We are still testing new algorithms and

software like ImageJ, MATLAB to quantify plot-wise plant stand and percent heading from RGB raster images and pixel by pixel temperature information from FLIR raster images.

Conclusions

The results showed that a UAV system may be successfully used in quantifying plant health (NDVI, NDRE) and plant height of thousands of breeding nursery plots frequently, efficiently and quickly. These data will provide time-series information on growth and plant health that will help breeders to increase the efficiency of selecting high yielding abiotic and biotic stress tolerant genotypes. There is still a need for finding a way to process raster images that provide plot-wise canopy temperature and percent flowering/heading. The next venture, stepping on this project, will be to determine the UAS based data collection and analyses protocol specific to a crop and trait. The protocol shall include but not limited to suitable stages of plant for data collection, time of the day on each stage, the height of the flight, and sensor to be used to measure the specific traits of ~ 15 crop species. It will also explain the procedure of processing images (stitching and mosaic production) and plot-wise quantification of the traits.

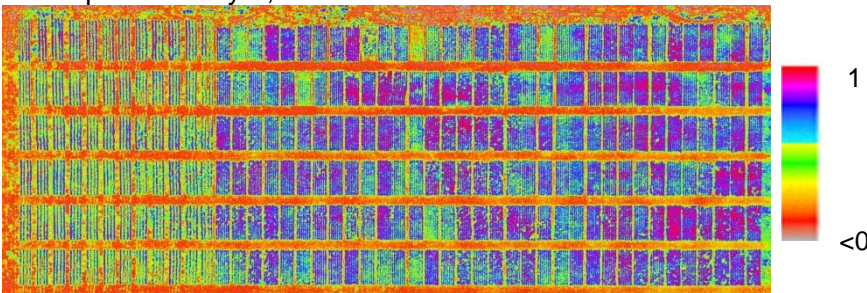
Figure 1. RGB orthomosaic of durum nurseries.
Aerial photos: July 24, 2019.



Picture 1. DJI MATRICE 600 PRO.



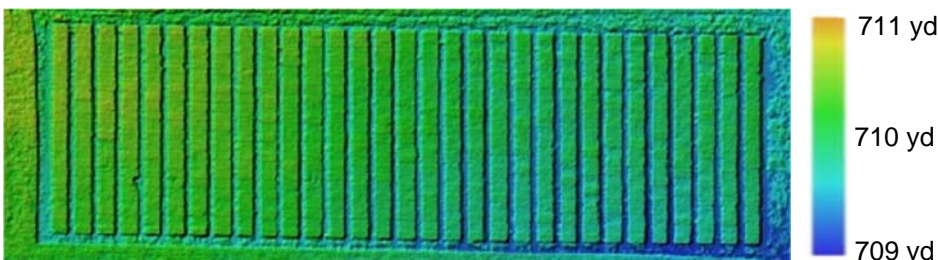
Figure 2. NDRE orthomosaic of a portion of WW nurseries.
Aerial photos: July 5, 2019.



Picture 2. DJI Mavic 2 PRO.



Figure 3. Digital elevation model (DEM) of barley nurseries.
Aerial photos: July 24, 2019.



Picture 3. MicaSense RedEdge-M – Multispectral Camera.



Figure 4. RGB orthomosaic with polygons identifying plots of barley nursery (“19 EXPT12WIR”). Aerial photos: Jul 24, 2019.

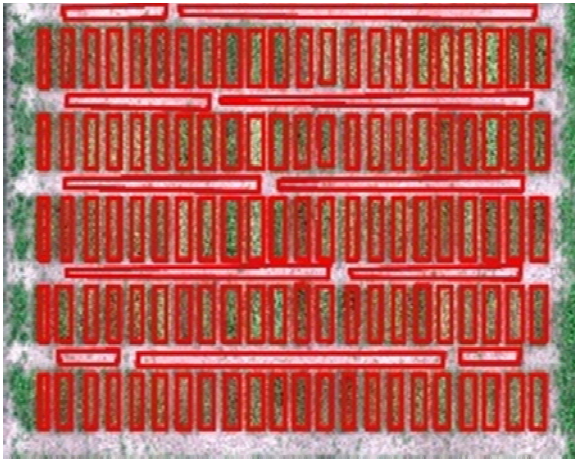


Figure 5. Plot-wise plant heights of barley nursery (“19 EXPT12WIR”) derived from DEM, categorized into eight classes and presented by overlaying on RGB orthomosaic.

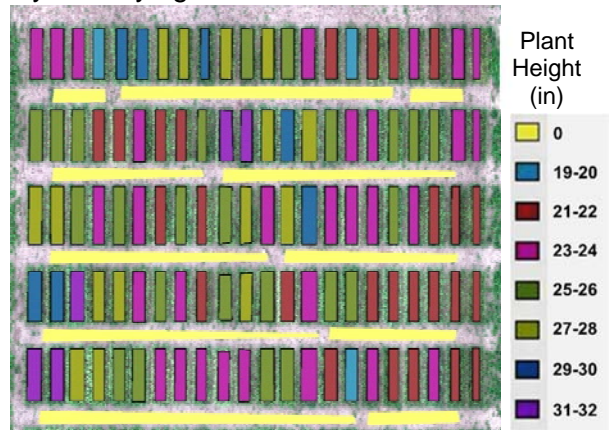


Figure 6. Plot-wise NDVI of barley nursery (“19 EXPT12WIR”) categorized into eleven classes. Aerial photos: July 24, 2019.

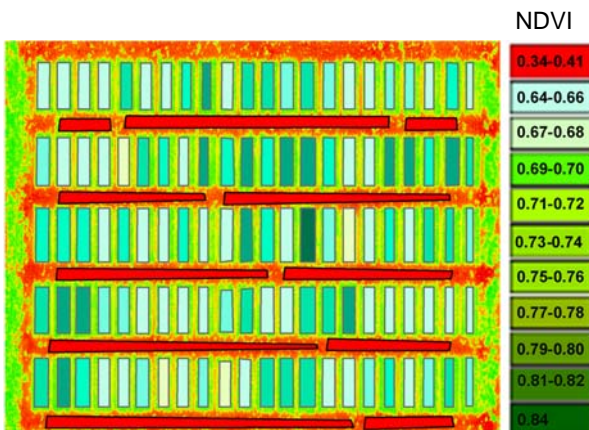
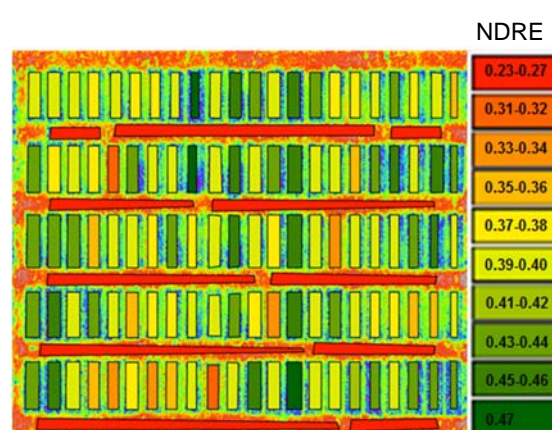


Figure 7. Plot-wise NDRE of barley nursery (“19 EXPT12WIR”) categorized into ten classes. Aerial photos: July 24, 2019.



Picture 4. DJI Zenmuse X3 – RGB Camera.



Picture 5. DJI Zenmuse XT2 – Thermal Camera.



Correlations between Yields of Spring Wheat Varieties and Normalized Difference Vegetation Index (NDVI) from Ground and Aerial Based Systems EARC, Sidney, MT and WREC, Williston, ND

Gautam Pradhan, Shuang Zhou, Apurba Sutradhar, and Chengci Chen

Materials and Methods:

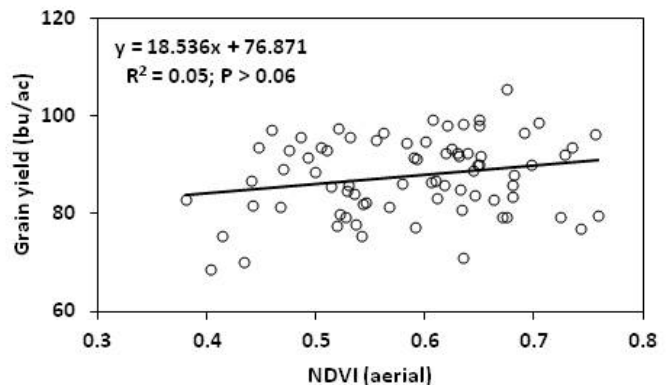
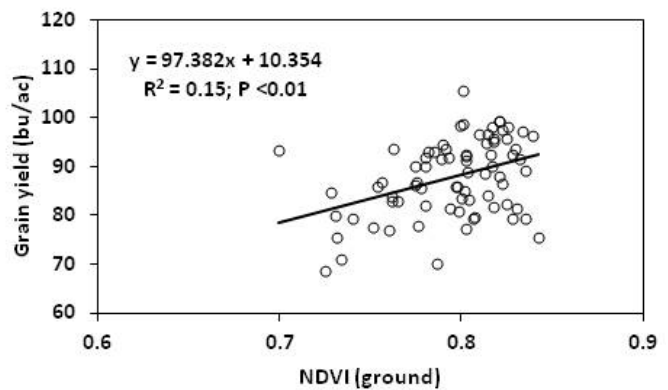
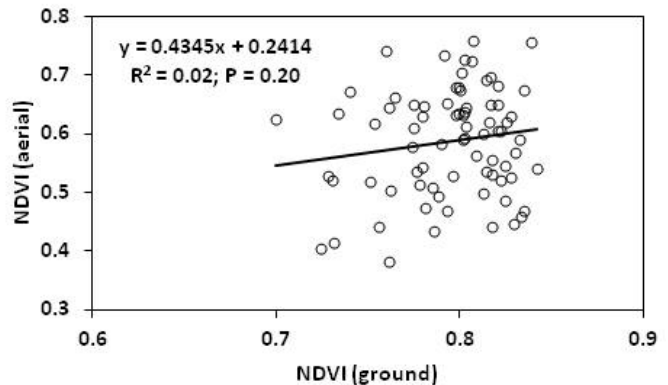
Location: EARC
 Planted: 4/18/2019
 Tillage: Conventional
 Experimental design: Randomized Complete Block
 Rainfall: 21.5"
 Fertilizers (obtained): 60 lbs N/ac and 30 lbs P₂O₅/ac.

Previous crop: Fallow
 Harvested: 8/19/2019
 Plot size: 5" x 10"
 Replications: 4
 Soil type: Williams Clay Loam

Plotwise NDVI data was extracted from imageries collected on 06-20-2019 using a DJI Matrice 600 Pro system and a Micasense Rededge-M multispectral camera attached. A hand-held GreenSeeker was used to collect ground-based NDVI data on the same day.

In the figure from the top, relationships between NDVI readings extracted from imageries using an unmanned aerial system and a hand-held GreenSeeker, between grain yields and ground based NDVI, and between grain yields and aerial-based NDVI.

Grain yields were adjusted to 12% moisture content.



Sustainable Agroecosystem for Soil Health in the Northern Great Plains (Williston, ND - 2019)

Gautam Pradhan¹, Jim Staricka¹, Audrey Kalil¹, Jerry Bergman¹, Bart Stevens², Upendra Sainju², Kyle Dragseth¹, Cameron Wahlstrom¹, Meredith Miller¹, Taheni Gargouri Jbir¹, David Weltikol¹, Lyn Soldberg-Rodier²

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This long-term dryland research project was initiated in 2013 with the objectives of developing agricultural systems that improve soil health, crop production, precipitation use, and economic sustainability of no-till dryland farming systems in the Northern Great Plains of the USA. In this project, there were five fixed and six dynamic rotations. Every year, each phase of every fixed rotation has been included. The experimental design is randomized complete block with four replications. The plot size is 60 ft. x 200 ft. In 2019, based on the results from previous five years, treatment structure was modified to seven fixed rotations and two dynamic rotations, which are as follows:

Fixed Rotations from 2019

| 2019 | 2020 | 2021 | 2022 | 2023 |
|---------------|---------------|-----------------|---------------|---------------|
| Durum | Fallow | Durum | Fallow | Durum |
| Durum | Durum | Durum | Durum | Durum |
| Cover Crop | Pea | Durum | Canola | Safflower |
| HRWW | Pea | Durum | Canola | Safflower |
| Durum | Pea | Durum | Lentil | Durum |
| Durum + SC | Sweet Clover | Durum + SC | Sweet Clover | Durum + SC |
| Perennial Mix | Perennial Mix | Perennial Grass | Perennial Mix | Perennial Mix |

Note: Cover crop is a mixture of turnip, soybean, flax, sorghum sudangrass, and oats. HRWW = hard red winter wheat; SC = sweet clover. SC + Durum = sweet clover is companion cropped with durum.

Dynamic Rotations from 2019

| 2019 | 2020 | 2021 | 2022 | 2018 |
|-----------|------|------|------|------|
| Safflower | TBD | TBD | TBD | TBD |
| Durum | TBD | TBD | TBD | TBD |

- Crops in the dynamic rotations will be determined each year based on weather and market conditions and using the following tools:
 - The USDA-ARS Crop Sequence Calculator (An interactive program for viewing crop sequencing information and calculating returns; www.mandan.ars.usda.gov)
 - The NDSU Projected Crop Budgets for Northwest North Dakota (www.ag.ndsu.edu/publications/farm-economics-management).

Methods

Planting date, seeding rate, varieties and harvest dates are indicated in the table below. Rotations were differentially fertilized based on soil test and crop history. Durum, canola and safflower received 50 lbs of MEZ (12-40-0-10S-1Zn). Durum was fertilized based on 110 lb N/ac target minus a 40 lb no-till credit, a 26 lb/ac legume credit, starter and results of soil tests. Treatments 15, 3 and 18 received 102 lbs/ac urea. Treatments 6, 11, 18 and 19 had sufficient N based on soil tests and credits and thus did not receive urea. Canola was fertilized based on a 140 lb N/ac target minus a 40lb no till credit and results of the soil test. Canola plots received 100lbs/ac AMS and 76lbs/ac urea. Safflower plots received 35 lbs/ac urea (95 lb/ac N target minus no-till credit and soil test N). Peas, lentils and sweet clover were not fertilized as soil tests indicated approximately 40lbs/ac N was available. No fungicides were applied to durum, peas, lentils or canola. Safflower was treated with a foliar fungicide (azoxystrobin, 9 oz/ac) at early bloom and mid-bloom for control of Alternaria blight.

| Crop | Seeding Rate | Seeding Date | Harvest Date |
|----------------------|------------------|--------------|--------------|
| Durum (ND Riveland) | 1 million PLS/ac | 5/3/2019 | 8/21/2019 |
| Canola (CP9919RR) | 6 lbs/ac | 5/9/2019 | 8/16/2019 |
| Safflower (Cardinal) | 30 lb/ac | 5/2/2019 | 9/20/2019 |
| Peas (Midas) | 385,000 PLS/ac | 5/3/2019 | 8/2/2019 |
| Lentils (Richlea) | 70 lb/ac | 5/9/2019 | 8/29/2019 |

Results – Agronomic

There was a significant effect of crop rotation on durum yield and grain protein, but not on test weight. Durum following fallow, pea or sunflower (treatments 1, 6, 11 and 18) produced the highest yield compared with durum grown on durum stubble or grown as a mixture with sweet clover on HRSW stubble (treatments 3 and 15) (Table 1). Durum grown with sweet clover on HRSW stubble had the lowest grain protein. The test weight, averaged across the treatments, was 62.2 lb/bu.

Table 1. Durum yield, test weight, and protein content under different treatments.

| Treatment # | Crop | | Yield (bu/ac) | Test Weight (lb/bu) | Protein (%) |
|-------------|-------------|------------|---------------|---------------------|-------------|
| | 2018 | 2019 | | | |
| 1 | Fallow | Durum | 78.5 A | 62.3 A | 13.1 A |
| 3 | Durum | Durum | 57.2 D | 62.2 A | 11.7 A B C |
| 6 | Pea | Durum | 70.6 A B | 62.1 A | 11.7 A B C |
| 11 | Pea/BP3 | Durum | 75.7 A B | 62.1 A | 11.5 B C |
| 15 | HRSW | Durum + SC | 54.9 D | 62.6 A | 10.3 C |
| 19 | Lentil | Durum | 69.3 B C | 62.4 A | 12.1 A B |
| 18 | Sunflower | Durum | 72.2 A B | 62.1 A | 12.8 A B |
| 21 | Small grain | Durum | 61.0 C D | 61.9 A | 12.9 A B |

Note: Different letters within a column indicates significant difference at *p* value of 0.0001 for yield and 0.016 for percent protein. HRSW = hard red spring wheat. SC = sweet clover. Small grain indicates either barley or durum in 2018. BP3 = Biological primer 3 (cover crop mixture).

There was a significant effect of crop rotation on pea yield, but not on test weight or grain protein. Pea preceded by HRWW in 2018 produced the highest yield compared pea seeded following BP1 or flax (treatments 5 and 10). The pea test weight and protein averaged across the crop rotation was 64.2 lb/bu and 20.5%, respectively.

Table 2. Pea yield, test weight, and protein content under different treatments.

| Treatment # | Crop | | Yield (bu/a) | Test Weight (lb/bu) | Protein (%) |
|-------------|----------|------|--------------|---------------------|-------------|
| | 2018 | 2019 | | | |
| 5 | BP1 | Pea | 74.3B | 63.8A | 20.8A |
| 10 | HRWW/BP2 | Pea | 79.8A | 64.5A | 20.6A |
| 16 | Flax | Pea | 73.5B | 64.3A | 20.1A |

Note: BP1 and BP2 are biological primers (cover crop mixtures). Different letters within a column indicates significant difference at *p* value of 0.02 for yield.

The effect of crop rotation was not evident on the grain yield of other cash crops. The average yield of safflower, canola, lentil, and winter wheat were 1904 lb/ac, 1661 lb/ac, 2582 lb/ac, and 38 bu/ac, respectively.

The sweet clover and cover crop were cut for hay July 24th and July 29th respectively. The cover crop plots produced in total 1,900 lbs/ac and the sweet clover plots produced 2,960 lbs/ac.

Results – Plant Pathology

Table 3. Early season foliar fungal leaf spotting disease and Fusarium Head Blight in durum

| Rotation (2013 - 2019) | Feekes 2 | | Feekes 11.2 | |
|--|----------|-------|-------------|--------|
| | LS INC | LS SV | FHB INC | FHB SV |
| Fallow - Durum | 0 | 0 | 22.5 | 1.1 |
| Durum - Durum | 1.5 | 0.04 | 22.5 | 1.6 |
| Pea - Corn -Safflower- Durum – BP1 - Pea - Durum | 0 | 0 | 29.2 | 2.0 |
| Pea/BP2- Corn - Safflower - Durum - HRWW/BP3 - Pea/BP2 - Durum | 0 | 0 | 23.3 | 1.1 |
| Sunflower - HRSW - HRWW - Lentil - Durum - Sunflower - Durum | 0 | 0 | 15.8 | 0.9 |
| Pea - Durum - Safflower - Barley - HRSW - Lentil - Durum | 1 | 0.04 | 33.3 | 2.2 |
| | NS | NS | NS | NS |

Note: LS = Leaf spotting diseases such as tan spot, Septoria/Stagnospora blotch. FHB = Fusarium head blight (scab). INC = incidence or percent of plants exhibiting disease symptoms. SV = severity or the percent of the plant tissue exhibiting disease. NS = not significant, indicating no difference among the treatments.

Conclusions

Taking the 40 lb/ac no-till credit and a 26 lb/ac legume credit did not seem to reduce durum yield as they were comparable across treatments 1, 6, 11 and 18 (Table 1) with only treatment 18 receiving urea fertilization. The durum crops with the lowest yield were those following durum or HRSW (Table 1). Further studies are needed to determine if the practice of companion cropping durum with sweet clover results in yield and protein loss. Foliar disease levels overall were very low and Fusarium head blight was observed at consistent levels in durum across rotational treatments.

Determining soybean planting date and soil temperature for no-till semi-arid condition of western North Dakota

Gautam P. Pradhan, James Staricka and Jerald W. Bergman

NDSU Williston Research Extension Center

Funding Agency: North Dakota Soybean Council

Introduction

Planting date plays a crucial role in the performance and success of a field crop. Early or late planting may decrease grain yield and quality of a crop due to increased biotic (insect, disease, weed), and abiotic (frost, drought, and high temperature) stress. Kandel (2013) noted that soybean is susceptible to frost and prolonged exposure to near-freezing conditions in the spring and fall; and recommended that soybean be planted in North Dakota and Northwestern Minnesota when the soil temperature is $>50^{\circ}\text{F}$. Western North Dakota has a cool semi-arid climate with annual precipitation of <15 inches, which is at least 5 inches lower than the eastern part of the state. In this part of the state, the last spring freeze may occur in the last week of April and the first fall freeze in October. Thus, there is a need of determining optimal soybean planting dates and soil temperature for the western part of North Dakota that provide optimum growing period, decrease chances of frost and/or drought damage, and enhance grain yield.

Materials and Methods

Two glyphosate tolerant soybean varieties, 'ND17009GT' and 'ND18008GT' were seeded at Williston Research Extension Center, Williston, using a GPS based autosteered seven rows no-till plot seeder that maintained a row to row distance of 7". The treatments comprised of seven seeding dates: 2nd, 9th, 16th, 23rd, and 30th of May, and 6th and 13th of June 2019 as main plots; two varieties: as subplots, and two seed treatments (treated and not treated) as sub-sub plots. During plant growth, the soil moisture and temperature data at four inches depth were continuously recorded using soil sensors. Unmanned aircraft systems equipped with multispectral, thermal, or RGB cameras were flown over the experimental field to estimate Canopy Temperature (CT), Normalized Difference Vegetation index (NDVI), Normalized Difference Red Edge (NDRE), and plant heights at different growth stages. At maturity, soybean was harvested using a plot combine.

Results

Preliminary results showed that there was a significant effect of planting date and variety but not of seed treatment on seed yield and test weight. Varieties responded differentially to the planting date for these traits. When averaged across the other two treatments, soybean variety 'ND18008GT' produced 4.5 bushels more seeds per acre than variety 'ND17009GT' (Fig. 1); and soybean planted on May 9th had the highest seed yield and one planted on June 13th had the lowest seed yield (Fig. 2). When averaged across seed treatment, the Variety 'ND17009GT' produced higher yield when planted on May 9th and June 6th as compared to all other planting dates; however, the variety 'ND18008GT' produced statistically similar yield when planted in the month of May but had a decline in yield when planting was delayed to June 6th. (Fig. 3). When averaged across the other two treatments, the test weight of the variety 'ND18008GT' was slightly lower than the variety 'ND17009GT' (Fig. 4); and the effect of planting date on the test weight was not evident in soybean planted from May 2nd to 23rd. A sharp decline in test weight was observed when soybean was planted on and after June 6th (Fig. 5). When averaged across seed treatment, the effect of late planting was detrimental to both soybean varieties for the test weight, (Fig. 6). However, the degree of decline in test weight as a result of late planting was higher in 'ND17009GT' than in 'ND18008GT'.

Figure 1. Effect of variety on soybean yield.

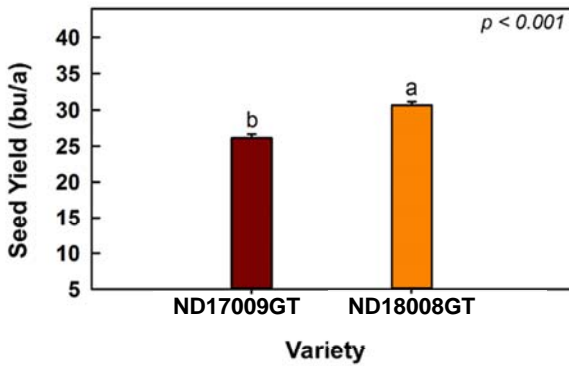


Figure 2. Effect of planting date on soybean yield.

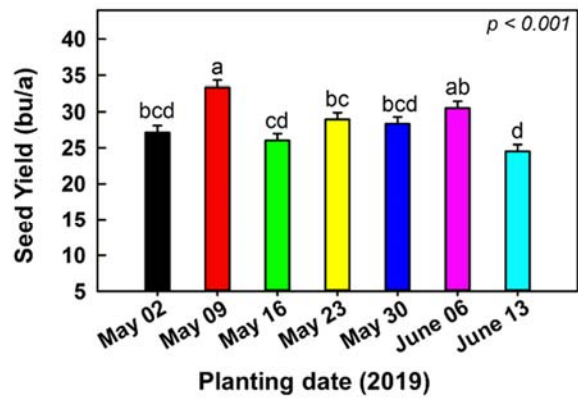


Figure 3. Differential responses of soybean varieties to planting dates for seed yield.

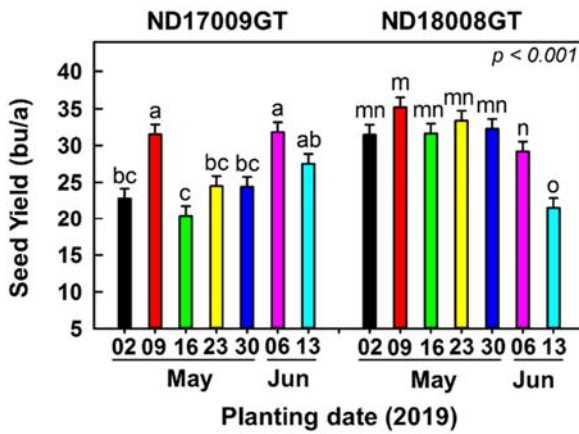


Figure 4. Effect of variety on soybean test weight.

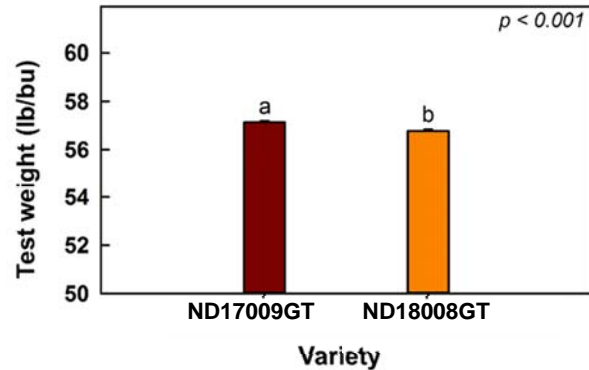


Figure 5. Effect of planting date on soybean test weight.

