# 2023 Agricultural Research Update

## NDSU Williston Research Extension Center

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## MSU Eastern Agricultural Research Center

**Serving the MonDak Region**

**Regional Report No. 29 ï December 2023**

# NDSU-WREC FACULTY & STAFF - 2023

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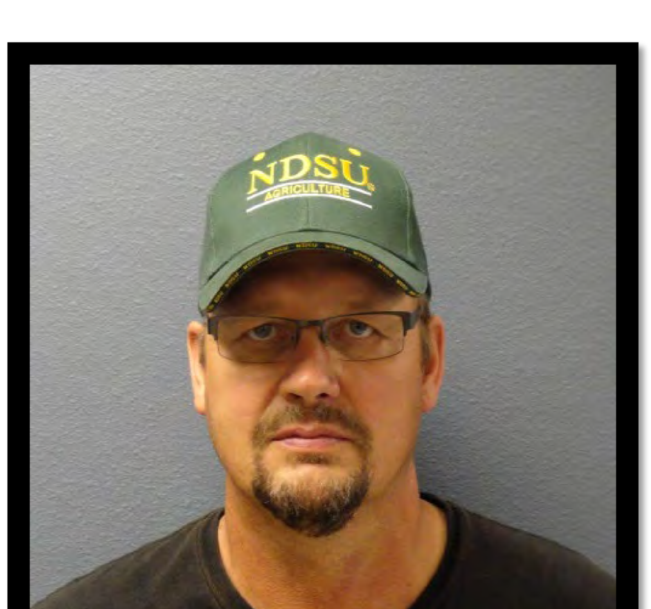

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