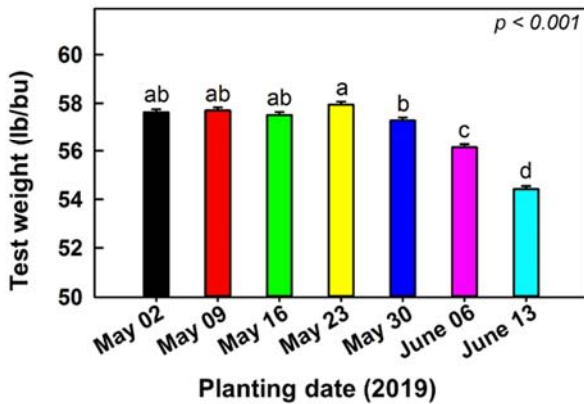
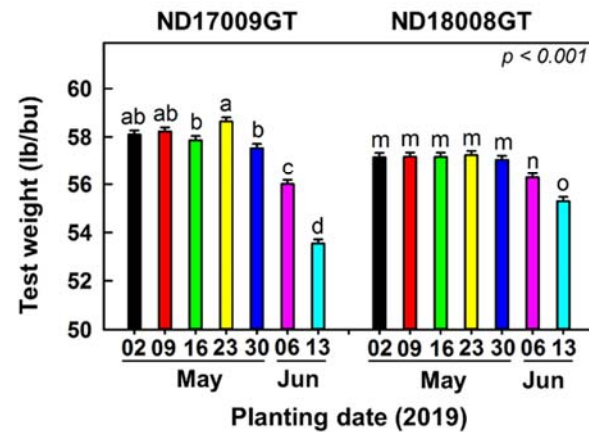


Figure 6. Differential responses of soybean varieties to planting dates for test weight.



Flax Seeding Date and Rate for No-Till Semi-arid Western North Dakota

Gautam P. Pradhan, Jerald W. Bergman, James Staricka

Meridith Miller, Cameron Wahlstrom

Funding Agency: AmeriFlax

Introduction

North Dakota (ND) is the largest flax growing state in the nation. In ND, more than 40% of the flax acreage belonged to the northwestern region of the state (USDA/NASS 2018). This region is characterized by cold semi-arid climate and no-till production practices. There is a lack of information on suitable agronomic practices that enhance flax yield and quality under these conditions. Seeding date and rate play a significant role in field crop production. Early or late seeding may decrease grain yield and quality of a crop due to increased biotic (insect, disease, weed, and bird incidence), and/or abiotic stress (frost, drought, and high temperature). On the other hand, a higher seeding rate may decrease yield and quality due to competition for resources (water, solar radiation, soil nutrients) and lower seeding rate may adversely affect plant growth and yield due to the scanty number of plants per unit area, heavy weed infestation, and nonuniform maturity. The objective of this experiment is to determine suitable flax seeding date and rate for no-till semiarid western ND that enhance flax yield, quality, and the profit of flax producers.

Materials and Methods

This experiment was conducted at NDSU Williston Research Extension Center, Williston, ND (Lat. 48.1346°, Lon. -103.7400°; Elevation 2105 ft). The soil type of the research site is Williams-Bowbells Loam. The average long-term annual precipitation of the research site is <15". The experiment was seeded using a GPS based autosteered seven rows plot seeder that maintained a row to row distance of 7". The treatments comprised of six seeding dates: Apr 23rd, May 2nd, 9th, 16th, 23rd, and 30th as main plots; two Varieties: CDC Melyn and CDC Glas as subplots; and four seeding rates: 15, 25, 35, 45 lb/ac as sub-sub plots. During plant growth, plant stand was estimated by counting the seedlings, and the physiological data were recorded using an unmanned aircraft system equipped with multispectral and thermal cameras. The soil moisture data were collected using a neutron probe. At maturity, flax was harvested using a plot combine.

Results

There was a significant effect of seeding date, variety, and seeding rate on plant stand when averaged across the other treatments. The May end seeding increased plant stand by 59 to 271% compared to early seeding dates (Fig. 1A). The variety, CDC Glas, had 121% more plant stand than CDC Melyn (Fig. 1B). The seeding rate of 45 lb/ac had 22 to 128% more plant stand than other seeding rates (Fig. 1C). There was a significant effect of seeding date and variety on plant height and days to flowering, when averaged across the other treatments. Flax seeded after the third week of May was about two to seven inches taller than earlier seeding dates (Fig. 2A) and CDC Glas was about one inch taller than CDC Melyn (Fig. 2B). Flax seeded after the second week of May took three to twelve fewer days to flower than earlier seeding dates (Figure 3A) and CDC Glas flowered one and half-day earlier than the CDC Melyn (Fig. 3B).

There was a significant effect of seeding date, variety, and seeding rate on seed yield and test weight, when averaged across the other treatments. Flax seeded at the end of May produced 2 to 11 more bu/ac of seeds (Fig. 4A) and had 2 to 5 more lb/bu of test weight (Fig. 5A) than earlier seeding dates. CDC Glas outperformed CDC Melyn for seed yield by 9.4 bu/ac (Fig. 4B); however, the test weight of CDC Glas was 1 lb/bu fewer than the CDC Melyn (Fig 5B). The seeding rate of 45 lb/ac produced 2.4 to 4.3 more bu/ac of flax seeds as compared to seeding rates of 15 and 25 lb/ac (Fig. 4C); however, higher seeding rates resulted in 0.5 to 1 fewer lb/bu of test weight than 15 lb/ac seeding rate (Fig. 5C).

There was a differential response of varieties to the seeding date and/or seeding rate for plant stand, yield, and test weight (data not presented). In this experiment, the data from April 23rd seeding was not analyzed for all traits as the 3rd and 6th rows were never seeded due to seed tube clogging.

Summary

Under the no-till semiarid condition of western ND, flax seeded on the last week of May had higher plant stand, plant height, and yield compared to earlier seeding dates. An increase in seeding rate from 15 to 45 lb/ac resulted in higher plant stand and seed yield. In general, flax variety CDC Glas had higher plant stand, plant height, and yield and lower test weight than CDC Melyn. This experiment will be repeated next year to validate the findings.

Figure 1. Response of flax to (A) seeding date, (B) variety, and (C) seeding rate for plant stand.

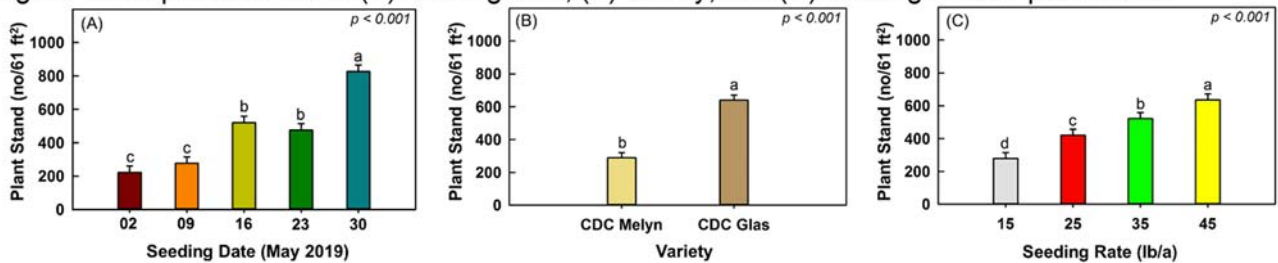


Figure 2. Response of flax to (A) seeding date and (B) variety for plant height.

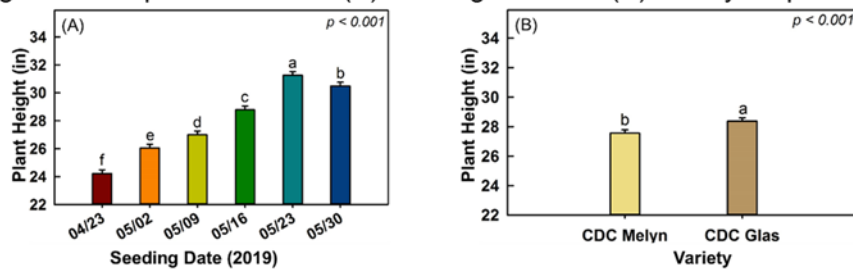


Figure 3. Response of flax to (A) seeding date and (B) variety for days to flowering.

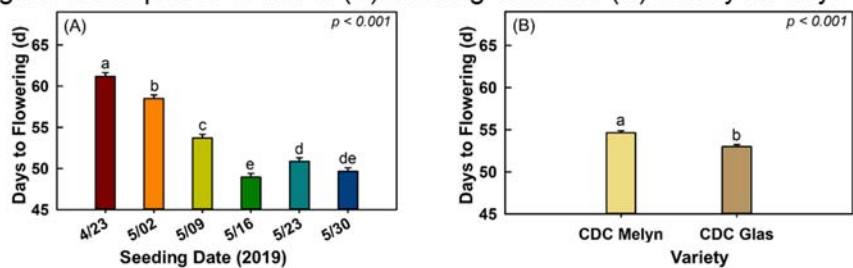


Figure 4. Response of flax to (A) seeding date, (B) variety, and (C) seeding rate for seed yield.

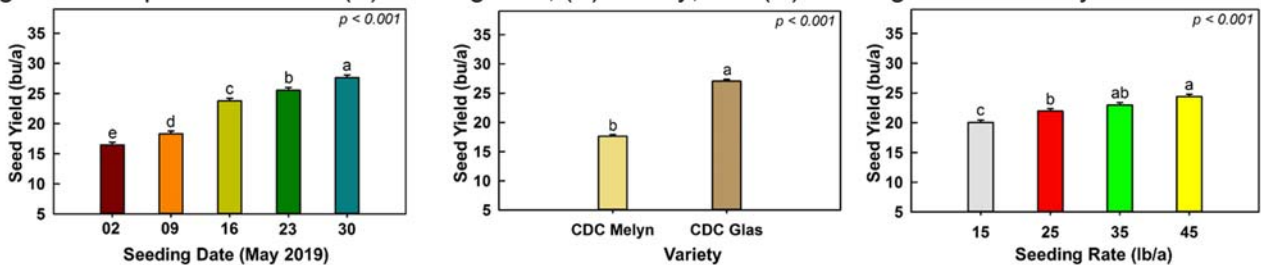
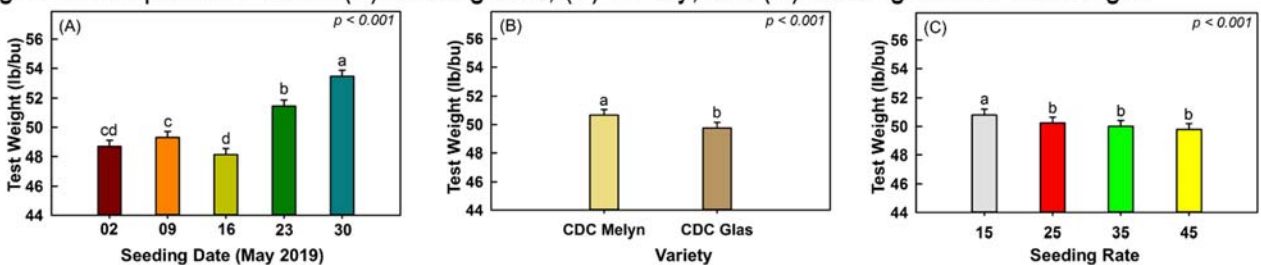


Figure 5. Response of flax to (A) seeding date, (B) variety, and (C) seeding rate for test weight.



Effects of Cropping Sequence, Ripping, and Manure on Pipeline Reclamation in Western North Dakota

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¹NDSU Williston Research Extension Center, Williston, ND; ²NDSU Dept. of Soil Science, Fargo, ND; ³NDSU Range Program, Fargo, ND; ⁴NDSU Extension Service, Minot, ND

Funding provided by the ND Industrial Commission – Oil & Gas Research Program



Summary

Soil disturbance during the construction of pipelines, roadways, and well pads has become a serious issue in western North Dakota. Within cropland, soil health and yields need to be restored during the reclamation process. Reclamation in a cropland setting has not been extensively researched and little is known about the best management practices for restoring crop yields. During the spring of 2015, installation of a 36” water pipeline was completed at the Williston Research Extension Center. We took advantage of this opportunity by planting a long-term experiment with five annual crop rotations and two perennial covers in pipeline, roadway, and undisturbed (control) areas. In addition to cropping sequence, ripping and manure are being tested as subplots in a split plot design in efforts to decrease compaction and add organic matter. This study is designed to address barriers to successful pipeline reclamation. More specifically, this study aims to provide long-term management strategies for landowners to restore productivity to cropland. If economical reclamation options are available to stakeholders, more effective reclamation plans can be composed and more efficient pipeline installations will be possible. Preliminary results indicate soil compaction and crop yields are significantly different between disturbance areas. Additional soil and plant data collection will determine differences between ripping, ripping/manure, and no-till subplots.

Design

| Rotation | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|----------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 1 | Durum | Durum | Durum | Durum | Durum | Durum | Flax |
| 2 | Durum | Peas | Barley | Safflower | Durum | Flax | Flax |
| 3 | Peas | Barley | Safflower | Durum | Durum | Peas | Flax |
| 4 | Cover Crop* | Durum | Cover Crop | Durum | Durum | Cover Crop | Flax |
| 5 | Durum | Cover Crop | Durum | Cover Crop | Durum | Safflower | Flax |
| 6 | Alfalfa | Alfalfa | Alfalfa | Alfalfa | Durum | Durum | Flax |
| 7 | Perennial Grass | Perennial Grass | Perennial Grass | Perennial Grass | Perennial Grass | Perennial Grass | Perennial Grass |

Figure 1. The crop rotations used in this study for the first five years and planned for the next two years. *Cover Crop Mix = Pearl Millet, Sorghum, Sudan, Turnip, Radish, Burseem Clover, Sunflower, Soybean, Cow Pea, Flax, Hairy Vetch, Phacelia, Mammoth Red Clover, Italian Ryegrass.

| | | |
|----------------------|---------------|-------------------|
| Undisturbed - Ripped | Road - Ripped | Pipeline - Ripped |
|----------------------|---------------|-------------------|

| | | |
|-----------------------------|----------------------|--------------------------|
| Undisturbed – Ripped+Manure | Road – Ripped+Manure | Pipeline – Ripped+Manure |
| Undisturbed – No Till | Road – No Till | Pipeline- No Till |

Figure 2. The plots for each cropping sequence were sub-divided in to sub-plots with one sub-plot being no/minimal tillage, one was deep-ripped, and the third was deep-ripped and had manure added.



Figure 3. Manure application and tillage methods.

Soil Compaction and Subsidence

Soil compaction is a serious problem along pipelines and reclaimed well pads. The heavy equipment traffic and mixing of topsoil and subsoil leads to varying degrees of soil compaction, decreased water infiltration and holding capacity. Compacted soil can severely impact soil health and reduce crop yields.

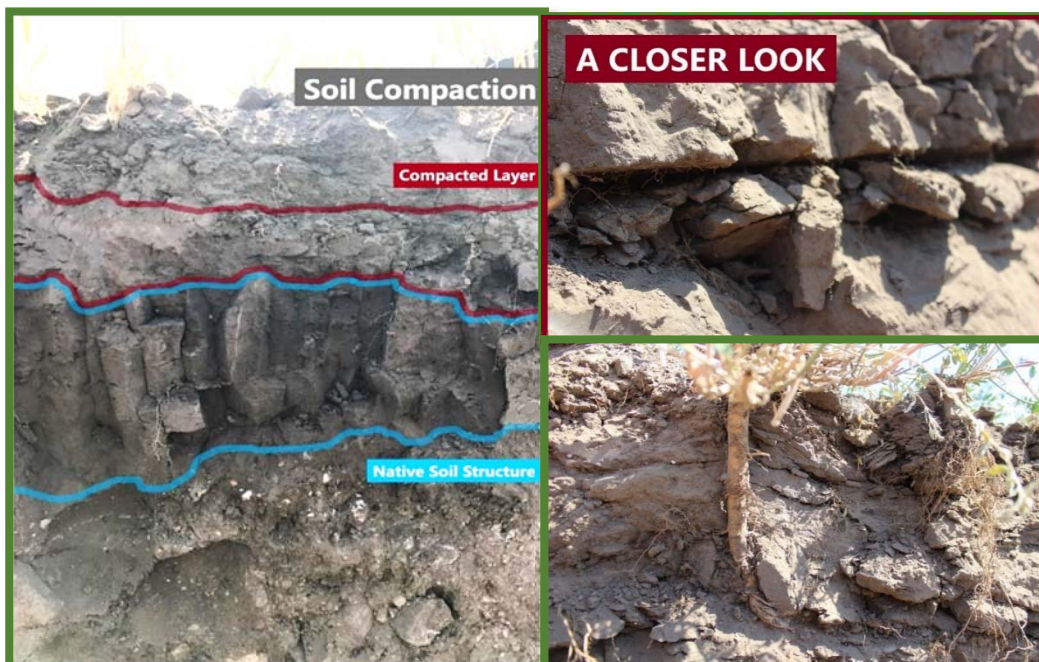


Figure 4. In the left image, the native soil structure is outlined in blue, while the compacted layer is shown above. The compacted layer doesn't have any of the structure of the native soil. The upper right image shows a close up of compacted soil in the roadway area of this project. The bottom right image is of a taproot unable to penetrate the compaction, which restricts its growth.

Soil subsidence is another problem that is frequently encountered following pipeline installations. The soil can compress and sink down along the pipeline, increasing the compaction of the soil in that area. This can lead to low spots and crevices in the field which can be hazardous for farm equipment. The need to fill in the subsided areas leads to further compaction from additional heavy equipment traffic and soil fertility issues. Following a significant rain event in July 2018, much of the pipeline disturbance area subsided. In some areas, crevices as deep as 30 inches occurred. Due to the severity of the subsidence, we were not able to harvest the pipeline plots. This demonstrates the potential impacts similar occurrences could have on producer's yields.



Figure 5. Images of subsidence along the pipeline disturbance area. The upper two images were taken shortly after the subsidence occurred in July 2018. The aerial image was taken in March of 2019, the sunken area is outlined in white.

We used a truck-mounted dynamic cone penetrometer to measure compaction throughout the three disturbance areas. During the first two years of the project, no reduction in compaction occurred. In 2017, the ripping and manure treatments were introduced. This appears to reduce compaction more effectively than full-season tap-rooted cover crops in the roadway area (the most compacted of the three areas).

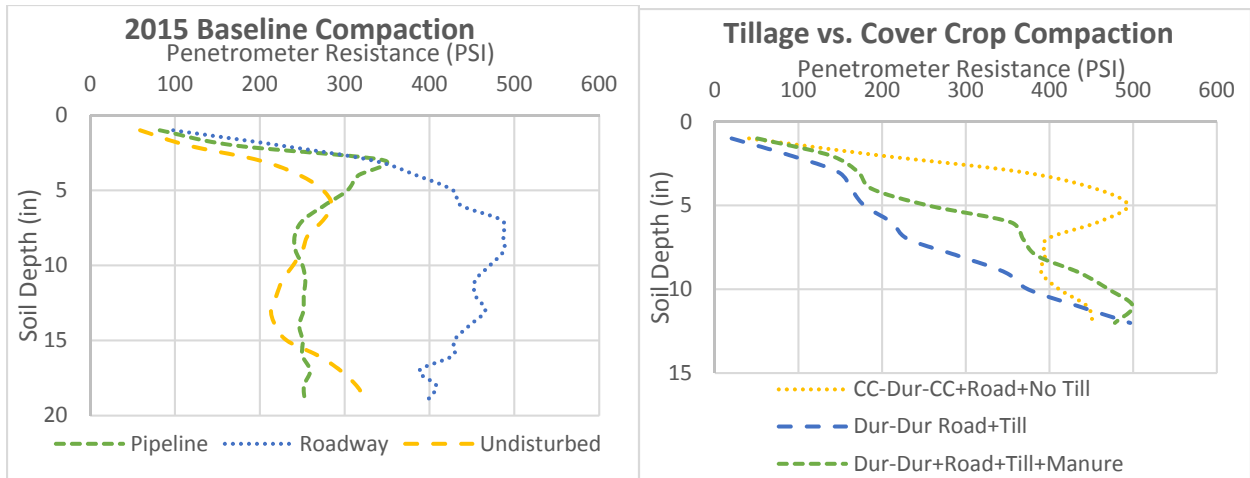


Figure 6. The baseline compaction in the first year of the study (2015) is on the left. The roadway is considerably more compacted than both the undisturbed and pipeline disturbance area. Any compaction in excess of 300 PSI is considered extremely compacted and begins to impact plant growth. The graph on the right shows the roadway compaction in Year Three (2017) after ripping and manure additions. The compaction was reduced more on the ripped plots than on the no-till plots that had deep tap-rooted cover crops planted for two of the three years.

Preliminary Agronomic Results

- ❖ In Years One and Two, annual crops yielded significantly less in road and pipeline areas, the roadway areas had the lowest small grain yields both years ($P \leq .05$).
- ❖ In Year Three (2017), all three areas had reduced yields in the annual crops due to the drought conditions
- ❖ Year Four (2018) had increased yields in all three disturbance areas, but the compacted roadway still had lower yields.
- ❖ In Year Two, alfalfa yielded significantly higher in the pipeline area ($P \leq .05$).
- ❖ In Year Three, alfalfa did not yield significantly different between disturbance areas ($P \leq .05$).
- ❖ Dynamic Cone Penetrometer data trends suggest tillage treatments reduce compaction initially more effectively than deep-rooted annual cover crops.

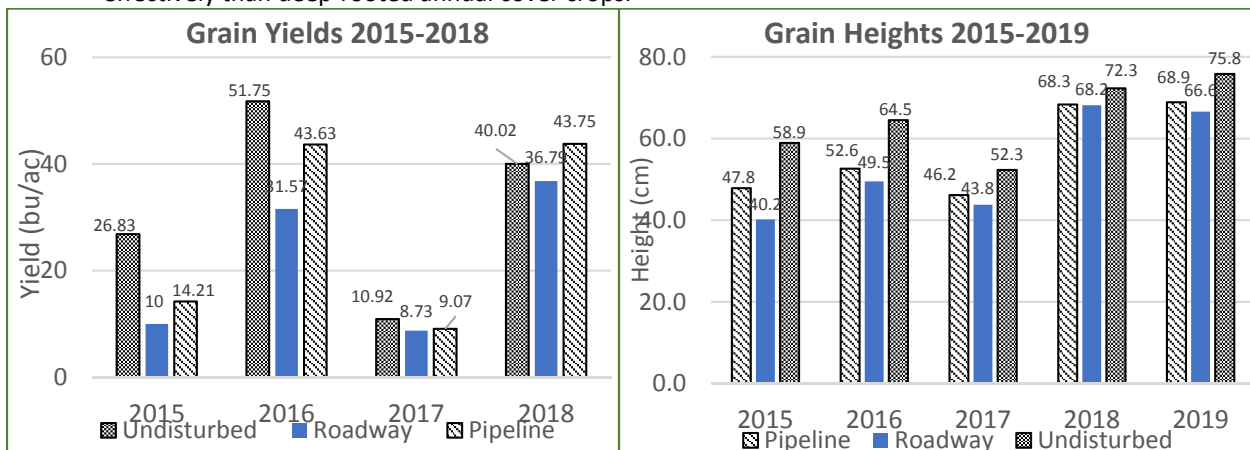


Figure 7. Grain Yields for Year One through Four (on the left) and Grain Heights for Years One through Five (on the right). In Year One (2017), spring wheat was planted, the other years durum was planted.

Future Work

- ❖ In 2020, we will be planting a variety of annual crops to compare yields and effects across disturbance areas.
- ❖ In 2021, we will plant the entire study area, excluding the perennial grass plots, to one crop (flax) to better compare the different cropping rotations and tillage methods across disturbance areas.
- ❖ We are still working to complete in-depth data analysis for each year of the project, comparing the different crops, cropping rotations and perennial covers (alfalfa and grasses) to determine which crops and rotations are the most effective at reducing compaction and restoring soil health.

Evaluation of Spring Canola Varieties in Eastern Montana

EARC, Sidney, MT

Chengci Chen, Simon Fordyce, Apurba Sutradhar, Calla Kowatch-Carlson, and Thomas Gross

Materials and Methods:

Irrigated

| | |
|--|---|
| Location: EARC | Previous crop: Sugarbeet |
| Latitude 47.7288N; Longitude 104.1501 W; Elevation 1949 | Soil type: Williams Clay Loam |
| Planted: 05/16/2019 | Harvested: 08/26/2019 |
| Tillage: Conventional | Plot size: 5" x 18" |
| Experimental design: Randomized Complete Block | Harvest type: Direct cut |
| # Varieties: 14 | Replications: 4 |
| Pesticide: Sevin @ 16 oz/ac three times on 7/3/2019, 6/4/2019, and 6/18/2019 | Herbicide: Stinger @ 6 oz/ac sprayed on 6/24/2019 |
| Rainfall: 10.4" | Irrigation: 6.5" |

Comments: 1. Grain yield was adjusted to 8% moisture; 2. Grain yield may have been affected by early season flea beetle damage; & 3. Early season weed damage.

Table 1. Initial soil test results. A composite soil sample was collected prior to planting canola.

| Depth | pH | OM | NO ₃ -N | P-Olsen | K | Ca | Mg | Na | Zn | Fe | Mn | Cu | B | CEC |
|-------|-----|-----|--------------------|---------|-----|------|-----|-----|------|-----|------|------|----------|------|
| Inch | | % | ----- ppm ----- | | | | | | | | | | meq/100g | |
| 0-12 | 8.2 | 3.7 | 38.0 | 17 | 431 | 6050 | 615 | 148 | 0.57 | 8.1 | 6.08 | 1.18 | 1.8 | 37.1 |

Table 2. Description of Varieties

| Variety name | Description | | | | |
|---------------|--------------|--------------------|--------------|----------|----------|
| | Distributor | Shatter Resistance | Herbicide | Blackleg | Clubroot |
| 16CH4181 | Cargill | N | Conventional | R | -- |
| 16MH6001 | Cargill | N | CL | R | -- |
| 16MH6004 | Cargill | N | CL | R | -- |
| 4187RR | Brett Young | N | RR | R | R |
| 5545CL | Brett Young | Y | CL | R | -- |
| 6090RR | Brett Young | Y | RR | R | R |
| CP930RR | Winfield | Y | RR | R | -- |
| CP955RR | Winfield | Y | RR | R | R |
| DKTF91SC | Dekalb/Bayer | Y | TruFlex RR | R | -- |
| DKTF92SC | Dekalb/Bayer | Y | TruFlex RR | R | -- |
| InVigor L233P | BASF | Y | LL | R | -- |
| InVigor L234P | BASF | Y | LL | R | R |
| InVigor L255P | BASF | Y | LL | R | R |
| NCC101S | Photosyntech | Y | Conventional | MR | -- |

Note: Shatter resistance, N = no, Y = yes; Herbicide resistance, CL = Clearfield, RR = Roundup Ready, LL = LibertyLink; Blackleg disease, R = resistance, MR = moderately resistance; and Clubroot disease, R = resistance. No significant shattering and lodging observed.

Table 3. Summary of Agronomic Data of Canola Varieties Tested.

| Variety | Plant Stand (acre) | Plant Height (inch) | Test Weight (lb/Bu) | Grain Yield (lb/ac) | Oil (%) | Oil Yield (lb/ac) |
|----------------|--------------------|---------------------|---------------------|---------------------|----------|-------------------|
| 16CH4181 | 291307 | 24.8 a | 52.2 e | 1288 abc | 44.0 cd | 575 abc |
| 16MH6001 | 294030 | 17.0 bc | 54.2 ab | 1160 abcd | 45.1 abc | 529 bcd |
| 16MH6004 | 242302 | 18.8 bc | 53.3 abcde | 1428 a | 44.5 bc | 643 ab |
| 4187RR | 358009 | 19.8 b | 53.7 abcd | 1544 a | 46.6 a | 724 a |
| 5545CL | 355286 | 19.0 bc | 54.1 ab | 1024 bcde | 46.0 ab | 472 bcde |
| 6090RR | 300061 | 15.2 bc | 53.2 bcde | 661 efg | 43.4 cde | 287 efg |
| CP930RR | 302197 | 24.3 a | 53.9 abc | 1408 ab | 46.7 a | 658 ab |
| CP955RR | 322616 | 26.8 a | 54.1 ab | 1386 ab | 46.2 ab | 641 ab |
| DKTF91SC | 302197 | 18.8 bc | 52.7 cde | 907 cdef | 42.4 def | 389 cdef |
| DKTF92SC | 250470 | 16.0 bc | 50.9 f | 595 fg | 41.1 f | 248 fg |
| InVigor L233P | 296752 | 17.5 bc | 52.4 de | 993 cde | 42.4 def | 425 cdef |
| InVigor L234P | 370260 | 15.3 c | 52.4 de | 904 cdef | 42.0 ef | 383 def |
| InVigor L255P | 345757 | 15.5 c | 54.5 a | 869 def | 44.6 bc | 389 cdef |
| NCC101S | 393401 | 17.3 bc | 48.8 g | 359 g | 35.4 g | 127 g |
| Mean | 315414 | 19.0 | 53.0 | 1046 | 43.6 | 468 |
| P > F | 0.15 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| LSD (P = 0.05) | 102001 | 3.80 | 1.35 | 389 | 1.83 | 187 |
| CV (%) | 22.3 | 13.8 | 1.68 | 25.6 | 2.90 | 27.6 |

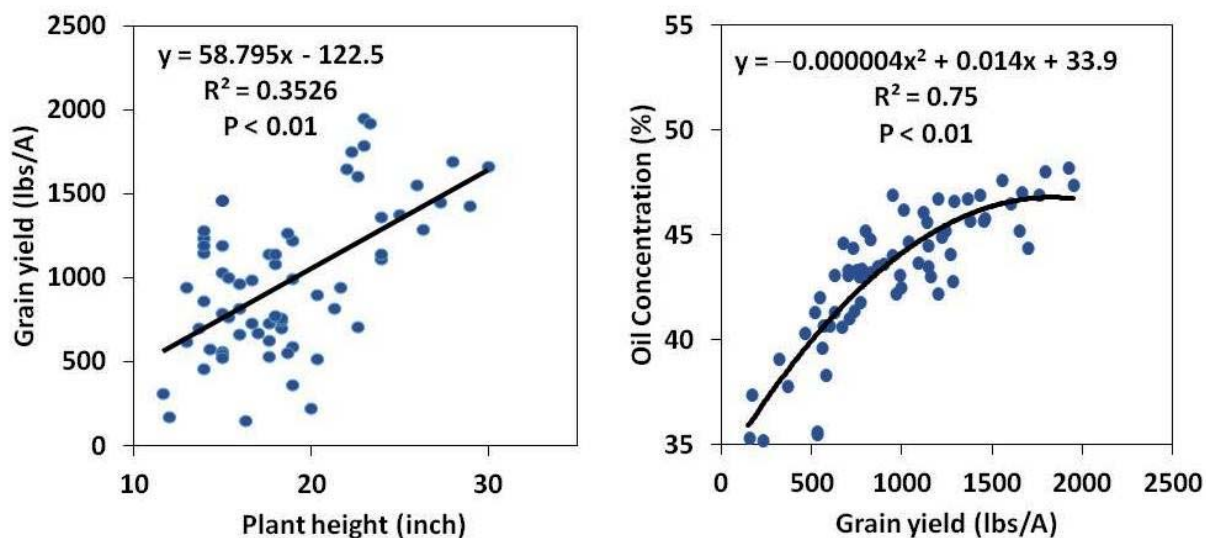


Figure 1. Relationships between canola grain yield, plant height and seed oil concentration.

DON Accumulation in Durum Varieties

Taheni Jbir, Cameron Wahlstrom, Marilen Nampijja, Eric Eriksmoen, Dr. Audrey Kalil
Funding provided by the ND Wheat Commission

Introduction

Fusarium Head Blight (FHB), or scab, is a disease of durum wheat (*Triticum durum*) caused by the fungal pathogen *Fusarium graminearum*. This pathogen produces a toxin, Deoxynivalenol (DON), which contaminates wheat grain. Durum varieties are all generally considered susceptible to FHB compared to Hard Red Spring Wheat. FHB disease levels and DON can vary greatly across North Dakota in a given season due to differences in humidity, amount of rainfall and timing of rainfall. The goal of this project was to assess DON levels in the harvested grain of durum varieties grown at several locations in western and central North Dakota to identify the varieties that consistently accumulate the least DON under different environmental conditions.

Methods

Variety trials were conducted at ten locations in 2019. Trials were set up in a randomized complete block design, with 5 x 14 ft. plots and three replicated plots per variety. No fungicides were applied. Grain from each plot was analyzed for DON using the Reveal Q+ mycotoxin extraction kit and AccuScan II GOLD reader (Neogen). Results presented are an average of data from three replications per variety.

Results

DON was highest at the Rugby site. There was no DON detected in any durum varieties at the Arnegard, Minot, Mohall and Nesson Valley locations. Average DON in harvested grain for each variety at six sites is presented in Table 1. Williston is excluded in the means calculated across sites due to low DON.

| Variety | Scab Rating | DON (ppm) | | | | | | |
|-----------------------------|-------------|----------------|----------|-------|-----------|----------------|--------|----------------|
| | (1-9)* | Crosby | Garrison | Keene | Williston | Rugby | Wilton | ALL** |
| Alkabo | 6 | 0.3 <i>bc</i> | < 0.3 | 0.3 | < 0.3 | 0.6 <i>c</i> | 0.8 | 0.4 <i>bc</i> |
| Carpio | 5 | < 0.3 <i>c</i> | 0.3 | 0.9 | < 0.3 | 0.7 <i>bc</i> | 0.4 | 0.5 <i>abc</i> |
| Divide | 5 | < 0.3 <i>c</i> | 0.4 | 0.3 | < 0.3 | 0.6 <i>c</i> | 0.3 | 0.3 <i>bc</i> |
| Grenora | 6 | 0.2 <i>bc</i> | 0.9 | 0.4 | < 0.3 | 0.7 <i>c</i> | 0.4 | 0.5 <i>abc</i> |
| Joppa | 5 | 0.3 <i>bc</i> | < 0.3 | 0.4 | < 0.3 | 0.4 <i>c</i> | 0.4 | 0.3 <i>c</i> |
| Lebsock | 6 | < 0.3 <i>c</i> | 0.6 | 0.8 | < 0.3 | 0.5 <i>c</i> | 0.4 | 0.5 <i>abc</i> |
| Mountrail | 8 | 0.9 <i>a</i> | 0.8 | 0.7 | < 0.3 | 1.3 <i>abc</i> | 0.6 | 0.8 <i>abc</i> |
| ND Grano | 6 | 0.6 <i>ab</i> | 0.6 | 0.7 | < 0.3 | 1.8 <i>ab</i> | 0.3 | 0.8 <i>ab</i> |
| ND Riveland | 5 | < 0.3 | 0.5 | < 0.3 | < 0.3 | 0.5 <i>c</i> | 0.5 | 0.4 <i>bc</i> |
| Tioga | 6 | 0.6 <i>ab</i> | 0.8 | 0.6 | 0.6 | 2 <i>a</i> | 0.8 | 0.9 <i>a</i> |
| Mean | | 0.4 | 0.5 | 0.5 | < 0.3 | 0.9 | 0.5 | 0.6 |
| p-value ($\alpha < 0.05$) | | < 0.0001 | NS | NS | NA | 0.0003 | NS | 0.0001 |

Table 1. Average DON in durum varieties across selected sites in 2019. Different letters within columns (sites) indicate treatments that are significantly different. For statistical analysis, treatments with no detectable DON were assigned a value of 0.15. NS = non-significant. NA = not analyzed due to no/low of DON *NDSU durum breeder scab rating scores from 1-9, with 1 = resistant and 9 = very susceptible. ** Williston data excluded from the analysis

Conclusions

Durum varieties Mountrail, Tioga and ND Grano had the highest DON according to results of Crosby and Rugby sites as well as average DON from five locations. ND Riveland and Divide had the lowest DON. Other varieties tested had more variation in DON accumulation across sites and were considered intermediate based on these data. Varieties with lower DON according to this study should not be considered resistant, but may provide slightly better performance under moderate scab pressure.

Fungicide Rotations for Ascochyta Blight Management in Chickpea

Nicole Stanhope, Makenna Girard, Darby Howatt, Taheni Jbir and Dr. Audrey Kalil

Introduction

A study was initiated at the Nesson Valley Irrigated Research Site to evaluate fungicides within a three-spray program for control of Ascochyta Blight in chickpea. Previous research by Dr. Michael Wunsch at the Carrington REC has found tank mixing Proline with chlorothalonil to be beneficial for the control of Ascochyta blight. Thus, fungicides were applied with and without the addition of chlorothalonil to the tank mix.

Study Description

The study was a randomized complete block design with 5 ft x 18 ft plots, 4 replicates per treatment. Registered Sierra chickpea seed was purchased for this study. The trial was planted April 24th. Outside border plots were inoculated June 12th with one handful each of overwintered chickpea residue. Foliar fungicide applications were made June 25th at initial bloom (A), July 8th (B) and July 23rd (C) (15 gal/ac water, NIS @ 0.25% v/v). Care was taken to ensure that chlorothalonil mixes were adequately agitated prior to application. Ascochyta disease assessments were made June 20th, July 8th, July 18th and August 5th on 10 plants per plot based on percent canopy necrosis. The trial was harvested September 6th. Treatments are listed in the table below.

| Fungicide Rotation Treatments (A, B, C) | |
|---|---|
| 1 | Untreated |
| 2 | A: Quadris Opti B: Miravis Top C: Miravis Neo |
| 3 | A: Quadris Opti B: Miravis Top + chlorothalonil C: Miravis Neo + chlorothalonil |
| 4 | A: Miravis Neo B: Miravis Top C: Proline |
| 5 | A: Miravis Neo + chlorothalonil B: Miravis Top + chlorothalonil C: Proline + chlorothalonil |
| 6 | A: Miravis Top B: Miravis Top C: Proline |
| 7 | A: Miravis Top + chlorothalonil B: Miravis Top + chlorothalonil C: Proline + chlorothalonil |

Results

| Treatment | Ascochyta Severity (%) 7/8/2019 | Ascochyta Severity (%) 7/18/2019 | Ascochyta Severity (%) 8/5/2019 | Yield @ 13.5% moisture (lb/ac) |
|-----------|------------------------------------|-------------------------------------|------------------------------------|--------------------------------------|
| 1 | 26.3 a | 85.3 a | 82.3 a | 0 c |
| 2 | 7.9 b | 33.6 bc | 52.6 b | 323 bc |
| 3 | 4.9 b | 54.8 b | 59.0 b | 491.5 b |
| 4 | 4.2 b | 30.0 cd | 55.4 b | 343.7 bc |
| 5 | 2.5 b | 9.1 de | 31.8 c | 1064.3 a |
| 6 | 2.4 b | 18.0 cde | 44.0 bc | 326 bc |
| 7 | 1.6 b | 6.8 e | 29.1 c | 798.3 ab |

Differences among treatments are indicated by different letters ($\alpha < 0.05$).

Conclusions

Treatments 5 and 7 had the lowest disease at the last time point assessed and the highest overall yield. Both of these treatments included chlorothalonil in the tank mix and yield was more than doubled in comparison to treatments 4 and 6, which were the same except for chlorothalonil was not added. Treatment 3 had similar levels of disease and yield to treatment 2, despite the addition of chlorothalonil in treatment 3. Based on these data it is unclear whether there is a synergy when tank mixing chlorothalonil with the Miravis products. This trial will need to be repeated to confirm results.

2019 Pulse Disease and Insect Pest Scouting

Dr. Audrey Kalil, Nicole Stanhope, Darby Howatt, Makenna Girard, Honggang Bu, Dr. Janet Knodel, Dr. Julie Pasche, Dr. Kim Zitnick-Anderson, Dimitri Fonseka, Taheni Gargouri-Jbir and Marilen Nampijja

Introduction

In the 2019 growing season a pea, lentil and chickpea scouting program funded by the Northern Pulse Growers Association was conducted. The goals of the program were to scout farmer fields for diseases and insect pests, monitor root rot pathogens and publish relevant findings in the NDSU Extension *Crop and Pest Report* and weekly maps on the NDSU IPM website.

Methods

Pea, chickpea and lentil fields were scouted for diseases including root rots, bacterial blight, *Ascochyta* blight, downy mildew, white mold, and powdery mildew, among others, and insect pests. Insect pests monitored were cutworms, grasshoppers, pea leaf weevil and aphids. Fields were located in the five northwest North Dakota counties. A total of 56 pea fields, 62 chickpea fields and 77 lentil fields were scouted. The scouts used standard scouting practices developed by ND Extension Specialists. This involves walking a “W” pattern in the field, and examining 10 plants at 5 sites in the field for diseases and insects. Scouts use visual counts for cutworm and pea leaf weevil damage, and a 15-inch sweep net for grasshoppers and aphids. Diseases were measured based on the number of plants affected (incidence) and the percent of the crop canopy exhibiting disease symptoms (severity).

Results

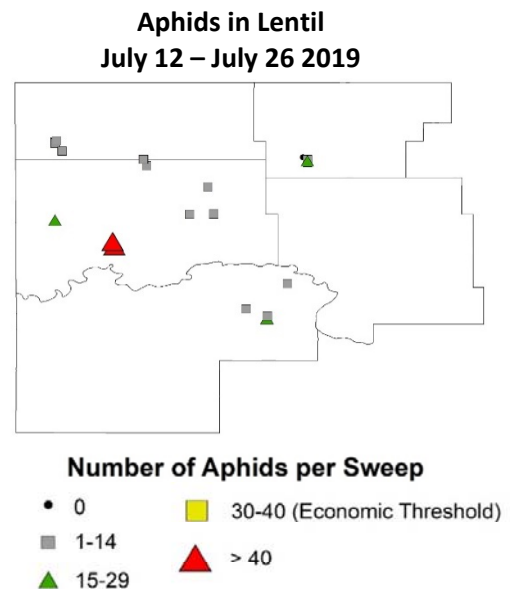
The results presented here reflect a summary of the data collected. To view all the mapped data collected during this survey please visit the NDSU IPM website: <https://www.ag.ndsu.edu/ndipm> and click on the “Lentil,” “Pea” and “Chickpea” links near the center of the page. *Crop and Pest Report* articles on the scouting efforts are also available at this website: <https://www.ag.ndsu.edu/cpr>

Insect Pests

Fields were scouted for cutworm feeding damage in May and June. The overall percentage of fields where cutworm damage was identified was – 39% of lentil fields, 29% of pea fields and 0% of chickpea fields. Damage levels were generally low and below economic thresholds.

Aphids were common in pea and lentil fields late July and into early August. White flecks (feeding damage) on the leaves were observed on samples brought in to the WREC. Populations reached and exceeded economic thresholds, however, this was when the crop was at later podding growth stages when insecticides are no longer considered necessary to manage feeding damage. One item of concern is that aphids can transmit viruses such as Pea Seedborne Mosaic Virus, among several others. The NDSU Plant Diagnostic Lab can test seed for PSbMV if growers are concerned about contaminated seed-lots.

Pea leaf weevil (*Sitona lineatus*) is a new insect pest of field pea that was first discovered in the fall of 2016 near Beach, ND. In 2019, the pulse crop scout looked for feeding injury (leaf notching) caused by pea leaf weevil by examining 100 plants per field. Pea leaf weevil was found in Williams, Burke, Divide, McKenzie and Mountrail Counties this year. When the number of leaf notches are greater than 9 per



plant, yield loss in that field can be significant next season (2020) if conditions are favorable for pea leaf weevil in the spring (warm springs, > 68°F). None of the counties scouted had fields where damage levels were that high.

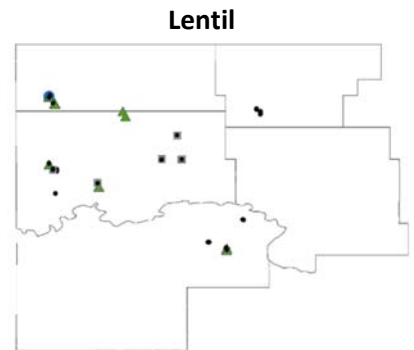
Diseases

Lentil: Very little foliar disease was observed in lentils this season. Of primary concern was root rot caused by *Fusarium* sp. and *Aphanomyces euteiches*. Above-ground symptoms of root rot including stunting, wilting and yellowing were present in 27% of fields scouted and up to 34% of plants were affected in one field. Above-ground symptoms became most obvious beginning in mid-July at the early pod growth stage, however infection likely began much earlier in the season. Isolations performed from diseased roots confirmed the presence of *Fusarium* root rot (Pasche, Zitnick-Anderson and Fonseca). Bioassays performed from diseased roots and field soil also confirmed the presence of *Aphanomyces euteiches* in some fields (Kalil, Howatt, Nampijja and Jbir).

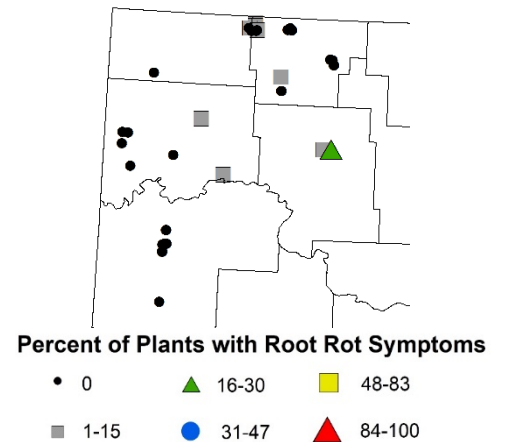
Peas: Bacterial blight symptoms were observed in field pea beginning in late May when the crop was at early vegetative growth stages and was also detected in late July at late pod-fill. Incidence ranged from 2-14% of plants being affected with 1-4% of the crop canopy exhibiting symptoms. Ascochyta blight was observed in Williams and Burke Counties with highest levels in Burke County at late pod-fill. Incidence reached up to 32%, however, only 1% of the crop canopy was affected. Root rot was observed in 16% of pea fields scouted.

Chickpeas: Onset of Ascochyta blight was in mid-June when the crop was at mid to late vegetative growth stages. Incidence of Ascochyta varied widely among fields, with some staying below 4% the entire season and others reaching 72% by the end of July. Percent of the crop canopy exhibiting symptoms generally stayed below 2%.

**Root Rot Incidence
2019 Season Final**



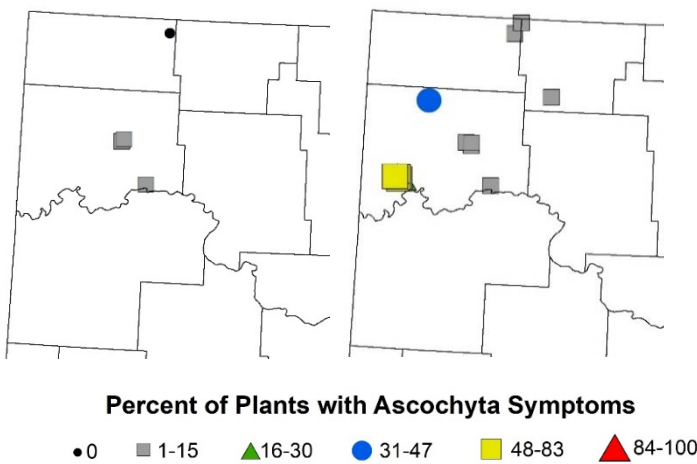
Pea



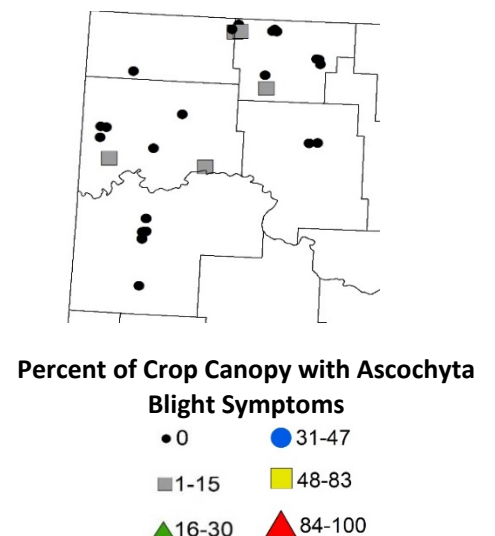
Chickpea Ascochyta Blight Incidence

June 14 – June 28

July 26 – August 9



**Pea Ascochyta Blight Severity
2019 Season Final**



2019 Chickpea Foliar Trial

Frankie Crutcher and Amber Ferda

EARC, Sidney, MT

OBJECTIVE: Test the efficacy of different fungicide combinations for control of *Ascochyta rabiei* on chickpeas under irrigation.

MATERIALS AND METHODS:

Irrigated

Variety: Sierra

Location: Sidney, MT

Planted: 4/25/19

Harvested: 9/6/19

Plot Size: 5' x 20'

Seeding Rate: 4 LS/ft²

Soil Type: Savage silty clay loam

Previous Crop: Sugarbeet

Residual Soil N to 3 ft: 25 lbs/A

Applied Fertilizer: None

Residual Soil P to 6 in: 25 ppm

Irrigated (sprinkler) on: 6/7/19, 6/13/19, 6/14/19, 7/22/19

Herbicide Applications: Durango 24 fl oz/A, Outlook 12 fl oz/A

Precipitation April – September: 19.38 inches

Vigor: 5/31/19

Treatments: Miravis Top, Miravis Neo, Proline, Propulse, Delaro, Endura, Quadris Opti

Date of first application: 6/26/19

Date of second application: 7/8/19

Date of third application: 7/21/19

Date of fourth application: 8/4/19

Disease assessments: 7/12/19, 7/30/19, 8/9/19

COMMENTS: Seeds were inoculated with peat-based commercial Rhizobium N-Charge® (Verdesian Life Sciences, Cary, NC). Fungicides were applied using a Teejet 80015VS Even Flat Spray nozzle tips at 14 GPA. Incidence was 100% for all treatments for disease assessments on 7/30/19 and 8/9/19. Trial was desiccated with Gramoxone (32 fl oz/A) on 8/28/19.

RESULTS:

Table 1: Effect of Fungicide Treatments on Chickpeas to Control *A. rabiei*

| Trt # | % Severity ^a 7/12 | % Incidence ^b 7/12 | % Severity ^a 7/30 | % Severity ^a 8/9 | Yield (lbs/A) |
|------------|---------------------------------|----------------------------------|---------------------------------|--------------------------------|---------------|
| 1 | 22.5 A | 100.0 A | 79.8 A | 76.8 A | 54.6 F |
| 2 | 14.3 AB | 97.5 A | 19.6 D-F | 31.3 E-H | 1975.0 BC |
| 3 | 12.4 B | 92.5 A | 47.3 BC | 52.5 BC | 898.1 DE |
| 4 | 11.5 B | 80.0 AB | 15.5 EF | 23.5 F-H | 2661.7 AB |
| 5 | 12.8 AB | 85.0 A | 10. F | 20.5 GH | 2803.1 AB |
| 6 | 10.0 B | 57.5 B | 8.50 F | 18.3 H | 3008.5 A |
| 7 | 14.8 AB | 80.0 AB | 31.3 C-E | 37.3 C-F | 1754.9 C |
| 8 | 14.9 AB | 85.0 A | 32.0 C-E | 39.5 C-E | 892.6 D-F |
| 9 | 14.8 AB | 85.0 A | 44.5 C | 49.5 B-D | 463.8 EF |
| 10 | 13.5 AB | 77.5 AB | 31.3 C-E | 35.8 D-G | 1379.7 CD |
| 11 | 13.0 AB | 87.5 A | 64.0 AB | 58.8 B | 151.0 EF |
| 12 | 16.8 AB | 100.0 A | 34.5 CD | 44.0 B-E | 1319.4 CD |
| Mean | 14.3 | 85.6 | 34.9 | 40.6 | 1446.9 |
| CV (%) | 47.5 | 23.4 | 66.9 | 46.8 | 76.6 |
| LSD (0.05) | 9.9 | 26.9 | 17.7 | 15.5 | 841.0 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

^aSeverity: Average area of ten plants covered by disease.

^bIncidence: Percent of ten plants per plot that had disease.

^cNumber of plants per acre calculated by stand counts.

Table 2: Fungicide Treatments for Irrigated Chickpeas

| Treatment # | Application Timing | Fungicide* | Rate |
|-------------|--------------------|------------------------|---------------------------|
| 1 | None | Control | None |
| 2 | A | Quadris Opti | 25 fl oz/A |
| | B | Miravis Top | 13.7 fl oz/A |
| | C | Miravis Neo | 13.7 fl oz/A |
| | D | Quadris Opti | 25 fl oz/A |
| 3 | A | Quadris Opti | 25 fl oz/A |
| | B | Miravis Top + Echo 720 | 13.7 fl oz/A + 22 fl oz/A |
| | C | Miravis Neo + Echo 720 | 13.7 fl oz/A + 22 fl oz/A |
| | D | Quadris Opti | 25 fl oz/A |
| 4 | A | Miravis Neo | 13.7 fl oz/A |
| | B | Miravis Top | 13.7 fl oz/A |
| | C | Proline | 5.7 fl oz/A |
| | D | Miravis Neo | 13.7 fl oz/A |
| 5 | A | Miravis Neo + Echo 720 | 13.7 fl oz/A + 22 fl oz/A |
| | B | Miravis Top + Echo 720 | 13.7 fl oz/A + 22 fl oz/A |
| | C | Proline + Echo 720 | 5.7 fl oz/A + 22 fl oz/A |
| | D | Miravis Neo | 13.7 fl oz/A |
| 6 | A | Miravis Top | 13.7 fl oz/A |
| | B | Miravis Top | 13.7 fl oz/A |
| | C | Proline | 5.7 fl oz/A |
| | D | Miravis Top | 13.7 fl oz/A |
| 7 | A | Miravis Top + Echo 720 | 13.7 fl oz/A + 22 fl oz/A |
| | B | Miravis Top + Echo 720 | 13.7 fl oz/A + 22 fl oz/A |
| | C | Proline + Echo 720 | 5.7 fl oz/A + 22 fl oz/A |
| | D | Miravis Top | 13.7 fl oz/A |
| 8 | A, B, C, D | Proline | 5.7 fl oz/A |
| 9 | A | Delaro | 12 oz/A |
| | B | Endura | 6 oz/A |
| | C | Proline | 5.7 oz/A |
| | D | Miravis Top | 13.7 fl oz/A |
| 10 | A | Proline + Echo 720 | 5.7 oz/A + 22 oz/A |
| | B | Endura | 6 oz/A |
| | C | Proline + Echo 720 | 5.7 oz/A + 22 oz/A |
| | D | Miravis Top | 13.7 fl oz/A |
| 11 | A | Delaro | 12 oz/A |
| | B | Proline + Echo 720 | 5.7 oz/A + 22 oz/A |
| | C | Propulse | 8 oz/A |
| | D | Proline | 5.7 oz/A |
| 12 | A | Delaro | 12 oz/A |
| | B | Proline | 5.7 oz/A |
| | C | Propulse | 10.3 oz/A |
| | D | Proline | 5.7 fl oz/A |

*All treatments contained NIS Activator 90 except Delaro and Endura.

Efficacy of Seed Treatments for Control of Chickpea *Ascochyta* Blight

Frankie Crutcher and Amber Ferda EARC, Sidney, MT

OBJECTIVE: Test the efficacy of different seed treatments for control of seed borne *A. rabiei* on chickpeas under dryland conditions.

MATERIALS AND METHODS:

Dryland

Variety: Farmer reported Sierra
 Location: Sidney, MT
 Planted: 4/18/19
 Harvested: 9/3/19
 Plot Size: 5' x 20'
 Seeding Rate: 4 LS/ft²
 Soil Type: Savage silty clay loam
 Previous Crop: Wheat

Residual Soil N to 3 ft: 7.5 lbs/A
 Residual Soil P to 6 in: 26 ppm
 Applied Fertilizer: None
 Irrigated (sprinkler): None
 Chemical Applications: Durango 24 fl oz/A, Proline 5 fl oz/A
 Precipitation April – September: 18.35 inches
 Vigor and stand counts: 5/14/19, 5/30/19, 6/10/19
 Seedling disease assessment: 6/13/19
 Foliar disease assessment: 7/30/19

COMMENTS: Seeds were inoculated with peat-based commercial Rhizobium N-Charge® (Verdesian Life Sciences, Cary, NC). Experiment used 16% QOI resistant *A. rabiei* infested seed. Trial was desiccated with Gramoxone (32 fl oz/A) on 8/28/19.

RESULTS:

Table 1: Seed Treatment Evaluation for Control of *Ascochyta rabiei* on Chickpeas

| Trt # | Stem lesions ^a 6/13 | Diseased Leaves ^b 6/13 | % Root Severity ^c 6/13 | % Root Incidence ^d 6/13 | Plants/A ^e 5/14 | Plants/A ^e 5/30 | Plants/A ^e 6/10 | % Severity ^f 7/30 | Yield (lbs/A) |
|------------|-----------------------------------|--------------------------------------|--------------------------------------|---------------------------------------|-------------------------------|-------------------------------|-------------------------------|---------------------------------|---------------|
| 1 | 18.5 A | 12.3 A | 10.6 A | 32.5 A | 7187.4 C | 11434.5 A | 12414.6 A | 25.2 A | 770.8 B |
| 2 | 15.8 AB | 5.8 A | 8.4 A | 27.5 A | 10998.9 A | 14048.1 A | 13721.4 A | 23.9 A | 1155.1 AB |
| 3 | 17.0 AB | 2.0 A | 6.4 A | 17.5 A | 8603.1 BC | 11761.2 A | 11325.6 A | 24.6 A | 842.5 AB |
| 4 | 12.8 AB | 2.8 A | 7.3 A | 15.0 A | 9909.9 AB | 11652.3 A | 10563.3 A | 26.4 A | 981.8 AB |
| 5 | 17.3 AB | 6.8 A | 6.1 A | 32.5 A | 8603.1 BC | 10890.0 A | 10781.1 A | 25.6 A | 1087.4 AB |
| 6 | 12.5 AB | 0.5 A | 7.0 A | 5.0 A | 8494.2 BC | 11216.7 A | 11216.7 A | 18.0 A | 1379.2 A |
| 7 | 12.0 B | 6.8 A | 10.8 A | 32.5 A | 10127.7 AB | 12196.8 A | 11543.4 A | 22.6 A | 924.6 AB |
| 8 | 13.5 AB | 3.5 A | 11.6 A | 22.5 A | 8929.8 A-C | 10998.9 A | 11107.8 A | 21.4 A | 871.7 AB |
| Mean | 14.9 | 5.0 | 8.5 | 23.1 | 9106.8 | 11774.8 | 11584.2 | 23.4 | 1001.6 |
| % CV | 29.9 | 170.6 | 50.5 | 96.0 | 20.1 | 20.4 | 23.2 | 24.8 | 40.6 |
| LSD (0.05) | 6.2 | 13.0 | 6.3 | 33.2 | 2388.3 | 3655.9 | 4153.0 | 8.7 | 597.5 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

^aAverage number of lesions per stem. Ten stems were evaluated for each plot.

^bAverage number diseased leaves per seedling. Ten plants were evaluated for each plot.

^cAverage percent area of root covered by disease. Ten roots were evaluated for each plot.

^dPercent of ten plants per plot that had visible root necrosis.

^eNumber of plants per acre calculated from stand counts.

^fAverage area of ten plants covered by disease.

Table 2: Seed Treatments for Control of Chickpea *Ascochyta* Blight

| Trt # | Product | Application Rate |
|-------|--|--|
| 1 | Cruiser | 1.28 fl oz/cwt |
| 2 | Cruiser Apron Maxx RTA | 1.28 fl oz/cwt 5 fl oz/cwt |
| 3 | Cruiser Vibrance Maxx | 1.28 fl oz/cwt Slurried w/ H ₂ O to 5 total oz/cwt (3.46 oz H ₂ O/cwt + 1.54 oz/cwt V.M.) |
| 4 | Cruiser Vibrance Maxx Mertect | 1.28 fl oz/cwt Slurried w/ H ₂ O to 5 total oz/cwt (3.46 oz H ₂ O/cwt + 1.54 oz/cwt V.M.) 1.57 fl oz/cwt |
| 5 | Cruiser Maxx Vibrance Pulse | 5 fl oz/cwt |
| 6 | Cruiser Maxx Vibrance Pulse Mertect | 5 fl oz/cwt 1.57 oz/cwt |
| 7 | Cruiser Evergol Energy | 1.28 fl oz/cwt 1 fl oz/cwt |
| 8 | Gaucho Evergol Energy | 1.6 fl oz/cwt 1 fl oz/cwt |

Efficacy of Seed Treatments for Control of Chickpea Ascochyta Blight

Frankie Crutcher and Amber Ferda EARC, Sidney, MT

OBJECTIVE: Test the efficacy of different seed treatments for control of *A. rabiei* on chickpeas.

MATERIALS AND METHODS:

Not Irrigated (Site 1)

Variety: Farmer reported Sierra

Location: Sidney, MT

Planted: 4/25/19

Harvested: 9/5/19

Plot Size: 5' x 20'

Seeding Rate: 4 LS/ft²

Soil Type: Savage silty clay loam

Previous Crop: Sugarbeet

Residual Soil N to 3 ft: 25 lbs/A

Residual Soil P to 6 in: 25 ppm

Applied Fertilizer: None

Irrigated (sprinkler): None

Chemical Applications: Durango 24 fl oz/A, Proline 5 fl oz/A

Precipitation April – September: 19.38 inches

Vigor and stand counts: 5/22/19, 6/5/19, 6/17/19

Seedling disease assessment: 6/14/19

Foliar disease assessment: 7/30/19

COMMENTS: Seeds were inoculated with peat-based commercial Rhizobium N-Charge® (Verdesian Life Sciences, Cary, NC). Experiment used 16% QOI resistant *A. rabiei* infested seed. No yield data was collected due to mechanical issues at harvest. Trial was desiccated with Gramoxone (32 fl oz/A) on 8/28/19.

RESULTS:

Table 1: Seed Treatment Evaluation Control of Ascochyta on Chickpeas

| Trt # | Stem lesions ^a | Diseased Leaves ^b | % Root Severity ^c | % Root Incidence ^d | Plants/A ^e | Plants/A ^e | Plants/A ^e | % Severity ^f |
|------------|---------------------------|------------------------------|------------------------------|-------------------------------|-----------------------|-----------------------|-----------------------|-------------------------|
| 1 | 10.25 B | 2.73 A | 8.90 A | 95.00 A | 8712.00 B | 9147.60 B | 9365.40 C | 50.00 A |
| 2 | 18.50 AB | 4.60 A | 7.25 A | 92.50 A | 8494.20 B | 8929.80 B | 8929.80 C | 56.25 A |
| 3 | 14.50 AB | 4.18 A | 6.63 A | 95.00 A | 10127.70 AB | 10890.00 AB | 10672.20 BC | 46.25 A |
| 4 | 18.00 AB | 1.73 A | 8.25 A | 95.00 A | 12850.20 A | 13830.30 A | 13503.60 AB | 48.75 A |
| 5 | 16.50 AB | 2.80 A | 6.75 A | 87.50 A | 12595.10 A | 14048.10 A | 14048.10 A | 64.13 A |
| 6 | 32.25 A | 5.53 A | 6.13 A | 77.50 A | 10781.10 AB | 11652.30 AB | 11107.80 A-C | 61.63 A |
| 7 | 18.50 AB | 1.78 A | 7.50 A | 82.50 A | 10454.40 AB | 11434.50 AB | 11325.60 A-C | 55.50 A |
| 8 | 15.50 AB | 4.48 A | 8.65 A | 82.50 A | 11107.80 AB | 11979.00 AB | 10890.00 BC | 50.75 A |
| Mean | 18 | 3.48 | 7.51 | 88.44 | 10685.81 | 11488.95 | 11230.31 | 54.16 |
| % CV | 75.27 | 88.32 | 35.53 | 14.39 | 23.50 | 23.58 | 22.68 | 23.57 |
| LSD (0.05) | 20.1 | 4.6 | 4.1 | 18.1 | 3249.9 | 3381.4 | 3148.6 | 18.7 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

^aAverage number of lesions per stem. Ten stems were evaluated for each plot.

^bAverage number diseased leaves per seedling. Ten plants were evaluated for each plot.

^cAverage percent area of root covered by disease. Ten roots were evaluated for each plot.

^dPercent of ten plants per plot that had visible root necrosis.

^eNumber of plants per acre calculated from stand counts.

^fAverage area of ten plants covered by disease.

Table 2: Seed Treatments for Chickpea Ascochyta Blight

| Trt # | Product | Application Rate |
|-------|--|--|
| 1 | Cruiser | 1.28 fl oz/cwt |
| 2 | Cruiser Apron Maxx RTA | 1.28 fl oz/cwt 5 fl oz/cwt |
| 3 | Cruiser Vibrance Maxx | 1.28 fl oz/cwt Slurried w/ H ₂ O to 5 total oz/cwt (3.46 oz H ₂ O/cwt + 1.54 oz/cwt V.M.) |
| 4 | Cruiser Vibrance Maxx Mertect | 1.28 fl oz/cwt Slurried w/ H ₂ O to 5 total oz/cwt (3.46 oz H ₂ O/cwt + 1.54 oz/cwt V.M.) 1.57 fl oz/cwt |
| 5 | Cruiser Maxx Vibrance Pulse | 5 fl oz/cwt |
| 6 | Cruiser Maxx Vibrance Pulse Mertect | 5 fl oz/cwt 1.57 oz/cwt |
| 7 | Cruiser Evergol Energy | 1.28 fl oz/cwt 1 fl oz/cwt |
| 8 | Gaucho Evergol Energy | 1.6 fl oz/cwt 1 fl oz/cwt |



EARC Assistant Professor, Frankie Crutcher, speaking, and EARC Research Associate, Amber Ferda, assisting during EARC Field Day

Resistance of Durum Varieties to Fusarium Head Blight

Frankie Crutcher, Mike Giroux, Amber Ferda, Samantha Hoesel

EARC, Sidney, MT

OBJECTIVE: Test the resistance of different durum varieties to Fusarium head blight caused by *F. graminearum*.

MATERIALS AND METHODS:

Irrigated

Variety: Misc.

Location: Sidney, MT

Planted: 5/8/19

Harvested: 8/22/19

Plot Size: 5' x 10'

Seeding Rate: 129 lbs/A

Soil Type: Savage silty clay loam

Previous Crop: Wheat

Residual Soil N to 3 ft: 25 lbs/A

Residual Soil P to 6 in: 17 ppm

Applied Fertilizer: 100-30

Irrigated (sprinkler) on: 6/15/19, 6/27/19

Chemical Applications: Durango 24 fl oz/A, Proline 5 fl oz/A, Carnivore

10 fl oz/A, Discover 16 fl oz/A

Precipitation April – September: 19.38 inches

Vigor: 5/31/19

Disease assessment(s): 7/21/19, 7/30/19

COMMENTS: Corn spawn inoculated with five isolates of *F. graminearum* was applied to the field on 6/14/19.

RESULTS:

Table 1: Durum Variety Responses to Fusarium Head Blight

| Variety | Severity(%) ^a 7/21 | Incidence(%) ^b 7/21 | Severity(%) ^a 7/30 | Incidence(%) ^b 7/30 | % FDK ^c | Yield (Bu/A) | DON (ppm) |
|------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|--------------------|--------------|-----------|
| Alkabo | 10.41 BC | 86.67 AB | 64.00 A-C | 100.00 A | 12.50 DE | 36.83 E-I | 9.01 D |
| Alzada | 36.83 A | 98.33 A | 70.33 A | 100.00 A | 22.50 B | 15.21 J | 16.22 A-D |
| Carpio | 9.08 C | 71.67 B | 43.17 FG | 100.00 A | 20.00 BC | 51.99 A | 13.14 A-D |
| Divide | 11.08 BC | 86.67 AB | 46.83 D-G | 98.33 AB | 15.00 C-E | 50.39 AB | 11.98 A-D |
| Dynamic | 22.08 B | 93.33 A | 53.83 B-F | 100.00 A | 15.00 C-E | 41.41 A-H | 19.97 AB |
| Fortitude | 15.42 BC | 91.67 A | 61.17 A-E | 100.00 A | 12.50 DE | 31.28 HI | 17.50 A-D |
| Grano | 20.83 BC | 100.00 A | 55.17 A-F | 100.00 A | 15.00 C-E | 39.98 B-H | 20.64 AB |
| Grenora | 13.83 BC | 93.33 A | 47.17 D-G | 100.00 A | 15.00 C-E | 40.96 A-H | 12.25 A-D |
| Joppa | 10.50 BC | 86.67 AB | 45.17 E-G | 96.67 B | 15.00 C-E | 45.07 A-F | 12.99 A-D |
| Mountrail | 12.25 BC | 86.67 AB | 55.33 A-F | 98.33 AB | 15.00 C-E | 40.18 B-H | 14.68 A-D |
| MTD16001 | 12.92 BC | 90.00 A | 42.67 FG | 98.33 AB | 17.50 B-D | 49.38 A-C | 13.93 A-D |
| MTD16002 | 17.25 BC | 98.33 A | 60.00 A-E | 100.00 A | 12.50 DE | 38.32 C-I | 13.43 A-D |
| MTD16004 | 17.67 BC | 100.00 A | 64.00 A-C | 100.00 A | 15.00 C-E | 36.00 E-I | 14.73 A-D |
| MTD16005 | 17.67 BC | 96.67 A | 64.33 A-C | 98.33 AB | 20.00 BC | 39.50 B-I | 17.68 A-D |
| MTD16006 | 18.67 BC | 98.33 A | 68.33 AB | 100.00 A | 17.50 B-D | 34.40 F-I | 21.80 A |
| MTD16007 | 21.67 BC | 100.00 A | 57.33 A-F | 100.00 A | 20.00 BC | 41.26 A-H | 21.42 AB |
| MTD16008 | 19.25 BC | 96.67 A | 64.83 A-C | 100.00 A | 35.00 A | 29.72 HI | 16.40 A-D |
| MTD16009 | 20.75 BC | 98.33 A | 69.83 AB | 100.00 A | 22.50 B | 27.89 HI | 16.27 A-D |
| MTD16010 | 19.50 BC | 93.33 A | 57.50 A-F | 98.33 AB | 17.50 B-D | 33.01 G-I | 16.68 A-D |
| MTD16011 | 18.08 BC | 98.33 A | 61.63 A-D | 100.00 A | 17.50 B-D | 36.14 E-I | 19.45 A-C |
| Precision | 15.00 BC | 95.00 A | 50.33 C-G | 100.00 A | 8.00 E | 43.82 A-G | 9.76 CD |
| Riveland | 11.00 BC | 85.00 AB | 34.00 G | 98.33 AB | 9.00 E | 46.37 A-E | 14.00 A-D |
| Tioga | 15.25 BC | 95.00 A | 49.50 C-G | 98.33 AB | 22.50 B | 49.24 A-D | 11.68 B-D |
| Vivid | 12.67 BC | 83.33 AB | 42.83 FG | 96.67 B | 11.50 DE | 37.61 D-I | 12.95 A-D |
| Mean | 16.65 | 92.64 | 55.39 | 99.24 | 16.81 | 40.00 | 15.4 |
| % CV | 43.71 | 9.73 | 20.44 | 1.59 | 36.00 | 23.33 | 32.0 |
| LSD (0.05) | 12.9 | 16.9 | 16.4 | 3.3 | 7.4 | 11.7 | 9.9 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

^aPest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot.

^bPest Incidence: Percent of thirty plants per plot that had visible FHB symptoms.

^cFusarium diseased kernels.

Efficacy of Seed Treatments for Control of Rhizoctonia Root Rot on Lentils

Frankie Crutcher and Amber Ferda EARC, Sidney, MT

OBJECTIVE: Test the efficacy of different seed treatments for control of *R. solani* on lentils.

MATERIALS AND METHODS:

Not Irrigated

| | |
|-------------------------------------|---|
| Variety: Richlea | Residual Soil N to 3 ft: 34 lbs/A |
| Location: Sidney, MT | Residual Soil P to 6 in: 31 ppm |
| Planted: 5/10/19 | Applied Fertilizer: None |
| Harvested: 9/4/19 | Irrigated (sprinkler): None |
| Plot Size: 5' x 20' | Chemical Applications: Durango 24 fl oz/A |
| Seeding Rate: 12 LS/ft ² | Precipitation April – September: 19.38 inches |
| Soil Type: Savage silty clay loam | Vigor and stand counts: 5/30/19, 6/10/19, 6/17/19 |
| Previous Crop: Sugarbeet | Root disease assessment: 6/18/19 |

COMMENTS: Seeds were inoculated with peat-based commercial Rhizobium N-Charge® (Verdesian Life Sciences, Cary, NC). Trial was desiccated with Gramoxone (32 fl oz/A) on 8/28/19. *R. solani* AG 2-2 isolate R9 grown on barley was used to inoculate plots at planting.

RESULTS: Pythium root rot was observed in all samples. In the entire trial, not just the treatments listed here, those that contained mefenoxam all performed better than those that contained metalaxyl. We believe this is why there are significant differences between treatments for yield, not the presence of Rhizoctonia root rot.

Table 1: Seed Treatment Evaluation Control of Rhizoctonia on Lentils

| Trt # | % Root Severity ^a 6/18 | % Root Incidence ^b 6/18 | Plants/A ^c 5/30 | Plants/A ^c 6/10 | Plants/A ^c 6/17 | Yield (lbs/A) |
|------------|--------------------------------------|---------------------------------------|-------------------------------|-------------------------------|-------------------------------|---------------|
| 1 | 11.7 BC | 100.0 A | 27181.4 AB | 28139.8 AB | 27878.4 A | 776.0 AB |
| 2 | 17.7 A | 100.0 A | 19602.0 C | 20908.8 C | 20037.6 B | 496.4 C |
| 3 | 11.9 BC | 100.0 A | 27094.3 AB | 27791.3 AB | 27094.3 A | 841.7 A |
| 4 | 13.6 BC | 98.0 AB | 24655.0 AB | 24916.3 A-C | 24306.5 A | 679.8 A-C |
| 5 | 14.0 A-C | 100.0 A | 24655.0 AB | 27181.4 AB | 25961.8 A | 750.9 A-C |
| 6 | 10.6 C | 90.0 B | 26310.2 AB | 26920.1 AB | 24829.2 A | 821.1 A |
| 7 | 14.1 A-C | 100.0 A | 28575.4 A | 29011.0 A | 26223.1 A | 639.1 A-C |
| 8 | 14.7 AB | 100.0 A | 23348.2 BC | 24045.1 BC | 23696.6 AB | 579.0 A-C |
| 9 | 12.6 BC | 98.0 AB | 25526.2 AB | 28052.6 AB | 25961.8 A | 547.9 BC |
| 10 | 13.2 BC | 97.8 AB | 23348.2 BC | 26484.5 AB | 24219.4 AB | 788.6 AB |
| Mean | 13.4 | 98.4 | 25029.6 | 26345.1 | 25020.9 | 692.1 |
| % CV | 24.4 | 7.5 | 15.7 | 15.8 | 14.7 | 32.4 |
| LSD (0.05) | 3.8 | 9.6 | 4336.6 | 4880.2 | 4248.9 | 270.8 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.
^aSeverity: Average percent area of root covered by disease. Ten roots were evaluated for each plot.
^bIncidence: Percent of ten plants per plot that had visible root necrosis.
^cNumber of plants per acre calculated by stand counts.

Table 2: Seed Treatments for Rhizoctonia on Lentils

| Trt # | Product | Rhizoc | Oomycete Control | Application Rate |
|-------|--------------------------------|--------|------------------|-------------------------------|
| 1 | Cruiser | No | - | 30 ga/100kg |
| 2 | Cruiser | Yes | - | 30 ga/100kg |
| 3 | Cruiser Apron Maxx RTA | No | Mefenoxam | 30 ga/100kg 5 fl oz/cwt |
| 4 | Cruiser Apron Maxx RTA | Yes | Mefenoxam | 30 ga/100kg 5 fl oz/cwt |
| 5 | Cruiser Vibrance Maxx | Yes | Mefenoxam | 30 ga/100kg 1.54 fl oz/cwt |
| 6 | Cruiser Maxx Vibrance Pulse | Yes | Mefenoxam | 5 fl oz/wt |
| 7 | Cruiser Evergol | Yes | Metalaxyl | 30 ga/100kg 1 oz/cwt |
| 8 | Gaucho Evergol | Yes | Metalaxyl | 1.6 fl oz/cwt 1 fl oz/cwt |
| 9 | Cruiser Obvius | Yes | Metalaxyl | 30 ga/100kg 4.6 fl oz/cwt |
| 10 | Cruiser A22782 | Yes | N/A | 30 ga/100kg 26.25 ga/100kg |

Resistance of Spring Wheat Varieties to Fusarium Head Blight

Frankie Crutcher, Luther Talbert, Amber Ferda, Samantha Hoesel

EARC, Sidney, MT

OBJECTIVE: Test the resistance of different spring wheat varieties to Fusarium head blight caused by *F. graminearum*.

MATERIALS AND METHODS:

Irrigated

Variety: Misc.

Location: Sidney, MT

Planted: 5/8/19

Harvested: 8/23/19

Plot Size: 5' x 10'

Seeding Rate: 60 lbs/A

Soil Type: Savage silty clay loam

Previous Crops: Wheat

Residual Soil N to 3 ft: 25 lbs/A

Residual Soil P to 6 in: 17 ppm

Applied Fertilizer: 100-30

Irrigated (sprinkler) on: 6/15/19, 6/27/19

Chemical Applications: Durango 24 fl oz/A, Proline 5 fl oz/A, Carnivore

10 fl oz/A, Discover 16 fl oz/A

Precipitation April – September: 19.38 inches

Vigor: 5/31/19

Disease assessment(s): 7/21/19, 7/30/19

COMMENTS: Corn spawn inoculated with five isolates of *F. graminearum* was applied to the field on 6/14/19.

RESULTS:

Table 1: Spring Wheat Variety Responses to Fusarium Head Blight

| Variety | Severity(%) ^a 7/21 | Incidence(%) ^b 7/21 | Severity(%) ^a 7/30 | Incidence(%) ^b 7/30 | % FDK ^c | Yield (Bu/A) | DON (ppm) |
|------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------|--------------------|--------------|-----------|
| Dagmar | 11.78 BC | 90.00 A | 50.44 B | 91.11 AB | 15.00 D | 36.14 C | 9.32 AB |
| Lanning | 11.50 BC | 86.67 A | 46.44 BC | 87.78 AB | 15.00 D | 42.23 BC | 6.93 BC |
| McNeal | 26.17 A | 94.44 A | 72.22 A | 98.89 A | 38.33 A | 18.40 E | 10.53 A |
| MT1716 | 4.56 D | 46.67 D | 21.67 E | 74.44 BC | 4.67 E | 54.06 A | 2.49 E |
| MT1807 | 6.61 CD | 64.44 B-D | 27.11 DE | 64.44 C | 16.67 CD | 41.76 BC | 4.57 C-E |
| MT1809 | 7.23 CD | 62.22 CD | 23.22 E | 73.33 BC | 5.33 E | 45.48 B | 3.52 DE |
| MT1821 | 11.94 BC | 73.33 A-C | 32.78 DE | 80.00 A-C | 20.00 B-D | 19.80 E | 8.08 AB |
| MT1870 | 14.00 B | 84.44 AB | 52.22 B | 97.78 A | 25.00 B | 26.57 D | 7.41 A-C |
| MT1872 | 11.06 B-D | 81.11 A-C | 50.44 B | 85.56 AB | 21.67 BC | 38.66 C | 8.18 AB |
| Vida | 11.83 BC | 80.00 A-C | 37.11 CD | 82.22 A-C | 6.67 E | 38.10 C | 5.94 B-D |
| Mean | 11.67 | 76.33 | 41.37 | 83.56 | 16.83 | 36.12 | 3.4 |
| % CV | 55.88 | 23.15 | 39.63 | 16.96 | 61.58 | 31.63 | 44.5 |
| LSD (0.05) | 6.6 | 21.5 | 11.9 | 19.3 | 6.1 | 6.6 | 3.4 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

^aPest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot.

^bPest Incidence: Percent of thirty plants per plot that had visible FHB symptoms.

^cFusarium diseased kernels.

Treatment Evaluation for Control of Rhizoctonia Root Rot of Sugarbeet

Frankie Crutcher and Amber Ferda EARC, Sidney, MT

OBJECTIVE: Test the ability of different seed treatments to control Rhizoctonia root rot on sugar beet.

MATERIALS AND METHODS:

Irrigated

| | |
|-----------------------------------|--|
| Variety: BS39RR8N | Residual Soil P to 6 in: 24 ppm |
| Location: Sidney, MT | Applied Fertilizer: 160-40 |
| Planted: 5/10/19 | Irrigated (flood) on 6/27/19, 6/28/19, 7/23/19, 8/5/19, 8/6/19, 8/16/19, 8/30/19, 9/4/19 |
| Harvested: 9/27/1 | Chemical Applications: Durango 24 fl oz/A |
| Plot Size: 6' x 30' | Seed Treatments: Kabina 14, Vibrance, Stamina, Systiva, Metlock, Rizolex |
| Seeding Rate: 43,560 seeds/A | Foliar Treatments: Priaxor, Quadris, Elatus |
| Soil Type: Savage silty clay loam | Precipitation April – September: 19.38 inches |
| Previous Crops: Barley | Stand counts: 6/3/19, 6/17/19, 7/1/19, 7/17/19 |
| Residual Soil N to 3 ft: 14 lbs/A | |

COMMENTS: *Rhizoctonia solani* AG 2-2 isolate R9 grown on barley was used to inoculate plots at planting.

RESULTS:

Table 1: Seed Treatment and Foliar Application Evaluations for *R. solani* on Sugarbeet

| Foliar Fungicide | Seed Treatment | Disease Index (0-100) ^a | % Ruppel class 0-3 | Yield (tons/acre) | % Pre-emergence damping off | % Post-emergence damping off |
|-------------------|---------------------------|------------------------------------|--------------------|-------------------|-----------------------------|------------------------------|
| Untreated Control | None (w/o <i>Rhizoc</i>) | 26.11 B | 73.06 A | 37.56 A | 31.39 D | 2.89 B |
| | None (w/ <i>Rhizoc</i>) | 97.98 A | 1.94 B | 1.23 B | 79.17 A | 72.77 A |
| | Kabina 14 | 98.06 A | 1.67 B | 1.35 B | 56.67 BC | 88.37 A |
| | Vibrance | 93.17 A | 6.67 B | 3.27 B | 49.72 C | 65.70 A |
| | Stamina + Systiva 2.5 | 95.83 A | 4.17 B | 1.52 B | 56.39 BC | 77.48 A |
| | Stamina + Systiva 5.0 | 95.99 A | 3.89 B | 1.93 B | 56.67 BC | 77.26 A |
| | Metlock + Rizolex | 98.45 A | 1.67 B | 0.64 B | 70.00 AB | 80.04 A |
| Priaxor | None (w/o <i>Rhizoc</i>) | 32.34 B | 66.11 A | 39.88 A | 35.28 D | 0.00 D |
| | None (w/ <i>Rhizoc</i>) | 98.69 A | 1.39 B | 0.39 B | 88.33 A | 80.45 AB |
| | Kabina 14 | 98.49 A | 1.11 B | 0.30 B | 55.83 C | 91.47 A |
| | Vibrance | 93.02 A | 6.11 B | 3.10 B | 60.83 BC | 55.37 C |
| | Stamina + Systiva 2.5 | 96.55 A | 2.78 B | 1.62 B | 71.94 B | 74.55 A-C |
| | Stamina + Systiva 5.0 | 95.52 A | 3.89 B | 2.07 B | 53.89 C | 68.74 BC |
| | Metlock + Rizolex | 98.10 A | 1.11 B | 2.74 B | 65.56 BC | 75.57 A-C |
| Quadris | None (w/o <i>Rhizoc</i>) | 30.83 B | 68.89 A | 37.71 A | 33.61 C | 1.82 C |
| | None (w/ <i>Rhizoc</i>) | 98.21 A | 1.67 B | 2.00 B | 88.89 A | 70.43 AB |
| | Kabina 14 | 96.51 A | 3.06 B | 2.95 B | 61.67 B | 78.51 A |
| | Vibrance | 94.92 A | 3.89 B | 2.08 B | 58.61 B | 46.15 B |
| | Stamina + Systiva 2.5 | 95.79 A | 3.33 B | 3.01 B | 60.56 B | 73.65 AB |
| | Stamina + Systiva 5.0 | 94.13 A | 5.83 B | 5.26 B | 58.89 B | 52.77 AB |
| | Metlock + Rizolex | 98.41 A | 1.11 B | 1.83 B | 71.94 B | 76.25 A |
| Elatus | None (w/o <i>Rhizoc</i>) | 23.65 D | 75.83 A | 40.86 A | 36.11 C | 0.00 C |
| | None (w/ <i>Rhizoc</i>) | 97.86 A | 1.94 D | 3.60 C | 85.00 A | 75.46 A |
| | Kabina 14 | 95.87 AB | 4.17 CD | 3.07 C | 57.50 B | 66.01 A |
| | Vibrance | 86.87 C | 10.83 B | 8.21 BC | 55.00 B | 32.47 BC |
| | Stamina + Systiva 2.5 | 91.59 BC | 6.94 BC | 6.76 BC | 65.83 B | 44.01 AB |
| | Stamina + Systiva 5.0 | 86.47 C | 11.67 B | 12.14 B | 59.44 B | 31.10 BC |
| | Metlock + Rizolex | 96.03 AB | 3.33 CD | 3.96 C | 63.89 B | 72.59 A |

Letters in common within treatment grouping and column did not differ significantly according to a t-test at a significance level of 5%.

^aCalculated based on Ruppel Scale (0-7), where 0% is no disease and 100% is completely rotten roots.

Table 2: Effect of Seed Treatments on Rhizoctonia Root Rot

| Seed Treatment | Disease Index ^a | % Ruppel 0-3 | Yield (ton/A) | Pre-emergence damping off (%) | Post-emergence damping off (%) |
|-----------------------|----------------------------|--------------|---------------|-------------------------------|--------------------------------|
| None | 28.23 C | 70.97 A | 39.00 A | 34.10 E | 1.18 D |
| None + <i>Rhizoc</i> | 98.18 A | 1.74 C | 1.81 C | 85.35 A | 74.78 A |
| Kabina 14 | 97.23 A | 2.50 C | 1.92 C | 57.92 CD | 81.09 A |
| Vibrance | 91.99 B | 6.88 B | 4.17 BC | 56.04 D | 49.92 C |
| Stamina + Systiva 2.5 | 94.94 AB | 4.31 BC | 3.22 BC | 63.68 BC | 67.42 AB |
| Stamina + Systiva 5.0 | 93.03 B | 6.32 B | 5.35 B | 57.22 CD | 57.47 BC |
| Metlock + Rizolex | 97.75 A | 1.81 C | 2.29 C | 67.85 B | 76.11 A |
| Mean | 85.9 | 13.5 | 8.3 | 60.3 | 58.3 |
| CV (%) | 28.5 | 180.8 | 162.7 | 31.4 | 60.0 |
| LSD (0.5) | 3.6 | 3.6 | 2.6 | 7.2 | 13.9 |

Letters in common within treatment grouping and column did not differ significantly according to a t-test at a significance level of 5%.

^aCalculated based on Ruppel Scale (0-7), where 0% is no disease and 100% is completely rotten roots.

Industrial Hemp- A Potential Crop for Eastern Montana EARC, Sidney, MT

Chengci Chen, Apurba Sutradhar, Bill Frank, Rebecca Garza, Calla Kowatch-Carlson, Thomas Gross, and Ronald Brown

Materials and Methods:

Irrigated

| | |
|--|-------------------------------|
| Location: EARC | Previous crop: Sugarbeet |
| Varieties: CRS-1 and Katani | Soil type: Williams Clay Loam |
| Planted: Early Planting 5/8/2019 | Harvested for seed: 8/29/2019 |
| Late Planting 5/29/2019 | Harvest type: Direct cut |
| Tillage: Conventional | Plot size: 6" x 30" |
| Experimental design: Randomized Complete Block | Replications: 4 |
| Pesticide: None | Herbicide: None |
| Fertilizers (obtained): 100 lb N/ac and 30 lb P ₂ O ₅ /ac blend applied at rosette stage | |
| Rainfall: 10.4" | Irrigation: 2.3" |

Comments: The plots were hand hoed and cultivated to control weeds.

Table 1. Initial soil test results. A composite soil sample was collected before planting hemp that contained at least 10 individual cores.

| Depth | pH | OM | NO ₃ -N | P-Olsen | K | Ca | Mg | Na | Zn | Fe | Mn | Cu | B | CEC |
|-------|-----|-----|--------------------|---------|-----|------|-----|-----|------|-----|------|------|-----|----------|
| Inch | | % | | | | | ppm | | | | | | | meq/100g |
| 0-12 | 8.3 | 2.1 | 11.0 | 16 | 161 | 5324 | 402 | 114 | 0.69 | 6.1 | 4.47 | 0.80 | 1.0 | 30.9 |

Table 2: Main effect of planting time and variety on industrial hemp height, biomass yield, seed yield, and cannabidiol (CBD) concentration.

| Effect | Treatments | Plant Height (inch) | Biomass (lb/ac) | Seed Yield (lb/ac) | CBD (%) | Wheat Yield† (bu/ac) |
|----------------------|------------|------------------------|--------------------|-----------------------|------------|-------------------------|
| Planting Time | Early | 65.6 A | 10835 A | 1257 A | 0.89 | 41.8 |
| | Late | 59.0 B | 6361 B | 739 B | 0.83 | 31.7 |
| Variety | CRS-1 | 72.7 a | 924 a | 1055 | 0.84 | -- |
| | Katani | 51.9 b | 794 a | 941 | 0.88 | -- |
| Sources of Variation | | -----P > F----- | | | | |
| Time | | 0.0004 | <0.0001 | 0.009 | 0.71 | 0.08 |
| Variety | | <0.0001 | 0.09 | 0.47 | 0.75 | -- |
| Time*Variety | | 0.72 | 0.40 | 0.40 | 0.42 | -- |

† Wheat variety Elgin was planted. Yield was adjusted to 12% moisture content.

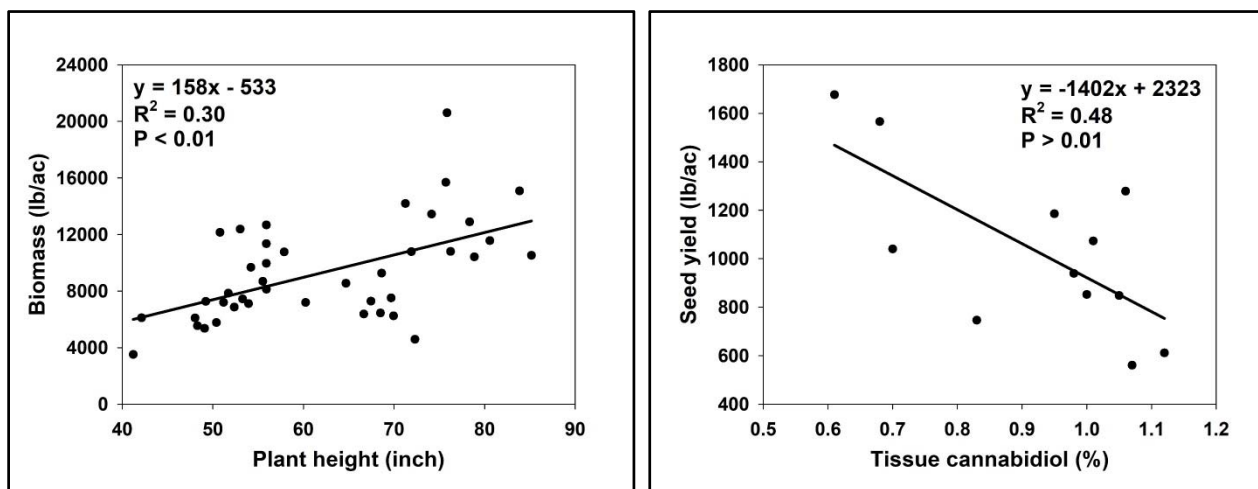


Figure 1: Relationships between biomass and plant height (left), and between seed yield and tissue CBD concentration (right).

Kernza® a new dual-use crop for the MonDak

Clair Keene

Kernza® is intermediate wheatgrass (*Thinopyrum intermedium*), a cool-season perennial grass that has been bred intensively for the last 15 years for increased seed size and yield. Old forage types of intermediate wheatgrass have been grown in the Northern Great Plains for over 40 years and have done well in our semi-arid, short season conditions. Kernza lines are being developed by breeders at The Land Institute (TLI) in Salina, Kansas and the University of Minnesota. Kernza is the first perennial grain brought to market in the United States and there are many food companies eager to include a perennial grain in their supply chains. Spring growth of Kernza is comparable to a high-quality grass forage and can be grazed or hayed. Grain harvest occurs in late summer and the quality of remaining biomass is comparable to wheat straw and can be used as bedding or mixed in to feed rations. Most Kernza research to date has been done in Minnesota and Wisconsin, and in these environments, 2 or 3 years of grain harvest have been observed. It is possible that in drier regions, 3 or 4 years of grain production may be possible, but there has been little research on Kernza in semi-arid environments.



Kernza head (top) and HRSW head (below).

Kernza variety trial at the Williston REC

A Kernza variety trial was seeded at the WREC dryland farm on Sept 7, 2018. Nine varieties were included: 2 from TLI, 5 from UMN, and 2 old forage types Oahe and Rush. The trial was no-till seeded into cover crop residue at 10 lbs per ac at 0.75" depth. No fertilizer was applied and no herbicides were used. Kernza is a hulled grain: combined samples were sent to TLI for cleaning and de-hulling to obtain naked seed yield per acre. Hulls are estimated to account for 30% of harvested weight.

| Variety | Yield lbs/ac | Seed weight [†] |
|----------------------|--------------|--------------------------|
| Oahe | 149 | 141 |
| Rush | 161 | 137 |
| TLI-C3 | 342 | 181 |
| TLI-C5 | 352 | 215 |
| MN-1501 | 293 | 222 |
| MN-1502 | 245 | 184 |
| MN-1503 | 251 | 179 |
| MN-1504 (Clearwater) | 273 | 184 |
| MN-1505 | 342 | 187 |
| Mean | 267 | 181 |
| LSD 5% | 73 | 13 |

[†]Seed weight = mg / 20 de-hulled seeds

Harvested: 9/16/2019

TLI-C5, TLI-C3, and MN-1505 had the highest yields and TLI-C5 and MN-1501 had the highest seed weight. Kernza lines exhibited roughly twice the yield and 1.5 times the seed weight of old forage types. This variety trial and a spring-seeded trial planted on May 10, 2019 will continue next year. Additional trials planned for 2020 include evaluating herbicide safety and spring N fertilizer rates.

Funding for this work provided by The Land Institute and ND-APUC project # BDAPUC19-24

Saline Seep Formation and Background of the Seep at WREC

Clair Keene, Jim Staricka, Kyle Dragseth, Jerry Bergman, and Jane Holzer, Montana Salinity Control Association

Background

The WREC and Montana Salinity Control Association (MSCA) partnered to monitor and reclaim a saline seep at the WREC dryland research farm. The project is located in T154N R102W Section 36 of the Fifth Principle Meridian Public Land Survey System (PLSS).

The saline seep started forming in the 1990's and was characterized by a depression in the south west corner of the field that lay wet in the spring, struggled to produce crops, and had a weedy cover of foxtail barley and kochia. In dry years, ground water and salts wicked upwards from the shallow water table to evaporate and form a white, salt crust on the soil surface. At the study outset, the seep was approximately one acre in size, however, a larger area of the field exhibited reduced production.

Investigation

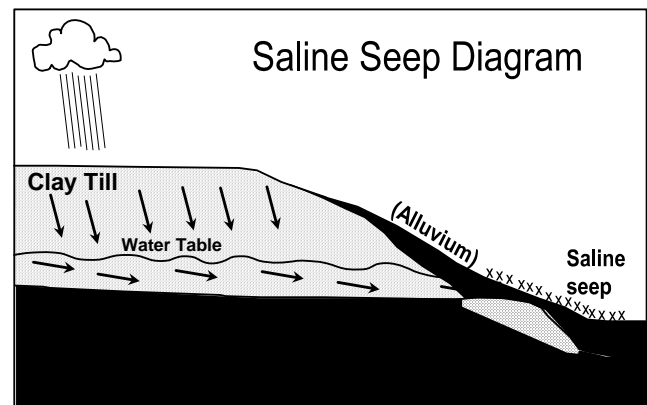
Fieldwork:

On August 18, 2014, ten shallow ground water monitoring wells were installed - nine recharge identification wells and one discharge area well. All of the wells were cased at the time of drilling with 2" PVC well casing, backfilled with pea gravel in the saturated zone and sealed with bentonite within the top five feet of the ground surface. Each well was surveyed for surface elevation in relation to the other wells. Ground surface elevations and well measurements to the water table are used to determine the direction of ground water flow and the location of the recharge area.

Soils:

In the investigated area, the soil texture in the upper 0- to 5-foot soil profile is predominantly Clay or Sandy Clay Loam derived from Glacial Till left behind from the previous glacial periods. Glacial till in this area is mainly clay and clay loam soils.

Clay and Sandy Clay Loam have a water holding capacity of 2.0-2.2 inches of Plant Available Water (PAW) per foot of soil. Cereal grains and other annual crops typically root four feet deep or shallower. The total PAW can be estimated based on the soil type in the recharge area by using the average of 2.0 in. PAW/foot of moist soil for Clay soil multiplied by the four feet of rooting depth. Therefore, the top four feet of soil can store about 8 inches of water that is available to plants. When the soil profile is recharged or at moisture capacity, any excess soil moisture will leach below the rooting zone and recharge the water table. The sand and gravel layers hold less than one inch of PAW.



Saline Seep Reclamation with Salt-tolerant Perennial Forages Update

Clair Keene, Jim Staricka, and Kyle Dragseth

This on-going research and extension project is reclaiming acres lost to a saline seep on the dryland farm at the Williston Research Extension Center. In 2014, shallow ground water monitoring wells were installed to identify the recharge and discharge areas associated with a saline seep that had been growing for approximately 15 years. In June 2016, an area of approximately 40 acres was planted to salt-tolerant alfalfa varieties and perennial grasses to lower the water table and allow salts concentrated at the soil surface to be washed down into the soil profile and, eventually, deeper than the plant rooting zone. Over the worst part of the saline seep, we planted a variety trial to evaluate the salt tolerance of four alfalfa varieties and two perennial grasses: alfalfa varieties AFX 457, PGI 427, Magnum Salt, and Rugged; perennial grasses Garrison creeping foxtail and AC Saltlander.

Stand evaluations in May 2017 estimated all alfalfa varieties at 80-90% ground cover with the stand in good to very good condition. The perennial grasses did not establish as well as the alfalfa and had poor to fair stands due to difficulty establishing in the no-till, heavy-residue conditions. In May 2018, all alfalfa varieties had very good stands and 90-95% ground cover, demonstrating good winter hardiness in Northwest North Dakota. In early June 2019, alfalfa stands were rated as good to very good and the perennial grasses were starting to fill in, though they still had not achieved consistent ground cover in all the plots. May 2019 average temperatures were 10°F cooler than May 2018 and we think this was a major cause of slower spring growth and less biomass accumulation in 2019.

The variety trial plots were cut once in the seeding year and twice in 2017, 2018, and 2019. In 2017, the region experienced a severe drought and less than 1” of rain fell between early May and mid-July. Despite the lack of rain, second cutting alfalfa in the saline seep yielded well, demonstrating that it was able to take advantage of the shallow water table. In 2018, about 8” of rain was received between May and July and second cutting yields were similar to the first cut. In 2019, April and May were cool and dry, but June and July rainfall totaled about 7.” The fall of 2019 was extremely wet with 2” of rain in August and a record-breaking 8” in September. The September rain prevented us from harvesting a second cutting in most of the field.

Saline seep alfalfa yields 2016 - 2019 in Tons/ acre.

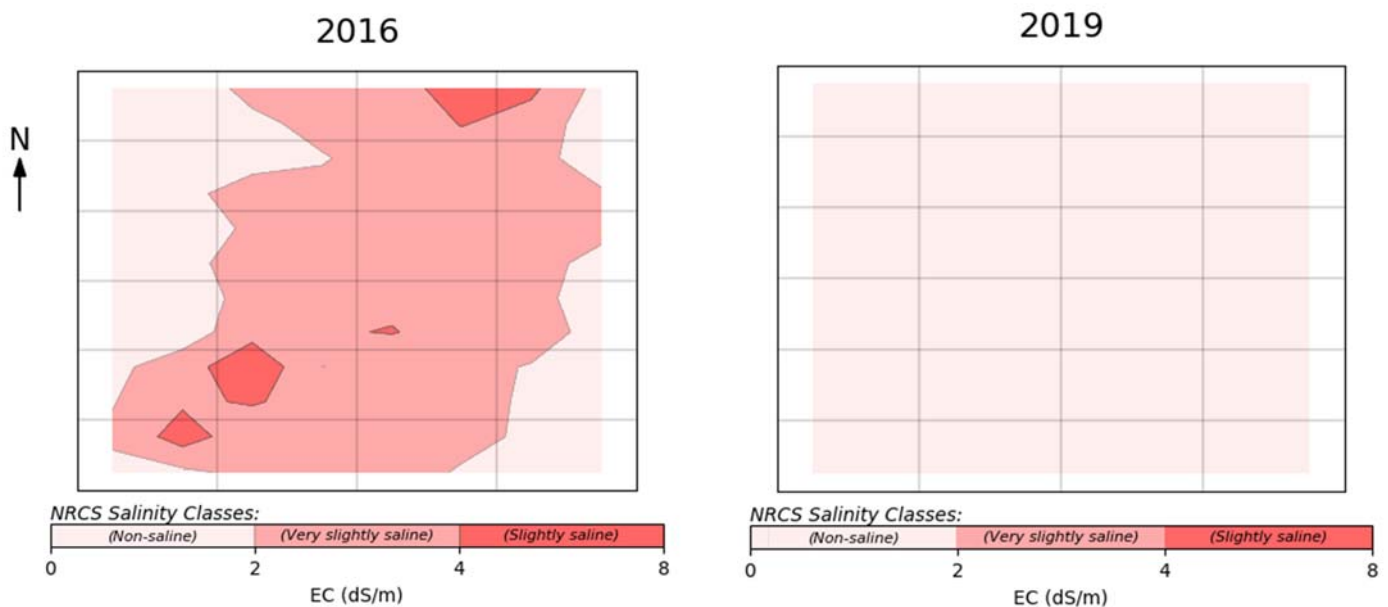
| 2016 | | 2017 | | | 2018 | | | 2019 | | |
|------------------------|-----|-------------------------|-------------------------|------------|-------------------------|-------------------------|------------|-------------------------|-------------------------|------------|
| 12 WAP [†] | | 1 st cutting | 2 nd cutting | Total | 1 st cutting | 2 nd cutting | Total | 1 st cutting | 2 nd cutting | Total |
| Alfalfa variety | | | | | | | | | | |
| AFX 457 | 0.7 | 2.0 | 1.7 | 3.7 | 2.2 | 2.0 | 4.2 | 1.1 | 1.3 | 2.4 |
| PGI 427 | 0.6 | 1.9 | 1.2 | 3.1 | 2.7 | 2.1 | 4.8 | 2.3 | 1.2 | 3.5 |
| Rugged | 0.7 | 1.7 | 1.9 | 3.6 | 2.3 | 2.2 | 4.5 | 1.4 | 0.7 | 2.1 |
| Magnum Salt | 0.7 | 1.7 | 1.3 | 3.0 | 2.0 | 1.8 | 3.8 | 1.7 | 1.1 | 2.8 |

[†]WAP = weeks after planting

In 2019, 125 round hay bales weighing 1,600 lbs each were made from the approximately 40 acres of the saline seep field and the strip of alfalfa running along the east side of the quarter section. Our best estimate of per acre yield for the field is 2.5 tons/ acre.

Soil Salinity Monitoring

Fall soil sampling has been conducted each year to monitor changes in electrical conductivity (EC), an indicator of salinity. Soil cores were taken with a hand probe to a depth of 3 inches in a grid pattern and then in the lab, cores were mixed with deionized water to form a thick paste prior to measuring with a Field Scout® Direct Soil EC Meter (Spectrum Technologies). Below are maps of EC values measured in 2016 on the left and in 2019 on the right. The scale shown is EC values by NRCS Salinity Classes, ranging from non-saline (0-2 dS/m), very slightly saline (2-4 dS/m), to slightly saline (4-8 dS/m) at this site. We note that this site was not strongly saline at the outset. If this site had been strongly saline, EC > 16 dS/m, we do not anticipate that the alfalfa varieties tested would have been as successful establishing as they were. This highlights the importance of testing soil EC prior to planting perennials to determine how salt-tolerant a species is needed. In 2016, the average EC of all samples was 2.18 dS/m; in 2019, the average is 0.85 dS/m. These data show we have successfully reduced salinity in the top 0-3" of the soil profile.



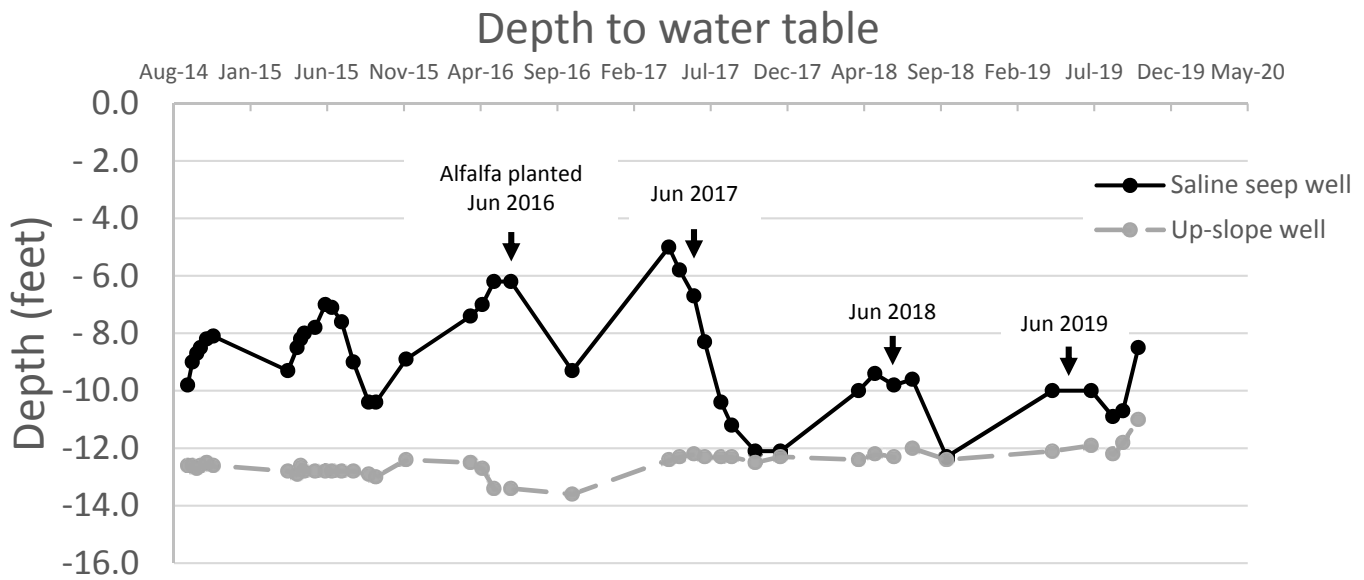
In 2018 and 2019, we took a series of deep soil cores with a hydraulic probe to check EC values (salinity) in deeper layers of the soil profile. These cores were tested by the NDSU Soil Testing Lab. In all samples, EC values increased with depth; from 2018 to 2019 EC decreased in all plots at all depths. We attribute this to the extremely high rainfall, approximately 17", received July-September 2019 flushing salts deeper into the soil. We are encouraged to see the deep core results parallel those of the 0-3" samples tested at WREC illustrated in the figures above. The high in-season rainfall flushed salts deeper than the 24" sampling depth. This progress reducing EC in the top 24", a critical zone for plant establishment, is encouraging. This sampling will be repeated in 2020.

Deep Soil EC (dS/m)

| | Plot | 201 | | 206 | | 301 | | 306 | | |
|------------|--------|------|-----|-----|-----|-----|-----|-----|-----|-----|
| | | Year | 18 | 19 | 18 | 19 | 18 | 19 | 18 | 19 |
| Depth (in) | 0-3" | | 3.3 | 0.8 | 3.3 | 2.1 | 2.9 | 1.8 | 4.0 | 2.0 |
| | 3-6" | | 5.4 | 2.5 | 6.0 | 3.6 | 4.2 | 3.7 | 6.9 | 3.9 |
| | 6-12" | | 7.9 | 3.2 | 8.0 | 5.2 | 6.9 | 4.9 | 8.1 | 5.5 |
| | 12-24" | | 9.2 | 4.7 | -- | -- | 9.1 | 5.8 | -- | -- |

Water Table Management

Depth to water table has been monitored using shallow ground water wells. Below is a figure of measurements taken at two wells at the site from 2014-2019. The black line is from the well closest to the saline seep and the gray dotted line is from a well at a higher elevation up-slope from the seep. The peaks in the black line show the water table rising under the seep, i.e. ground water recharge, after spring snow melt. We see a strong drawdown in the water table during the dry 2017 growing season when the alfalfa used soil water without additions from precipitation. The truncated peak in 2018 shows that the alfalfa successfully limited recharge during a growing season with above-normal precipitation. In 2019, another truncated peak shows the alfalfa preventing a spike in the groundwater after a snowy 2018-2019 winter. The sharp increase in the water table observed at the last reading in October 2019 is a result of the 8" of rain received during September.



Summer interns sampling alfalfa biomass in June 2019.



Dr. Jim Staricka soil sampling the top 0-3" of the plots in October 2019.

Acknowledgements: Jane Holzer, Montana Salinity Control Association and Don Miller, Alforex Seeds

Irrigation Research at Nesson Valley 2019

Justin Jacobs, NDSU – Williston Research Extension Center

Weather Summary - Nesson Valley, ND⁺

| Month | Precipitation | | Temperature | | Days above 89 ⁰ |
|---------------------------------------|---------------|------------------|-----------------------------------|------|----------------------------------|
| | 2019 | Avg [‡] | 2019 | Avg | |
| | -inches- | | -----degrees F ⁰ ----- | | |
| Oct-Dec. 2018 | 0.70 | 3.85 | | | |
| April | 0.89 | 0.44 | 41.8 | 33.7 | 0 |
| May | 0.88 | 1.49 | 49.6 | 58.5 | 1 |
| June | 2.90 | 4.54 | 63.1 | 65.6 | 5 |
| July | 3.46 | 2.36 | 67.7 | 67.7 | 6 |
| August | 2.17 | 1.07 | 65.8 | 66.7 | 6 |
| September | 10.03 | 1.85 | 57.3 | 52.9 | 2 |
| April-July | 8.13 | 8.83 | 55.5 | 56.4 | 12 |
| April-Sept | 20.33 | 11.74 | 57.5 | 57.5 | 20 |
| Total- (Oct 2018 - September 2019) | 21.03 | 15.59 | | | |

Last spring frost = May 12, 2019 (27.6°)

First fall frost = October 2, 2019 (31.8°)

⁺ NDAWN Hofflund site

[‡] Average since January 1, 2006

too late and impacted growth and yields. The heavy rains also caused pods to shatter and shell out in canola, field pea, and soybean. The table below identifies the average yields for each of the trials conducted this year. Several of the trials had additional varieties compared to previous years. It is important to include the newest varieties along with the older varieties each year to provide multi-year data for varietal selection. If there are varieties that have not been tested that you wish to see, please let me know. The complete tables for these crops can be found throughout this Ag Research Update.

| Crop (# of varieties) | 2019 Average | Crop | 2019 Average |
|-----------------------|------------------|---------------------------|------------------|
| Winter Wheat (22) | 99 bu/a | Misc Bean (12) | 1736 lb/a |
| Spring Wheat (48) | 93 bu/a | Field Pea (6) | 50 bu/a |
| Durum Wheat (21) | 72 bu/a | Lentil (11) | 2096 lb/a |
| Barley (12) | 132 bu/a | Flax (13) | 32 bu/a |
| Oat (15) | 152 bu/a | Safflower (22) | 1215 lb/a |
| Corn (24) | 152 bu/a | Canola (12) | 1960 lb/a |
| Faba Bean (5) | 2209 lb/a | Sunflower (16) | 2329 lb/a |
| Navy Bean (3) | 1324 lb/a | RR Soybean (41) | 37 bu/a |
| Pinto Bean (10) | 1719 lb/a | Conventional Soybean (27) | 44 bu/a |

This was the second year of research on intercropping at Nesson, looking at interseeding chickpea and flax together and field pea and canola. The chickpea/flax trial was not used as the chickpeas failed to emerge. The results from the field pea and canola show positive results when interseeded together versus planted alone. The objective of this project is to see that when field pea and canola are interplanted together, lodging in the field pea is reduced, and a secondary objective, is to see that when canola is added to field pea, that the field pea yield is not negatively affected, and that a second crop can be grown and be marketable. Both of these objectives have been observed. I have highlighted the results in a written report in this Ag Research Update.



Two-thousand and twenty will bring some new challenges, but will continue to work hard to bring the best data out of Nesson Valley. We will be looking to fill two positions this winter and get these individuals on board and ready to go prior to spring planting. As always we hope that you will join us for our Irrigated Field Tour, July 9, 2020!

Improving Efficiency Using Intercropping – 2019

Intercropping under Irrigation

Justin Jacobs and James Staricka, NDSU – Williston Research Extension Center

Objective

Current agricultural practices are undergoing a major change and shift towards a more sustainable or regenerative system. Lowering commodity prices and its impacts on production Ag has changed the approach towards increasing production efficiency over normal practices of the past. Intercropping is being looked at as a way to become more efficient. Intercropping is a practice that has not been widely adopted, but has been around for a significant amount of time. Some early manuscripts suggest that the ancient Egyptians and ancient Romans practiced intercropping. Recent history even tells us that the Native Americans practiced a form of intercropping by growing corn, beans, and squash together in the same field. The practice of intercropping is growing two or more crops together in the same field.

Farmers have previously utilized production practices with companion crops to give an advantage or benefit to the cash crop being grown. Similarly cattle producers have been growing multiple crops together as a source of hay or forage. The idea of growing two crops together to be separated as individual cash crops is a relatively new and emerging idea. One of the key concepts of growing two crops together is to have varying seed sizes in order to allow for seeds to be separated easily. Another important factor is to make sure the crops have similar maturities. Field pea and canola would be an example of two crops working together.

Two-thousand and nineteen was the second year of intercropping research conducted at Nesson Valley. The intercropping study is looking at the use of irrigation to further increase the efficiency of intercropping. Non-irrigated intercropping is being conducted at the same time to draw comparisons between the two environments. One of the objectives with intercropping field pea and canola, is to utilize canola's standability to reduce lodging in field pea.

Materials and Methods

In 2018 there were six treatments comparing alternating rows to mixed rows. In the 2018 trial year the alternating rows showed the most potential, though, the canola yields suffered as a result of no Nitrogen fertilizer applied. As a result of the alternating rows out performing the mixed rows, and the recognition of a need for fertilizer to increase the canola yields, the decision was made to look solely at alternating rows in combination with three rates of Nitrogen fertilizer in 2019. In the future there is potential to take a look at the mixed rows once again. There are many unanswered questions with intercropping, therefore it is easier to answer one or two questions at a time. The Nitrogen fertilizer rates were adjusted according to the soil test data obtained the previous fall. A

Table 1. Planting ratios in a field pea and canola intercrop

| Ratio (Field Pea : Canola) | Planting Rate (lb/a) | Plant Population (seeds/a) |
|-------------------------------|-------------------------|-------------------------------|
| 100:0 | 180 : 0 | 352,000 : 0 |
| 0:100 | 0 : 4 | 0 : 304,000 |
| 66:66 | 120 : 2.6 | 239,000 : 203,000 |
| 66:33 | 120 : 1.3 | 239,000 : 101,000 |
| 50:50 | 90 : 2 | 176,000 : 159,000 |
| 33:66 | 60 : 2.6 | 112,000 : 203,000 |

Potassium Sulfate fertilizer was applied to the entire trial in order to achieve a 30 lb/a rate of sulfur for the canola. Each planting ratio was planted once in each of the fertilizer rates being tested, and replicated four times. Additionally the trial was replicated as an irrigated and a non-irrigated trial.

The trial was planted on May 10. Each crop was planted separately, with field

pea being planted first followed by canola. The field pea variety used was AC Agassiz and the canola variety was CS2200 CL. The use of a clearfield canola allowed the use of Imazamox to be applied for a broader control of broadleaf weeds that would be tougher to control with a conventional canola variety. Prowl H2O was used as a preemergent herbicide; Section 3EC and Assure II were applied for grass control, and Beyond was used for broadleaf control. In-season observations on lodging in field pea, flowering dates, plant height, and maturity dates were recorded during the growing season. Harvest occurred on August 30. After harvest, yield, oil content, and protein content were measured on the harvested seeds.

Table 2. Nitrogen fertilizer rates in a field pea and canola intercrop

| Fertilizer Percentage (%) | Nitrogen Fertilizer Rate (lb/a) |
|------------------------------|------------------------------------|
| 100 | 120 |
| 50 | 60 |
| 0 | 0 |

30 lb/a of Sulfur was applied using Potassium Sulfate

Results and Discussion

Table 3. Field pea lodging across planting ratios

| Field Pea | | | | | |
|----------------------|---------|------------------|----------------------|---------|------------------|
| IRRIGATED | | | NON-IRRIGATED | | |
| Ratio | Lodging | Means separation | Ratio | Lodging | Means separation |
| (Field Pea : Canola) | (0-9)* | | (Field Pea : Canola) | (0-9)* | |
| 100:0 | 2.75 | a | 100:0 | 3.83 | a |
| 66:33 | 2.25 | ab | 66:33 | 2.58 | b |
| 50:50 | 2.17 | ab | 66:66 | 2.17 | b |
| 66:66 | 1.67 | bc | 50:50 | 2.00 | b |
| 33:66 | 1.25 | c | 33:66 | 1.83 | b |

* (0-9) : 0 = no lodging, 9 = plants lying flat

planting ratios in both the irrigated and non-irrigated trials. The lodging scale is a 0-9 scale with 0 being the plants standing straight up, and with 9 being the plants lying flat. Values that are followed by the same lower case letter are not significantly different. However, lodging can only be compared to results in the same system (i.e. irrigated or non-irrigated). As the ratio of canola increased in the intercropped treatments the lodging in field pea was reduced.

Table 4. Field pea yield across planting ratios

| Field Pea | | |
|----------------------|--------|------------------|
| IRRIGATED | | |
| Ratio | Yield | Means separation |
| (Field Pea : Canola) | (bu/a) | |
| 100:0 | 40 | a |
| 66:33 | 28 | b |
| 66:66 | 26 | bc |
| 50:50 | 23 | bc |
| 33:66 | 22 | c |
| NON-IRRIGATED | | |
| Ratio | Yield | Means separation |
| (Field Pea : Canola) | (bu/a) | |
| 100:0 | 34 | a |
| 66:66 | 28 | b |
| 66:33 | 27 | b |
| 50:50 | 21 | c |
| 33:66 | 20 | c |

Significant differences were seen in yields of both canola and field pea across fertilizer rates and planting ratios in both the irrigated and non-irrigated trial. As the rate of fertilizer increased, the yield of field pea decreased, while the canola yield increased. The yield of the field pea and means separation across planting ratios can be seen in table 4. The irrigated trial showed no significant difference between the 66:66, 66:33, and the 50:50 planting ratios. The 50:50 ratio showed significant difference from the 66:66 and 66:33 ratios in the non-irrigated trial. Table 5 shows the canola yield in both the irrigated and non-irrigated trials. Canola yields were affected by the planting ratios being tested. There was no significant difference between the canola yield in the 66:66, 66:33, 50:50 and 33:66 treatments in the irrigated trial. Significant differences were seen in the 33:66 and 66:66 treatments when compared to the monocropped canola. Similarly the 50:50, 33:66, and 66:66 treatments showed significant difference in yield compared to the monocropped canola plot in the non-irrigated trial.

Table 5. Canola yield across planting ratios

| Canola | | |
|----------------------|--------|------------------|
| IRRIGATED | | |
| Ratio | Yield | Means separation |
| (Field Pea : Canola) | (lb/a) | |
| 33:66 | 1704 | a |
| 66:66 | 1662 | a |
| 66:33 | 1581 | ab |
| 50:50 | 1469 | ab |
| 0:100 | 1249 | b |
| NON-IRRIGATED | | |
| Ratio | Yield | Means separation |
| (Field Pea : Canola) | (lb/a) | |
| 50:50 | 1346 | a |
| 33:66 | 1240 | ab |
| 66:66 | 1073 | ab |
| 0:100 | 864 | b |
| 66:33 | 831 | b |

Summary

The addition of fertilizer to the trial resulted in higher canola yields and better performance in an intercropped system. Field pea lodging was reduced across planting ratios. Yields in field pea were reduced when intercropped, while the use of intercropping increased the yield of the canola. When an economic analysis is taken into consideration, the addition of canola into an intercropping production practice provides favorable returns. Research will continue in 2020, and will include testing on chickpeas and flax.

In 2018 a reduction was seen in the lodging of field pea when intercropped with canola. Additionally the trial in 2019 also showed a significant reduction in the lodging of field pea when intercropped with canola. Table 3 shows the lodging scores given to the

Effects of Sugarbeet Factory Spent Lime on Soil and Crop Production in a Crop Rotation of Wheat and Sugarbeet. (Sidney Sugars).

Tyler Tjelde, James Staricka, Justin Jacobs, David Schmidt, Kyra Candee, and Ken Burbach

Introduction

Sidney Sugars contracts on average 30,000 acres of sugarbeets yearly. Each year there is approximately 16-18 thousand tons of spent lime produced as a by-product of the beet sugar purification process. There is approximately 75 years' worth of the spent lime available at the Sidney Sugars facility. Is this a product that can be utilized to improve soil health, increase nutrients in the soil, and/or improve crop production? Research has been conducted in eastern ND and western MN demonstrating the benefits of lime on the soil and crop production. Some of the benefits reported from this work are long term control of *Aphanomyces* and the addition of phosphorus and other micro nutrients. No negative responses from the lime were determined. How will this lime affect the sugarbeet production and how will other rotational crops be affected by the addition of lime to the soil? Will the results differ in western ND where the soil pH is upper 7 to low 8, compared to eastern ND and northwestern MN where the soil pH is upper 6 to low 7.

Methods and Experimental Design

The study is being conducted at the Nesson Valley Irrigation Research Site (48°09'75" N, 103°06'32" W), approximately 28 miles east of Williston, ND. The soil type is a Lihen sandy loam (sandy, mixed, frigid Entic Haplustoll), consisting of very deep, somewhat excessively or well drained, nearly level soil that formed in sandy alluvium, glacio-fluvial, and eolian deposits in places over till or sedimentary bedrock (Soil Survey of Williams County, ND 1991).

The experimental design is a Randomized Complete Block Design (RCBD) with four replications. Each plot is 25 ft. by 75 ft. with lime rates randomized for each plot. The treatments consist of six lime rates (0, 2.5, 5, 10, 15, 20 tons per acre) applied only once for the duration of the project. Soil samples were taken from each plot prior to lime application and each year following harvest. Lime application occurred in the spring 2016 for each plot at the treatment rate. Lime was incorporated using a mulcher prior to planting wheat. Soil analysis includes nitrogen, phosphorus, potassium, sodium, calcium, zinc, manganese, iron, copper, magnesium, sulfur, EC, pH, and organic matter.

Year 1 Results

Wheat was planted May 3, 2016 and after emergence, plant growth was observed to identify any differences between treatments. Plant heights prior to harvest and yields were measured from each plot and data statistically analyzed. Spent lime showed no significant effects on plant growth or yield (Table 1). Significant differences ($P < 0.05$) between protein and test weight were observed among treatments but the relationship between treatments did not reflect the addition of spent lime. Soil sampling occurred following harvest and the most notable change was an increase in calcium and pH.

| WREC - Nesson Valley 2016 | | | | |
|--|-------------------------|-----------------------------------|-------------------------|-----------------------|
| Treatment Spent Lime tons/a | Plant Height inch | Protein ¹ 2016 % | Test Weight lb/bu | Yield 2016 bu/a |
| 0 | 39 | 16.4 | 56.3 | 66.1 |
| 2.5 | 39 | 16.4 | 56.9 | 64.2 |
| 5 | 39 | 16.1 | 57.1 | 64.8 |
| 10 | 39 | 16.5 | 56.5 | 63.4 |
| 15 | 39 | 16.2 | 57.4 | 67.3 |
| 20 | 39 | 16.6 | 56.8 | 63.0 |
| Mean | 39.0 | 16.4 | 56.8 | 64.8 |
| C.V. % | - | 1.5 | 0.6 | 8.4 |
| LSD 5% | - | 0.31 | 0.45 | n.s. |
| Planted: 5/3/2016 | | | Harvested: 8/16/2016 | |
| Protein ¹ = reported on an as is moisture basis | | | | |

Year 2 results

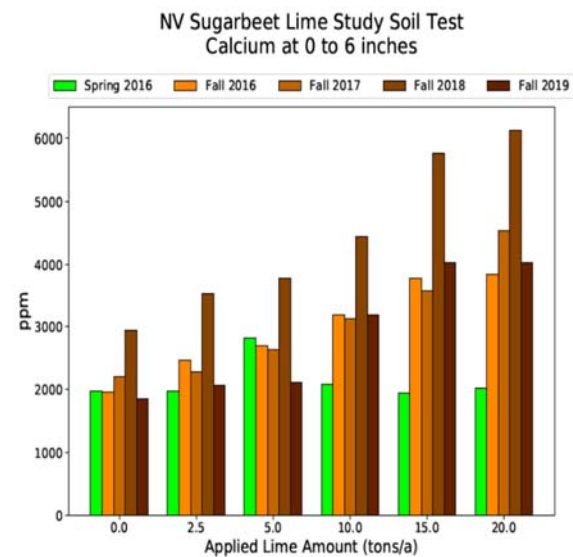
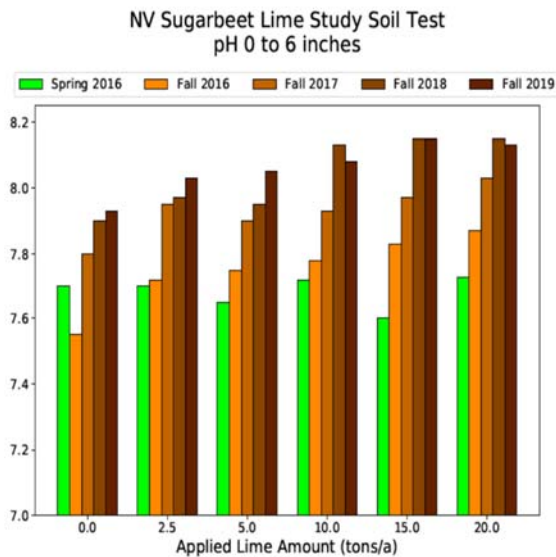
Sugarbeet was planted April 28, 2017. Stand counts were taken after emergence and no differences observed between the treatments. No visual differences in crop growth were observed throughout the growing season. Root samples were taken from ten feet of row in each plot on August 10th, August 30th and September 19th. Stand counts, percent sugar, and yields were measured for each treatment from these samples. Significant differences ($P < 0.1$) between yield and recoverable sugar were observed among treatments in the August 10 and 30th root samples (Table 2 and 3). The September 19th final harvest sample did not show any statistical differences between treatments (Table 4).

Spent lime had no effect on soil nutrients except calcium and pH increased with increased rates of applied lime (see graphs below).

| Table 2. Sugarbeet (August 10) | | | WREC - Nesson Valley 2017 | |
|--------------------------------|-------------|------------|---------------------------|-------------------|
| Treatment Spent Lime | Plant Stand | Sugar 2017 | Yield 2017 | Recoverable Sugar |
| tons/a | beets/10ft | % | ton/a | lb/a |
| 0 | 14 | 13.6 | 27.4 | 7486 |
| 2.5 | 13 | 13.4 | 29.1 | 7794 |
| 5 | 14 | 13.4 | 28.1 | 7547 |
| 10 | 12 | 13.3 | 32.6 | 8669 |
| 15 | 14 | 13.2 | 31.7 | 8374 |
| 20 | 13 | 13.1 | 30.9 | 8112 |
| Mean | 13.2 | 13.3 | 30.0 | 7997.0 |
| C.V.% | 24.4 | 3.3 | 8.2 | 8.6 |
| LSD 10% | n.s. | n.s. | 3.0 | 848.0 |
| Planted: 4/28/2017 | | | Harvested: 9/19/2017 | |

| Table 3. Sugarbeet (August 30) | | | WREC - Nesson Valley 2017 | |
|--------------------------------|-------------|------------|---------------------------|-------------------|
| Treatment Spent Lime | Plant Stand | Sugar 2017 | Yield 2017 | Recoverable Sugar |
| tons/a | beets/10ft | % | ton/a | lb/a |
| 0 | 12 | 16.3 | 32.0 | 10413 |
| 2.5 | 13 | 16.1 | 35.2 | 11320 |
| 5 | 12 | 16.2 | 32.4 | 10507 |
| 10 | 11 | 16.1 | 38.4 | 12366 |
| 15 | 11 | 16.6 | 33.5 | 11143 |
| 20 | 11 | 15.8 | 30.7 | 9684 |
| Mean | 11.8 | 16.2 | 33.7 | 10905.4 |
| C.V.% | 27.3 | 2.3 | 9.7 | 9.4 |
| LSD 10% | n.s. | 0.46 | 4.0 | 1543.6 |

| Table 4. Sugarbeet (September 19) | | | WREC - Nesson Valley 2017 | |
|-----------------------------------|-------------|------------|---------------------------|-------------------|
| Treatment Spent Lime | Plant Stand | Sugar 2017 | Yield 2017 | Recoverable Sugar |
| tons/a | beets/10ft | % | ton/a | lb/a |
| 0 | 9 | 17.1 | 38.4 | 13111 |
| 2.5 | 9 | 17.5 | 37.1 | 12947 |
| 5 | 10 | 17.0 | 42.6 | 14440 |
| 10 | 11 | 17.1 | 40.2 | 13704 |
| 15 | 11 | 17.3 | 39.6 | 13698 |
| 20 | 10 | 17.2 | 37.3 | 12814 |
| Mean | 10.2 | 17.2 | 39.2 | 13452.4 |
| C.V.% | 25.0 | 2.9 | 14.2 | 12.9 |
| LSD 10% | n.s. | n.s. | n.s. | n.s. |



Year 3 Results

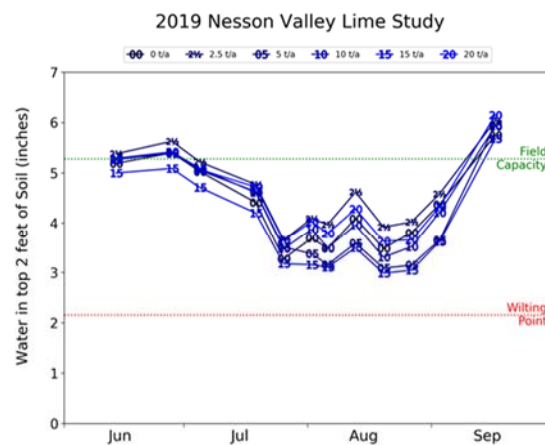
Wheat was planted May 7, 2018 and after emergence, plant growth was observed to identify any differences between treatments. Plant heights prior to harvest and yields were measured from each plot and data statistically analyzed. The addition of spent lime showed no significant effects ($P < 0.05$) on plant growth, protein, test weight or yield (Table 5). Soil sampling occurred following harvest and the most notable change was an increase in calcium and pH.

| Table 5. Irrigated HRSW | | | WREC - Nesson Valley 2018 | | |
|--|--------------|---------------------------|---------------------------|------------|--|
| Treatment Spent Lime | Plant Height | Protein ¹ 2018 | Test Weight | Yield 2018 | |
| tons/a | inch | % | lb/bu | bu/a | |
| 0 | 23 | 18.6 | 58.8 | 70.9 | |
| 2.5 | 23 | 18.7 | 59.2 | 74.3 | |
| 5 | 22 | 18.8 | 58.7 | 70.9 | |
| 10 | 23 | 18.6 | 59.1 | 72.1 | |
| 15 | 22 | 18.9 | 58.8 | 71.4 | |
| 20 | 22 | 18.8 | 58.8 | 66.7 | |
| Mean | 22.6 | 18.7 | 58.9 | 71.1 | |
| C.V.% | 4.7 | 2.7 | 0.9 | 10.2 | |
| LSD .10 | n.s. | n.s. | n.s. | n.s. | |
| Planted: 5/7/2018 | | | Harvested: 8/31/2018 | | |
| Protein ¹ = reported on an as is moisture basis | | | | | |

Year 4 Results

Sugarbeet was planted May 6, 2019. Stand counts were taken after emergence and no differences observed between the treatments. No visual differences in crop growth were observed throughout the growing season. Root samples were taken from ten feet of row in each plot on September 23. Stand counts, percent sugar, and yields were measured for each treatment from these samples. No significant differences ($P < 0.1$) were observed between sugar percent, yield and recoverable sugar among treatments. Moisture readings were taken from each plot throughout the growing season to measure available soil moisture and to identify if the addition of lime influenced these moisture readings in any way. In this particular location the water holding capacity of the soil has not changed with the addition of lime.

| Sugarbeet (September 23) | | WREC - Nesson Valley 2019 | | |
|--------------------------|-------------|---------------------------|------------|-------------------|
| Treatment Spent Lime | Plant Stand | Sugar 2017 | Yield 2017 | Recoverable Sugar |
| tons/a | beets/10ft | % | ton/a | lb/a |
| 0 | 16 | 17.8 | 33.3 | 11850 |
| 2.5 | 17 | 17.7 | 31.9 | 11297 |
| 5 | 15 | 17.6 | 34.4 | 12096 |
| 10 | 14 | 17.7 | 35.7 | 12596 |
| 15 | 15 | 17.5 | 34.7 | 12136 |
| 20 | 15 | 17.5 | 32.7 | 11427 |
| Mean | 15.1 | 17.6 | 33.8 | 11900.1 |
| C.V.% | 10.6 | 2.1 | 10.2 | 9.1 |
| LSD 10% | 1.9 | n.s. | n.s. | n.s. |



On-Farm Evaluation of Micronutrients on Sugarbeet Root Yield, Sugar Content, and Sugar Quality EARC, Sidney, MT

Chengci Chen, Apurba Sutradhar, Bill Frank, Rebecca Garza, Calla Kowatch-Carlson, Thomas Gross, Ronald Brown, W. Tanner Stevens, and Sooyoung Frank

Materials and Methods:

Locations: Crane, Culbertson and Sidney
 Plot size: 12"W x 30"L
 Experimental design: Randomized Complete Block

Tillage: No-till
 Replications: 4

Table 1. Treatments structure. All micronutrient products were foliar sprayed. Treatment 3 was applied about a month before final sampling for sugarbeet root yield and quality measurements.

| Trt no. | Product name | Rate / product description |
|---------|------------------------|--|
| 1 | Check | No micronutrient products were applied |
| 2 | Sugar Mover (early) | @ 2.0 quart/ac. Contains nitrogen (3.0%), boron (8.0%), and molybdenum (0.004%). |
| 3 | Sugar Mover (Late) | @ 2.0 quart/ac. Contains nitrogen (3.0%), boron (8.0%), and molybdenum (0.004%). |
| 4 | Harvest More Urea Mate | @ 2.5 lb/ac. Contains nitrogen (5.0%), available phosphate (P ₂ O ₅ , 10.0%), soluble potash (K ₂ O, 27.0%), calcium (4.0%), magnesium (1.5%), boron (0.15%), cobalt (0.008%), copper (0.3%), manganese (0.5%), molybdenum (0.008%), and zinc (0.5%). |
| 5 | Stroller Grow | @ 16.0 oz/ac. Contains nitrogen (4.0%), soluble potash (3.0%), copper (0.4%), magnesium (0.5%), manganese (0.4%), and zinc (1.6%). |
| 6 | Bio-Forge Advanced | @ 1.0 pint/ac. Contains nitrogen (3.0%), soluble potash (1.0%), cobalt (1.0%), and molybdenum (1.0%). |
| 7 | EDTA-Mg | @ 1.0 lb Mg/ac. |
| 8 | EDTA-Zn | @ 0.8 lb Zn/ac. |

Table 2: Initial soil test results. Composite soil samples were collected on in the spring before sugarbeet planting from 12 inch depth.

| Site | pH | OM | NO ₃ -N | P-Olsen | K | Ca | Mg | Na | Zn | Fe | Mn | Cu | B | CEC |
|------------|-----|-----|--------------------|---------|-----|------|-----|-----|------|------|------|------|-----|----------|
| | | % | | | | ppm | | | | | | | | meq/100g |
| Crane | 8.3 | 2.3 | 17.5 | 17 | 159 | 5158 | 554 | 162 | 0.81 | 7.5 | 2.39 | 1.06 | 0.9 | 31.5 |
| Culbertson | 8.3 | 2.4 | 12.5 | 8 | 157 | 4421 | 450 | 116 | 1.07 | 11.9 | 1.84 | 0.93 | 0.9 | 26.8 |
| Sidney | 8.1 | 1.5 | 17.5 | 34 | 158 | 3537 | 317 | 46 | 1.28 | 9.1 | 3.17 | 0.57 | 0.8 | 20.9 |

Results: Interactions between sites and all measured parameters were significant. Therefore, results are presented separately for each site.

Table 3. Sugarbeet stand, root yield, sucrose concentration, and sugar quality at Crane.

| Treatment No. | Plant stand (ac) | Root yield (ton/ac) | Sucrose (%) | Sucrose Yield (lb/ac) | Impurity value | SLM (%) | Ext. sucrose yield (lb/ac) |
|---------------|------------------|---------------------|-------------|-----------------------|----------------|---------|----------------------------|
| 1 | 38115 | 25.5 | 15.5 | 7934 | 0.55 | 0.82 | 7525 |
| 2 | 40838 | 25.8 | 15.3 | 7946 | 0.55 | 0.83 | 7522 |
| 3 | 49005 | 24.2 | 15.7 | 7590 | 0.52 | 0.78 | 7212 |
| 4 | 43841 | 28.9 | 15.2 | 8817 | 0.60 | 0.89 | 8299 |
| 5 | 39476 | 30.3 | 15.5 | 9378 | 0.59 | 0.88 | 8850 |
| 6 | 40838 | 28.2 | 15.3 | 8647 | 0.55 | 0.83 | 8180 |
| 7 | 40838 | 28.2 | 15.4 | 8639 | 0.61 | 0.91 | 8125 |
| 8 | 39476 | 27.9 | 15.3 | 8525 | 0.49 | 0.74 | 8118 |
| Mean | 41452 | 27.4 | 15.4 | 8435 | 0.56 | 0.84 | 7979 |
| P -value | 0.37 | 0.47 | 0.75 | 0.59 | 0.40 | 0.4 | 0.66 |
| CV | 15.3 | 14.7 | 2.47 | 15.3 | 13.6 | 13.6 | 15.7 |
| LSD (0.05) | 9551 | 5.93 | 0.56 | 1900 | 0.11 | 0.18 | 1840 |

Table 4. Sugarbeet stand, root yield, sucrose concentration, and sugar quality at Culbertson.

| Treatment No. | Plant stand (ac) | Root yield (ton/ac) | Sucrose (%) | Sucrose Yield (lb/ac) | Impurity value | SLM (%) | Ext. sucrose yield (lb/ac) |
|---------------|------------------|---------------------|-------------|-----------------------|----------------|---------|----------------------------|
| 1 | 47644 | 35.8 | 16.2 | 11562 | 0.60 | 0.90 | 10939 |
| 2 | 46283 | 39.1 | 16.0 | 12542 | 0.53 | 0.80 | 11920 |
| 3 | 43560 | 40.5 | 15.4 | 12452 | 0.53 | 0.80 | 11803 |
| 4 | 49005 | 36.8 | 15.9 | 11658 | 0.50 | 0.75 | 11107 |
| 5 | 54450 | 39.7 | 16.0 | 12636 | 0.60 | 0.90 | 11936 |
| 6 | 49005 | 39.0 | 15.9 | 12357 | 0.51 | 0.76 | 11766 |
| 7 | 47644 | 34.3 | 16.2 | 11697 | 0.60 | 0.90 | 11051 |
| 8 | 46283 | 41.5 | 15.5 | 12840 | 0.43 | 0.65 | 12293 |
| Mean | 47984 | 38.3 | 15.9 | 12235 | 0.54 | 0.80 | 11620 |
| P -value | 0.44 | 0.33 | 0.14 | 0.96 | 0.30 | 0.30 | 0.96 |
| CV | 16.7 | 16.6 | 2.84 | 16.2 | 19.30 | 19.30 | 16.3 |
| LSD (0.05) | 11770 | 9.38 | 0.68 | 2985 | 0.16 | 0.23 | 2856 |

Table 5. Sugarbeet stand, root yield, sucrose concentration, and sugar quality at Sidney.

| Treatment No. | Plant stand (ac) | Root yield (ton/ac) | Sucrose (%) | Sucrose Yield (lb/ac) | Impurity value | SLM (%) | Ext. sucrose yield (lb/ac) |
|---------------|------------------|---------------------|-------------|-----------------------|----------------|---------|----------------------------|
| 1 | 49005 | 33.4 | 14.6 | 9775 | 0.67 | 1.00 | 9111 |
| 2 | 46283 | 41.4 | 15.3 | 12663 | 0.60 | 0.91 | 11909 |
| 3 | 44921 | 40.9 | 15.0 | 12224 | 0.62 | 0.93 | 11465 |
| 4 | 49005 | 36.7 | 14.9 | 10949 | 0.66 | 0.99 | 10219 |
| 5 | 47644 | 37.3 | 14.7 | 10993 | 0.66 | 1.00 | 10251 |
| 6 | 51728 | 33.8 | 15.2 | 10214 | 0.61 | 0.91 | 9592 |
| 7 | 47644 | 35.3 | 14.6 | 10354 | 0.67 | 1.00 | 9650 |
| 8 | 54450 | 39.4 | 15.0 | 11857 | 0.66 | 1.00 | 11059 |
| Mean | 48834 | 37.3 | 14.9 | 11129 | 0.64 | 0.97 | 10407 |
| P -value | 0.86 | 0.54 | 0.50 | 0.40 | 0.24 | 0.24 | 0.36 |
| CV | 18.6 | 17.6 | 3.54 | 17.6 | 7.21 | 7.21 | 17.5 |
| LSD (0.05) | 13382 | 9.64 | 0.78 | 2882 | 0.07 | 0.10 | 2671 |

Fall and Spring Nitrogen Application and Foliar Application of Magnesium and Zinc to Improve Sugarbeet Yield and Sugar Content in Conventional Tilled and No-Till Managements

EARC, Sidney, MT

Chengci Chen, Apurba Sutradhar, Bill Frank, Rebecca Garza, Calla Kowatch-Carlson, Thomas Gross, Ronald Brown, W. Tanner Stevens, and Sooyoung Frank

Material and Methods:

Irrigated

| | |
|--|--|
| Location: EARC | Previous crop: Spring Wheat |
| Planted: 4/24/2019 | Harvested: 9/24/2019 |
| Tillage: Conventional and no-till | Soil type: Williams Clay Loam |
| Plot size: 24"W x 30"L | Row spacing: 2 ft. |
| Variety: Crystal S696 GEM 100 | Replications: 4 |
| Experimental design: Randomized Complete Block | N rates: 120, 160, and 200 lb. N/ac applied in fall 2018 and in spring 2019 |
| Mg and Zn rates: Mg @ 1.0 lb/ac and Zn @ 0.8 lb/ac foliar applied once | Herbicide: Powermax @ 24 oz/ac on 5/23/2019, 6/10/2019, and 6/24/2019. To control cercospora leaf spot, Inspire XT was aerial sprayed @ 8.5 oz/ac on 8/28/2019 |
| Rainfall: 10.4" | Irrigation: 9.81" |

Table 1. Initial soil test results. Composite soil samples were collected from conventional tillage (CT) and no-till (NT) managements from 12 inch depth in the spring before sugarbeet planting.

| Mgt | pH | OM | NO ₃ -N | P-Olsen | K | Ca | Mg | Na | Zn | Fe | Mn | Cu | B | CEC |
|-----|-----|-----|--------------------|---------|-----|------|-----|-----|------|-----|------|------|-----|----------|
| | | % | ppm | | | | | | | | | | | meq/100g |
| CT | 8.2 | 3.7 | 38.0 | 17 | 431 | 6050 | 615 | 148 | 0.57 | 8.1 | 6.08 | 1.18 | 1.8 | 37.1 |
| NT | 8.3 | 3.3 | 32.0 | 15 | 351 | 6209 | 614 | 156 | 0.54 | 8.5 | 5.74 | 1.33 | 1.8 | 37.7 |

Table 2: Sugarbeet stand, root yield, sucrose concentration, and sucrose yield as affected by tillage, N application timing, and fertilizer treatments.

| Experimental Factor | Treatments | Stand (ac) | Root Yield (ton/ac) | Sucrose (%) | Sucrose Yield (lb/ac) |
|--------------------------|--------------|-----------------|---------------------|-------------|-----------------------|
| Tillage | Conventional | 40888 A | 37.9 B | 16.3 | 12374 B |
| | No-till | 34082 B | 41.7 A | 16.2 | 13540 A |
| N application Timing | Fall | 37258 | 39.7 | 16.3 | 12923 |
| | Spring | 37712 | 39.9 | 16.3 | 12931 |
| Fertilizer Treatment | 120 N | 39249 | 38.2 | 17.1 a | 13013 |
| | 120 N + Mg | 40611 | 39.3 | 16.1 bcd | 12636 |
| | 120 N + Zn | 38342 | 36.1 | 16.4 bc | 11833 |
| | 160 N | 35166 | 40.7 | 16.6 ab | 13491 |
| | 160 N + Mg | 35166 | 42.7 | 15.8 d | 13500 |
| | 160 N + Zn | 36300 | 37.8 | 16.2 bcd | 12280 |
| | 200 N | 37434 | 39.8 | 16.3 bcd | 12985 |
| | 200 N + Mg | 37661 | 43.7 | 15.9 cd | 13964 |
| | 200 N + Zn | 37434 | 40.0 | 16.2 bcd | 12909 |
| Sources of Variation | | -----P > F----- | | | |
| Tillage | | <0.01 | <0.01 | 0.47 | <0.01 |
| Timing | | 0.68 | 0.84 | 0.79 | 0.85 |
| Treatment | | 0.32 | 0.02 | <0.01 | 0.16 |
| Tillage*Timing | | 0.55 | 0.09 | 0.01 | 0.47 |
| Tillage*Treatment | | <0.01 | 0.83 | 0.80 | 0.83 |
| Treatment*Timing | | 0.46 | 0.49 | 0.97 | 0.60 |
| Tillage*Timing*Treatment | | 0.25 | 0.93 | 0.33 | 0.84 |

Results:

Table 3: Sugarbeet stand, root yield, sucrose concentration, and sucrose yield as affected by seed treatments.

| Treatments | Stand | Root Yield | Sucrose | Sucrose Yield |
|--|--------|------------|---------|---------------|
| | --ac-- | --ton/ac-- | --%-- | --lb/ac-- |
| Plain Talc | 53543 | 40.9 | 16.7 | 13713 |
| Micro Talc | 59895 | 41.9 | 17.2 | 14406 |
| Micro Talc + SB MicroSurge | 50820 | 37.1 | 16.9 | 12548 |
| Micro Talc + Inceptive | 62618 | 39.5 | 16.8 | 13319 |
| Micro Talc + Encompass | 62618 | 37.5 | 17.1 | 12838 |
| Micro Talc + SB MicroSurge + Inceptive | 61710 | 42.0 | 16.9 | 14218 |
| Micro Talc + Encompass + Inceptive | 48097 | 39.2 | 16.8 | 13235 |
| EDTA-Mg | 51728 | 40.1 | 16.7 | 13379 |
| EDTA-Zn | 61710 | 36.7 | 16.9 | 12418 |
| Mean | 56970 | 39.4 | 16.9 | 13342 |
| P > F | 0.08 | 0.15 | 0.74 | 0.19 |
| CV (%) | 14.3 | 7.86 | 2.36 | 8.24 |
| LSD (0.05) | 11911 | 4.52 | 0.58 | 1605 |

Table 4: Sugarbeet quality as affected by seed treatments.

| Trt. No. | Concentration in Extract | | | Concentration in Sugarbeet | | | IV | SLM | Extract | Ext. Sucrose |
|------------|--------------------------|------|---------|----------------------------|------|---------|------|-------------|---------|--------------|
| | Na | K | Amino-N | Na | K | Amino-N | | | | |
| | ----- ppm ----- | | | | | | | -----%----- | | --lb/ac-- |
| 1 | 53.2 | 209 | 14.6 | 417 | 1637 | 115 | 0.66 | 1.00 | 94.0 | 12900 |
| 2 | 35.4 | 164 | 14.3 | 278 | 1289 | 112 | 0.53 | 0.79 | 95.4 | 13745 |
| 3 | 44.8 | 201 | 16.6 | 352 | 1573 | 130 | 0.64 | 0.96 | 94.3 | 11837 |
| 4 | 43.9 | 204 | 15.7 | 344 | 1599 | 124 | 0.64 | 0.96 | 94.3 | 12567 |
| 5 | 42.4 | 181 | 13.7 | 333 | 1416 | 108 | 0.57 | 0.86 | 95.0 | 12621 |
| 6 | 44.6 | 197 | 14.3 | 350 | 1545 | 112 | 0.62 | 0.92 | 94.5 | 13442 |
| 7 | 45.7 | 196 | 16.1 | 359 | 1539 | 126 | 0.63 | 0.95 | 94.3 | 12498 |
| 8 | 42.7 | 205 | 13.5 | 335 | 1606 | 106 | 0.62 | 0.93 | 94.4 | 12631 |
| 9 | 43.1 | 197 | 17.7 | 338 | 1542 | 139 | 0.64 | 0.95 | 94.4 | 11718 |
| Mean | 44.0 | 195 | 15.2 | 345 | 1531 | 119 | 0.62 | 0.93 | 94.5 | 12663 |
| P > F | 0.27 | 0.02 | 0.93 | 0.27 | 0.02 | 0.93 | 0.29 | 0.29 | 0.39 | 0.21 |
| CV (%) | 17.8 | 7.96 | 28.9 | 17.8 | 7.96 | 28.9 | 11.0 | 11.0 | 0.77 | 8.56 |
| LSD (0.05) | 11.7 | 23.1 | 6.55 | 91.5 | 182 | 51.4 | 0.10 | 0.15 | 1.08 | 1614 |

Note: IV, impurity value; SLM, sucrose loss to molasses; Ext. Sucrose, Extractable sucrose.

Determination of the Efficacy of the Talc Products in Enhancing Sugarbeet Yield and Sucrose Concentration

EARC, Sidney, MT

Chengci Chen, Apurba Sutradhar, Bill Frank, Rebecca Garza, Calla Kowatch-Carlson, Thomas Gross, Ronald Brown, W. Tanner Stevens, and Sooyoung Frank

Materials and Methods:

Irrigated

| | |
|---|--|
| Location: EARC | Previous crop: Wheat |
| Planted: 4/24/2019 | Harvested: 9/24/2019 |
| Tillage management: Conventional | Plot size: 12" x 30", alley: 5" |
| Experimental design: Randomized Complete Block | Replications: 4 |
| Fertilizers: 150 lb N/ac + 40 lb P ₂ O ₅ /ac applied in fall 2019 | Herbicide: Powermax @ 24 oz/ac on 05/23/2019, 06/10/2019, and 06/24/2019 and Inspire XT @ 8.5 oz/ac on 08/28/2019 as aerial application. |
| Rainfall (Apr – Aug): 10.40" | Soil type: Williams Clay Loam |
| Irrigation: 14.16" | |

Table 1: Treatment description.

| No. | Product | Description |
|-----|--|--|
| 1 | Plain Talc | No nutrients |
| 2 | Micro Talc | 0.7% iron and 0.9% manganese by volume |
| 3 | Micro Talc + SB MicroSurge | SB MicroSurge contains two strains of <i>Azospirillum Brasiliense</i> that increase nitrogen availability. |
| 4 | Micro Talc + Inceptive | Inceptive is a harpin protein immune system booster. |
| 5 | Micro Talc + Encompass | Encompass incorporates five microbial inoculants that fix nitrogen and mobilizes phosphorus. |
| 6 | Micro Talc + SB MicroSurge + Inceptive | -- |
| 7 | Micro Talc + Encompass + Inceptive | -- |
| 8 | EDTA-Mg | 0.11 oz actual magnesium mixed with 2.2 lbs sugarbeet seeds |
| 9 | EDTA-Zn | 0.11 oz actual zinc mixed with 2.2 lbs sugarbeet seeds |

Note:

Treatments 1-7: 1/8 teaspoon talc products mixed with 400 seeds
Seeds were treated before planting.

Table 2: Initial soil test results. A composite soil sample was collected before planting sugarbeet.

| Depth | pH | OM | NO ₃ -N | P-Olsen | K | Ca | Mg | Na | Zn | Fe | Mn | Cu | B | CEC |
|-------|-----|-----|--------------------|---------|-----|------|-----|-----|------|-----|------|------|-----|----------|
| Inch | | % | ----- ppm ----- | | | | | | | | | | | meq/100g |
| 0-12 | 8.1 | 3.0 | 50.0 | 24 | 325 | 6217 | 534 | 105 | 0.82 | 6.8 | 6.31 | 1.12 | 1.4 | 36.8 |

Results:

Table 3: Sugarbeet stand, root yield, sucrose concentration, and sucrose yield as affected by seed treatments.

| Treatments | Stand | Root Yield | Sucrose | Sucrose Yield |
|--|--------|------------|---------|---------------|
| | --ac-- | --ton/ac-- | --%-- | --lb/ac-- |
| Plain Talc | 53543 | 40.9 | 16.7 | 13713 |
| Micro Talc | 59895 | 41.9 | 17.2 | 14406 |
| Micro Talc + SB MicroSurge | 50820 | 37.1 | 16.9 | 12548 |
| Micro Talc + Inceptive | 62618 | 39.5 | 16.8 | 13319 |
| Micro Talc + Encompass | 62618 | 37.5 | 17.1 | 12838 |
| Micro Talc + SB MicroSurge + Inceptive | 61710 | 42.0 | 16.9 | 14218 |
| Micro Talc + Encompass + Inceptive | 48097 | 39.2 | 16.8 | 13235 |
| EDTA-Mg | 51728 | 40.1 | 16.7 | 13379 |
| EDTA-Zn | 61710 | 36.7 | 16.9 | 12418 |
| Mean | 56970 | 39.4 | 16.9 | 13342 |
| P > F | 0.08 | 0.15 | 0.74 | 0.19 |
| CV (%) | 14.3 | 7.86 | 2.36 | 8.24 |
| LSD (0.05) | 11911 | 4.52 | 0.58 | 1605 |

Table 4: Sugarbeet quality as affected by seed treatments.

| Trt. No. | Concentration in Extract | | | Concentration in Sugarbeet | | | IV | SLM | Extract | Ext. Sucrose |
|------------|--------------------------|------|---------|----------------------------|------|---------|------|-------------|---------|--------------|
| | Na | K | Amino-N | Na | K | Amino-N | | | | |
| | ----- ppm ----- | | | | | | | -----%----- | | --lb/ac-- |
| 1 | 53.2 | 209 | 14.6 | 417 | 1637 | 115 | 0.66 | 1.00 | 94.0 | 12900 |
| 2 | 35.4 | 164 | 14.3 | 278 | 1289 | 112 | 0.53 | 0.79 | 95.4 | 13745 |
| 3 | 44.8 | 201 | 16.6 | 352 | 1573 | 130 | 0.64 | 0.96 | 94.3 | 11837 |
| 4 | 43.9 | 204 | 15.7 | 344 | 1599 | 124 | 0.64 | 0.96 | 94.3 | 12567 |
| 5 | 42.4 | 181 | 13.7 | 333 | 1416 | 108 | 0.57 | 0.86 | 95.0 | 12621 |
| 6 | 44.6 | 197 | 14.3 | 350 | 1545 | 112 | 0.62 | 0.92 | 94.5 | 13442 |
| 7 | 45.7 | 196 | 16.1 | 359 | 1539 | 126 | 0.63 | 0.95 | 94.3 | 12498 |
| 8 | 42.7 | 205 | 13.5 | 335 | 1606 | 106 | 0.62 | 0.93 | 94.4 | 12631 |
| 9 | 43.1 | 197 | 17.7 | 338 | 1542 | 139 | 0.64 | 0.95 | 94.4 | 11718 |
| Mean | 44.0 | 195 | 15.2 | 345 | 1531 | 119 | 0.62 | 0.93 | 94.5 | 12663 |
| P > F | 0.27 | 0.02 | 0.93 | 0.27 | 0.02 | 0.93 | 0.29 | 0.29 | 0.39 | 0.21 |
| CV (%) | 17.8 | 7.96 | 28.9 | 17.8 | 7.96 | 28.9 | 11.0 | 11.0 | 0.77 | 8.56 |
| LSD (0.05) | 11.7 | 23.1 | 6.55 | 91.5 | 182 | 51.4 | 0.10 | 0.15 | 1.08 | 1614 |

Note: IV, impurity value; SLM, sucrose loss to molasses; Ext. Sucrose, Extractable sucrose.

Effect of Date and Rate of Planting on Mung and Adzuki Beans Growth and Yield

EARC, Sidney, MT

Fatemeh Etemadi, Chengci Chen, William Franck, Thomas Gross, Rebecca Garza, and Calla Kowatch-Crlson

OBJECTIVE: Find the best date and rate of planting for Mung and Adzuki Beans in Montana

MATERIALS AND METHODS:

Irrigated (sprinkler)

| | |
|--------------------------------------|---|
| Location: Sidney, MT | Planted: 05/14/2019 |
| Mung Bean Variety: Organic, L.N. | Harvested: 09/25/2019 |
| Adzuki Bean Variety: Organic, O.R. | Soil type: Clay loam |
| Plot size: 5.5' x 15' | Precipitation April – September 2019 = 21.13" |
| Applied Fertilizer: None | Chemical Applications: Outlook |
| Treatments: | |
| Seeding date 1: 05/20/2019 | |
| Seeding date 2: 05/30/2019 | |
| Seeding rate 1: 8 s/ft ² | |
| Seeding rate 2: 12 s/ft ² | |

RESULTS: Different date of planting caused the significant differences on yield and yield components. Mid-May planting of Mung and Adzuki Beans, better than planting late to produce higher yield. Different Rate of planting did not show significant differences on seed yield. So, planting with higher than 8 plants/ft² does not improve the seed yield. Further study will be conducted with lower seeding rate to optimize the best seeding rate for Mung and Adzuki Beans.

Table 1: Date of planting effect on seed yield and components of Mung Beans

| Treatment (Date of planting) | Seed Yield (lb/ac) | Pod#/Plant | Seed#/Pod | 1000 seed wt. (g) |
|---------------------------------|-----------------------|------------|-----------|----------------------|
| Seeding date 1 | 1656a | 5.9a | 10.9a | 63.4a |
| Seeding date 2 | 1117b | 4.8a | 10.9a | 55.3b |
| Mean | 1387 | 5.4 | 11 | 59.3 |
| CV (%) | 32 | 26.5 | 9.2 | 14.1 |
| LSD (0.05) | 384.4 | 1.2 | 0.8 | 7.1 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

Table 2: Date of planting effect on seed yield and components of Adzuki Beans

| Treatment (Date of planting) | Seed Yield (lb/ac) | Pod#/Plant | Seed#/Pod | 1000 seed wt. (g) |
|---------------------------------|-----------------------|------------|-----------|----------------------|
| Seeding date 1 | 1458a | 6.2a | 7.3a | 84a |
| Seeding date 2 | 1071b | 5.5a | 7.2a | 63b |
| Mean | 1264 | 5.9 | 7.2 | 74 |
| CV (%) | 30.5 | 17.3 | 15.8 | 14.1 |
| LSD (0.05) | 329.3 | 0.9 | 1.0 | 8.9 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

Effect of Fertility and Rhizobium on Mung and Adzuki Beans Nitrogen

Fixation

EARC, Sidney, MT

Fatemeh Etemadi, Chengci Chen, Calla Kowatch-Carlson, Thomas Gross, Rebecca Garza, and William Franck

OBJECTIVE: Testing if combination of fertilizer and rhizobium can increase nitrogen fixation and seed yield of Mung and Adzuki Beans

MATERIALS AND METHODS: Irrigated (sprinkler)
 Mung Bean Variety: Organic, Chemical Applications: Sonalan
 L.N. Precipitation April – September, 2019: 21.13 in.
 Adzuki Bean Variety: Organic, Treatments:
 O.R. (1) 100lb/ac (20-20-20),
 Location: Sidney, MT (2) 100 lb/ac (20-20-20) + 100 lb/ac (46-0-0),
 Planted: 05/14/2019 (3) 100 lb/ac (20-20-20) + 100 lb/ac (46-0-0) + Rhizobium,
 Harvested: 09/25/2019 (4) 100 lb/ac (20-20-20) + Rhizobium,
 Plot Size: 5.5' x 15' (5) Rhizobium
 Seeding Rate: 12 s/ft²
 Soil Type: Clay Loam

RESULTS: At full rate of fertilizer with rhizobium, Mung Beans yield was higher than Adzuki Beans. Applying fertilizer make significant differences among treatments. Applying full fertilizers (100lb/ac of 20-20-20 plus 100lb/ac of 46-0-0) with rhizobium to the seeds, produced the highest seed yield in both Beans following by applying both fertilizer without inoculation, 100 lb of 20-20-20 with inoculation, 100lb of 20-20-20, and just inoculation. It showed that application of just rhizobium is not enough and the combination with fertilizer could produce higher seed yield. The study will be repeated to optimize the fertility needs of Mung and Adzuki Beans.

Table 1: Fertility and Rhizobium effect on seed yield and components of Mung Beans

| Treatment | Seed Yield (lb/ac) | Pod#/Plant | Seed#/Pod | 1000 seed wt. (g) |
|------------|--------------------|------------|-----------|-------------------|
| 1 | 1113c | 6.1b | 11.1b | 66.9b |
| 2 | 1900ab | 7.9a | 11.0b | 83.3a |
| 3 | 2171a | 6.9ab | 13.5a | 85.4a |
| 4 | 1602b | 6.7b | 12.8a | 70.6b |
| 5 | 882c | 3.6c | 8.1c | 49.9c |
| Mean | 1534 | 6 | 11 | 71 |
| CV (%) | 23.4 | 15.2 | 9.7 | 10.2 |
| LSD (0.05) | 321 | 1.1 | 1.3 | 8.7 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.

Table 2: Fertility and Rhizobium effect on seed yield and components of Adzuki Beans

| Treatment | Seed Yield (lb/ac) | Pod#/Plant | Seed#/Pod | 1000 seed wt. (g) |
|------------|--------------------|------------|-----------|-------------------|
| 1 | 1009bc | 6.2c | 6.8a | 75.6ab |
| 2 | 1131ab | 12.2ab | 7.3a | 76.6ab |
| 3 | 1388a | 13.7a | 7.5a | 88.4a |
| 4 | 1053bc | 9.0bc | 7.1a | 76.3ab |
| 5 | 863c | 5.8c | 7.1a | 71.8b |
| Mean | 1089 | 9.4 | 7.2 | 77.8 |
| CV (%) | 33.4 | 36.6 | 11.2 | 15.6 |
| LSD (0.05) | 252.8 | 4.1 | 1 | 14.5 |

Letters in common did not differ significantly according to a t-test at a significance level of 5%.



Dryland and Irrigated Horticultural Crops
Research Update
By: Kyla Splichal

Horticulture in 2019

“If you want to be happy for a lifetime, plant a garden.”
-Chinese proverb

The summer of 2019 is here and gone-just like that. I ask myself every year where did the summer go? But the answer remains: time flies when you're having fun especially with the summer staff who work so hard to make the WREC horticulture gardens and landscapes look their absolute best. In addition to the returning folks, two new staff members joined the horticulture fun, one of which who had the opportunity of working alongside her mother, and the other who followed in her big sister's footsteps. I appreciate their hard work and dedication. I certainly could not do this job without them.

This year's weather patterns have undoubtedly been a lively topic of conversation. Winter began in its usual form with somewhat milder temps and little to no snow fall. It was looking like we were in the clear for any major snow storms-that is until the New Year began. Spring was a welcome relief to western North Dakota after the brutal subzero temperatures, and relentless snowfall events that seemed to never end in the months of January and February. Mother Nature had yet a few more surprises throughout the season, however, with relatively low growing degree days recorded from NDAWN at 2051 from May 1 through October 1 (base of 50), and a record rainfall of 7.9 inches in the month of September- making harvest extremely difficult to impossible for farmers in the region.

All-America Selection Garden

This year, we planted 20 different varieties of All-America Selection flowers and nearly 50 vegetable varieties. Due to the low growing degree days, some of the vegetables performed under par compared to others, but all in all over 700 pounds of produce was collected from the garden. WREC has been a public display garden for nearly a decade and each season keeps us looking forward to the selections in which AAS has deemed winners and top performers in their class. Keep All-America Selections in mind as you begin receiving seed catalogs for next year's garden. Visit their website for more cultivar information as well as recipes and landscape ideas-you won't be disappointed!

<https://all-americanselections.org/>

Haskap

Haskap, also known as the Honeyberry (*Lonicera caerulea*) is an edible fruiting shrub belonging to the Honeysuckle family. The fruits are unique in that they are oval to oblong shaped, and bluish to purple in color. In the early 2000's, several cultivars have come out of two primary breeding programs, Dr. Bob Bors with the University of Saskatchewan and Dr. Maxine Thompson with Oregon State University, and are now available to home gardeners (See Table 1 for WREC cultivar trial information).

Haskap flowers are not self-compatible and do require a pollinator or companion plant in order to outcross and set fruit. In most cases the breeders have produced and released cultivars in pairs or series. See Table 1. Pollination information to see which cultivars coordinate with one another in the WREC trials.

Hops

The hop research program was started in 2014 as a result of a Specialty Crop Block Grant (SCBG) award to conduct a variety trial. In the fall of 2016, WREC was awarded a continuation SBCG to look at management practices on the established hop yards. Early, mid and late spring stringing dates were evaluated in 2017-2018. The 2019 growing season marked the 5th year of hops research through NDSU. The 5 year trend in overall yield can be found in in Figure 1. Significant differences were shown in all three effects, cultivar, year and cultivar by year interaction (Table 2.).

The stringing trial was conducted in 2017 and 2018 which impacted yields in those years. The overall trend in 2017 appears to be a reduction in yields with the exception of the cultivars 'Zeus' and 'Galena'. (Figure 1.). The cultivars with the lowest overall yields in 5 years were 'Mt. Hood' and 'Spalt Select' (Table 3.).

Master Gardener Pollinator Garden

Williams County and WREC received additional funds through the Extension Master Gardener Pollinator Garden Grants for the continued maintenance of the garden. This year we planted a 'Red Splendor' Crabapple tree. The purpose of these gardens is to provide Master Gardeners with volunteer opportunities, build a habitat that will nourish pollinators, and create a public teaching garden that can be jointly utilized by Master Gardeners and Extension Agents to encourage members of the general public to build home pollinator gardens.

Tree Trial

Under the direction of Dr. Todd West with the NDSU Woody Plant Improvement program, Williston REC and the cities of Dickinson, Bismarck, Minot and Williston received funding from a USDA Specialty Crop Block Grant to study the hardiness of commercially available tree species which may or may not be suitable for planting in western North Dakota. In the spring of 2016, '17 and '18, WREC along with the NDSU Woody Plant research team planted a total of 50 different tree species as part of the Western Tree Trial. The 2016 trial was planted at the WREC, while the 2017 and '18 trials were planted at Nesson Valley.

The purpose of this project is to provide updated tree species and/or cultivar information to North Dakota commercial nursery crop producers and retailers by evaluating potential woody species to enhance, diversify and increase the inventory of usable landscape plants for USDA hardiness zones 3-4. This trial will also help enhance and expand the North Dakota Tree Selector website (<http://www.ag.ndsu.edu/tree-selector/>). See Table 4 for species and cultivar information.

High Tunnel

In the fall of 2017, WREC along with NDSU High Value Crop Specialist, Dr. Harlene Hatterman-Valenti and Extension Horticulturist, Dr. Esther McGinnis were awarded a USDA Specialty Crop Block Grant through the North Dakota Department of Ag to look at high tunnels for season extension. One of the objectives was to evaluate how far Northern growers could go into the off-season using appropriate vegetable crops. Crops chosen for this research were spinach and kale cultivars for the off season (early spring and late fall) and beans and basil cultivars for the regular growing season (summer). Frost preventative tools such as low tunnel row covers and soil heating cables were used to evaluate the environmental influences on each crop. Data from this trial is being collected and will be evaluated at the conclusion of the study.

Table 1. Williston haskap cultivar trial information

| Cultivar name | Avg. berry size ^g | | Flavor | Bloom time | Ancestry Country of origin | Breeder | Pollination information |
|----------------------|------------------------------|-------------|-------------|------------|-------------------------------|---------------------|--|
| | | | | | | | |
| Aurora | 2.2 | Sweet | Sweet | Early-mid | Japan/Russia | BB ¹ | Pollinator for Borealis, Tundra, Indigo varieties |
| Berry Smart Blue | 0.8 | Tart/sweet | Tart/sweet | Mid-Late | Russia | Jim Gilbert | Pollinates "Indigo" varieties |
| Boreal Beauty | 2.6 | Sweet | Sweet | Mid-Late | Japan/Russia/Kurile | BB | Pairs with other "Boreal" varieties |
| Boreal Blizzard | 2.8 | Sweet | Sweet | Mid-Late | Japan/Russia | BB | Pairs with other "Boreal" varieties |
| Indigo Gem | 1.3 | Sweet/tangy | Sweet/tangy | Early | Japan/Russia/Kurile | BB | Needs a pollinator like Berry Smart Blue or Honeybee |
| Indigo Treat | 1.4 | Sweet | Sweet | Early | Japan/Russia/Kurile | BB | Needs a pollinator like Berry Smart Blue or Honeybee |
| Sugar Mountain® Blue | -- | Sweet | Sweet | Early | Czech Republic | Frantisek Krejci | Pairs with Sugar Mountain®Eisbar |
| Eisbar | -- | Sweet/tangy | Sweet/tangy | Early | Czech Republic | Kordes Jungpflanzen | Pairs with Sugar Mountain®Blue |
| Yesberry®Solo | 1.8 | Sweet/tangy | Sweet/tangy | Late | Japan | MT ² | Pairs with Maxie or other Yesberry® variety |
| YesBerry®Honey Bunch | 1.6 | Sweet | Sweet | Late | Japan | MT | Pairs with other Yesberry® variety |
| Yesberry® Maxie | 2.0 | Sweet/tangy | Sweet/tangy | Late | Japan | MT | Pairs with Solo or other Yesberry® variety |
| Yesberry® Sugar Pie | 1.8 | Sweet | Sweet | Late | Japan | MT | Pairs with other Yesberry® variety |

¹BB = Dr. Bob Bors-University of Saskatchewan breeding program

²MT = Dr. Maxine Thompson- Oregon State University

Table 2. P values for 5 year mean yield of hop trial conducted from 2015-2019.

| Effect | df | Yield | ---Probability > F--- |
|-----------------|----|-------|-----------------------|
| Cultivar | 11 | | 0.0001 |
| Year | 4 | | 0.0153 |
| Cultivar * year | 44 | | <.0001 |

Table 3. Williston hop trial cultivar information.

| Cultivar | Origin ¹ | Brew Usage ² | Typical Beer Style | Typical Alpha Acid Ranges | 2018 Tested Alpha Acid ³ | 2018 Harvested Moisture | 2018 Hop Storage Index ⁴ | Yield 5 year Avg. |
|---------------|---------------------|-------------------------|--------------------|---------------------------|-------------------------------------|-------------------------|-------------------------------------|-------------------|
| | | | | g/plant | | | | |
| Brewer's Gold | UK | B | Ale | 8-10 | 3.3 | 74 | 0.22 | 1249 |
| Cascade | DM | A | American Pale Ale | 5-7 | 5.0 | 75 | 0.34 | 1080 |
| Centennial | DM | D | American Pale Ale | 9.5-11 | 8.1 | 73 | 0.25 | 1037 |
| Challenger | UK | D | English Ale | 6.5-9 | 6.2 | 79 | 0.20 | 1869 |
| Galena | DM | B | English Ale | 10-15 | 6.7 | 77 | 0.10 | 1831 |
| Glacier | DM | D | American Pale Ale | 5.5 | 2.6 | 77 | 0.16 | 933 |
| Mt. Hood | DM | A | Lager | 4-7 | 2.2 | 74 | 0.17 | 450 |
| Newport | DM | B | Barley Wine | 13-17 | 6.2 | 78 | 0.24 | 940 |
| Nugget | DM | B | Barley Wine | 12-14 | 9.1 | 71 | 0.21 | 958 |
| Spalt Select | GE | A | Bock | 3-6.5 | 2.7 | 73 | 0.26 | 423 |
| Willamette | DM | A | English Style Ale | 4-6 | 2.9 | 76 | 0.28 | 774 |
| Zeus | DM | B | Pale Ale | 20 | 3.0 | 78 | 0.15 | 1924 |

¹DM = Domestic, UK = United Kingdom, GE = German as reported by Hopunion LLC.

²A = Aroma, B = Bittering, D = Dual purpose as reported by Hopunion LLC.

³Alpha acids adjusted to 10% moisture by sample weight. Missing values indicates insufficient sample size.

⁴HSI is a non-dimensional number calculated by measuring the adsorption of an alkaline methanolic hop extract at two different wavelengths using UV spectrophotometric analysis. Normal range is from 0.25 for fresh hops and 2.5 for fully oxidized hops.

Figure 1. Hop cultivar average yields over five years

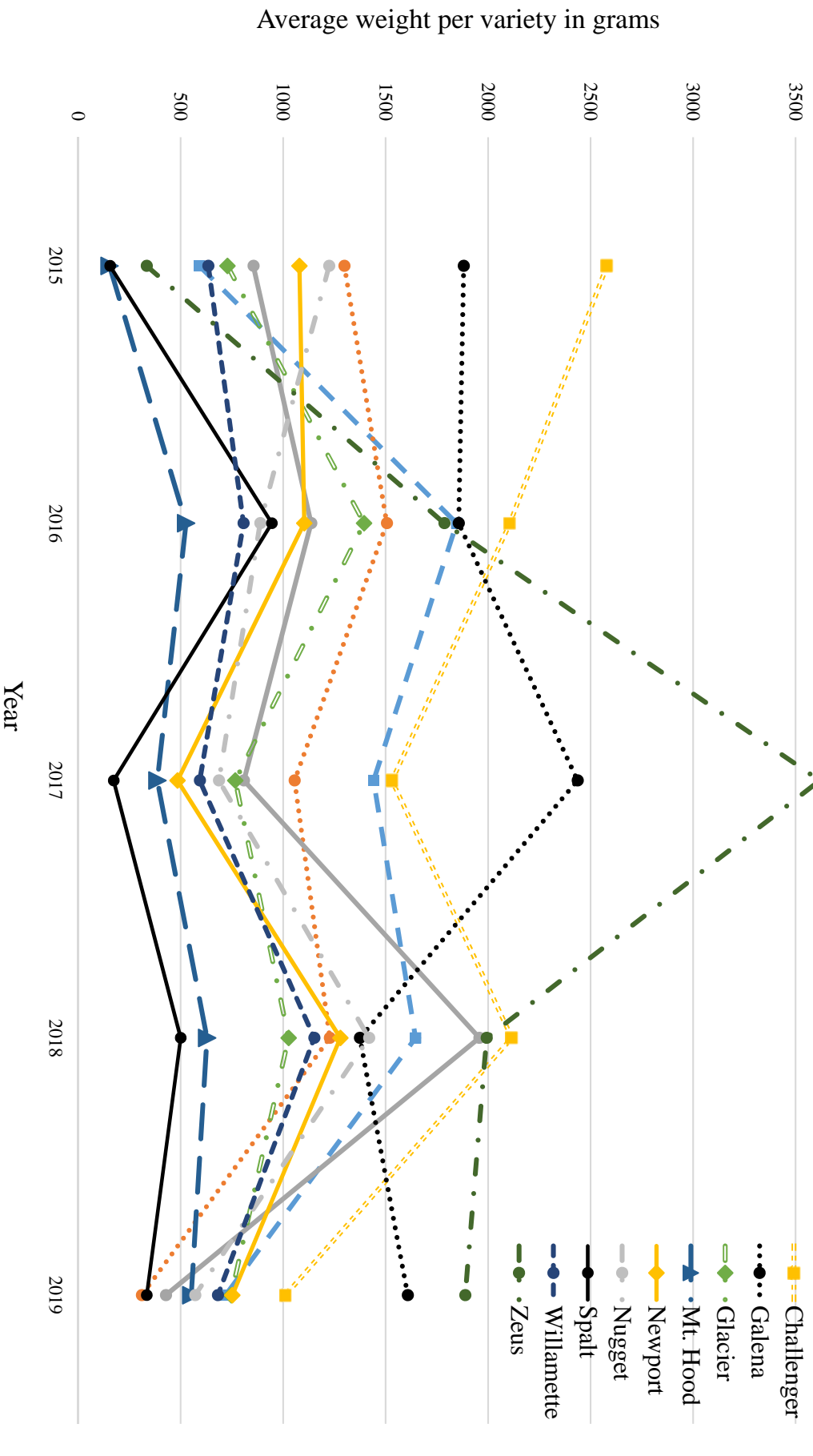


Table 4. Western Tree Trial cultivars

(*) Indicates survival as of summer 2019

Maples:

Commemoration® sugar maple
Fall Fiesta® sugar maple
Firefall™ freeman maple*
Hot Wings® Tartarian maple*
Northwood red maple
Princeton Gold® Norway maple
Red November™ Amur maple*
Royal Red Norway maple
Silver Queen silver maple*
Unity® sugar maple

Elms:

New Horizon hybrid elm*
Patriot elm*
Prairie Expedition® elm*
Princeton American elm*
Valley Forge American elm*

Oak:

Chinkapin oak
Crimson Spire® hybrid oak
Majestic Skies™ northern pin oak*
Prairie Stature™ hybrid oak
Regal Prince® hybrid oak
Swamp white oak*
Urban Pinnacle® bur oak

Crabapple:

Red Baron crabapple*
Gladiator™ crabapple*
Ivory Spear™ crabapple*
Marilee® crabapple*
Pink Spires crabapple*

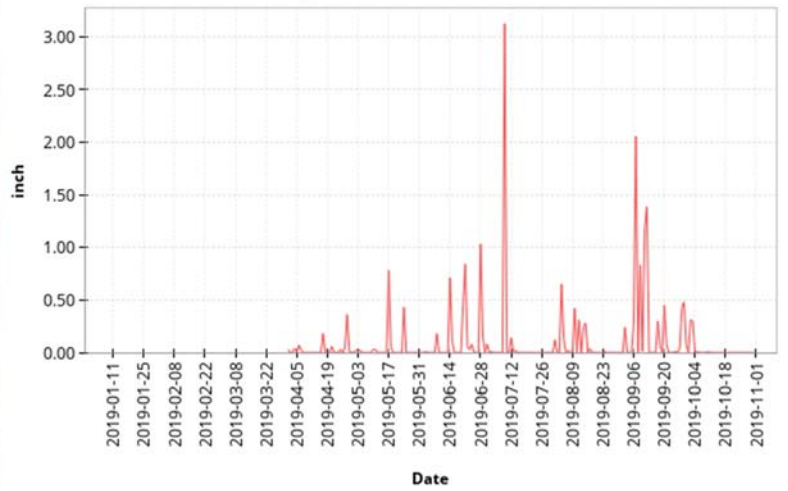
Other species:

Mountain Sentinel® aspen*
Prairie Gold® aspen*
Prairie Dream® paper birch*
Purple Robe black locust
Homestead buckeye
Sutherland caragana*
Heartland® catalpa
Espresso™ Kentucky coffee tree
Eye Stopper™ cork tree phellodendron*
His Majesty™ cork tree phellodendron
Autumn Gold ginko biloba
Prairie Sentinel® hackberry*
Northern Acclaim® honeylocust*
Street Keeper® honeylocust
Ivory Pillar™ Japanese tree lilac*
Boulevard American linden
Harvest Gold Mongolian linden
Amur maackia
MaacNificent® maackia*
Ironwood (Ostrya)
Mountain Frost® pear
Spring Wonder™ Sargent cherry*



1

Total Rainfall
(2019-01-01 - 2019-11-07)
North Dakota Agricultural Weather Network (NDAWN)



2



7



5



6



3



4

Photos from top right clockwise: 1. 2019 Horticulture staff from left to right: back row Corynna Turnquist, Tayder Jones and Ann Reinke. Front row Rojee Pradhan, Kyla Splichal and Grisha Pradhan; 2. Summarization of rain fall Williston; 3. All-America Selections display; 4. High tunnel at Nesson Valley; 5. Haskap berries; 6. Hop cones; 7. Summer staff in action.

WREC Foundation Seed Increase Update

NDSU Williston Research Extension Center

Kyle Dragseth, David Weltikol, Kelly Stehr, and Jerry Bergman

Well another year came and went and the future outlook for agriculture is shaky at best. With input prices rising and commodity prices hanging at the lowest prices in decades, there isn't a lot of optimism in the industry. However, we can help here at the Williston Research Extension Center. NDSU prides itself on truly caring about the state Ag economy and individual producers profitability. That is why NDSU has released 2 new durum varieties, ND Riveland & ND Grano, both with outstanding yields, low cadmium uptake, good quality, and good straw strength. ND Riveland had the highest yields and lowest Fusarium head blight and DON accumulation in variety testing plots across the state.

Another big way in which NDSU is striving to help producers is by releasing 2 glyphosate tolerant soybean varieties. ND17009GT is a 00.9 maturity, high yield potential, and is the first soybean variety where you can keep your own seed and replant it following years. By allowing this not only is your seed cost the first year on average 30% cheaper than private industry varieties, every year thereafter is just the cost to clean your own seed. So thanks to NDSU the input costs for soybean production is considerably cheaper than the private industry. Which really helps with the current downtrend in soybean prices and to make them profitable further west is drier climates.

There is also a new NDSU chickpea (Crown) and a new NDSU yellow pea on the horizon for availability in 2021.

Listed below are the varieties available for sale. Please contact either the WREC at 701-774-4315 or Kyle Dragseth at 701-770-1652 with any questions, availability, and prices.

| <u>HRWW</u> | <u>HRSW</u> | <u>Durum</u> | <u>Soybeans</u> | <u>Lentils</u> | <u>Peas</u> | <u>Oats</u> |
|-------------|-------------|--------------|-----------------|----------------|-----------------|-------------|
| Ray | Bolles | ND Riveland | ND17009GT | Avondales | Hampton (green) | Paul |
| | ND Vit-pro | ND Grano | | | | |
| | Lanning | Lebsock | | | | |
| | Mott | Carpio | | | | |
| | | Tioga | | | | |
| | | Divide | | | | |

The Capital Campaign

Invest in the Future of Agriculture

Seed Conditioning Facility

A \$1.5M capital fundraising campaign has been authorized by the North Dakota Legislative Assembly to fund construction of a new larger capacity seed conditioning facility with modern seed cleaning technology. A larger capacity horizontal handling and seed cleaning system with optical sorting technology is needed to condition and distribute pure seed of new value-added small grain, pulse crop, oilseed, and other specialty crop varieties for our North Dakota and Montana producers.

The current antiquated 5 floor seed conditioning facility at WREC, built in 1954, is the oldest and most outdated seed cleaning facility at the Research Extension Centers. This seed conditioning plant cleans only 35 bushels per hour, and is not suitable for cleaning pulse crops and other fragile seeds that require gentle handling and horizontal seed cleaning equipment and lines. New and improved varieties offer producers opportunities to increase profitability and enhance soil health.

A new seed conditioning facility with 200 bushel per hour capacity, optical sorter technology, and horizontal equipment layout is paramount to enable WREC to provide ample quality seed of new crop varieties to ag producers on a timely basis and transfer the economic and environmental benefits to our producers in North Dakota and Montana.

Multi-Use Greenhouse Facility

The North Dakota Legislative Assembly recently authorized WREC to proceed with a \$400,000 fundraising campaign for a WREC greenhouse. The 3,700 sq. ft. facility will include a 37' x 100' greenhouse, (2) zones/environments, ventilation system, evaporative cooling system, rolling benches 5' x 45', and crop lighting.

A WREC greenhouse facility will allow 1) the horticultural staff to conduct research on greenhouse crop production of fruits and vegetables 2) our plant pathologist to conduct new types of applied plant pathology research and fungicide efficacy testing 3) allow agronomic greenhouse studies on seed/seedling quality and plant.

The Capital Campaign Wall of Honor will be displayed in the entrance of the Ernie French Center

| | |
|--------------------|-------------------|
| <i>Leadership</i> | \$25,000+ |
| <i>Major</i> | \$15,000-\$24,999 |
| <i>Special</i> | \$10,000-\$14,999 |
| <i>Patron</i> | \$5,000-\$9,999 |
| <i>Contributor</i> | \$1,000-\$4,999 |
| <i>Supporter</i> | \$100-\$999 |

Your gift to the seed conditioning plant facility and/or a greenhouse facility campaign is an investment in the economic improvement of agricultural crop for western North Dakota and eastern Montana. Anyone wishing to contribute is invited to contact the Williston Research Extension Center.

Checks should be made payable to the NDSU Development Foundation with the memo 'WREC Capital Campaign.' Contributions to the Development Foundation are deductible under Sections 170 (c) and 501 (c) (3) of the Internal Revenue Code.

Williston Research Extension Center
14120 Highway 2
Williston, ND 58801 119

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Upcoming Events for 2020

| | |
|---------------------|---|
| January 14 | Diversity Direction & Dollars – Ramada Grand Dakota Lodge – Dickinson |
| January 27–28 | Northern Pulse Growers Assn. (NPGA) Annual Convention – Riverside Holiday Inn – Minot |
| January 29–31 | Ag Expo–North Dakota State Fair Center – Minot |
| February 4-5 | Montana Soil Health Symposium – Billings, MT |
| February 11–12 | Agri International Trade Show – Bismarck Event Center – Bismarck |
| February 13 | National Hard Spring Wheat Show – Raymond Center – Williston |
| February 14 | Best of the Best in Wheat Production in the West – Clarion Hotel – Minot |
| February 14 -15 | GATE – Eastern Plains Event Center – Glendive |
| February 19 | MonDak Pulse Day – Elks Club – Glasgow, MT |
| February 28 | 2020 NDFMGA & Local Foods Conference – Baymont Inn & Suites–Mandan |
| March 12–13 | MonDak Ag Days – Richland County Event Center – Sidney |
| March 10–11 | Western Crop/Pest Management School – Dickinson, ND |
| March 17–18 | KATQ Northeast Montana Farm Expo – Plentywood |
| June 23 | MSU–EARC & Sidney ARS Dryland Field Day – Sidney |
| June 25 | Northern Ag Research Center Field Day – Havre |
| June 24–28 | UMVF – Williston |
| June 30 | Southern Ag Research Center Field Day – Huntley |
| TBD | Dickinson Research Extension Center Field Day – Dickinson |
| July 8 | Williston Research Ext. Center Field Day (4:00 p.m.) – Williston |
| July 9 | Nesson Valley Irrigation Field Day – Nesson Valley |
| July 9 | Northwestern Ag Research Center Field Day – Kalispell |
| July 10 | Hettinger Research Extension Center Field Day – Hettinger |
| July 13 (estimated) | Agronomy Seed Farm Field Days – Casselton |
| July 14 | MSU Central Ag Research Center Field Day – Moccasin |
| July 14 (estimated) | Carrington Research Extension Center Field Days – Carrington |
| July 15 | North Central Research Extension Center Field Day – Minot |
| July 16 | MSU Eastern Ag Research Center Field Day – Sidney |
| July 16–17 | MT DRC Summer Conference at MSU–EARC – Sidney |
| July 18 | Langdon Research Extension Center Field Day – Langdon |
| July 22–30 | North Dakota State Fair – Minot |
| July 30 | Western Ag Research Center Field Day – Corvallis |
| August 5–8 | Richland County Fair |
| October 12 | Northeast Montana Ag Expo–Valley Event Center – Glasgow |

MSU-EARC FACULTY & STAFF—2019



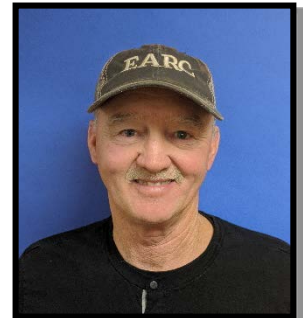
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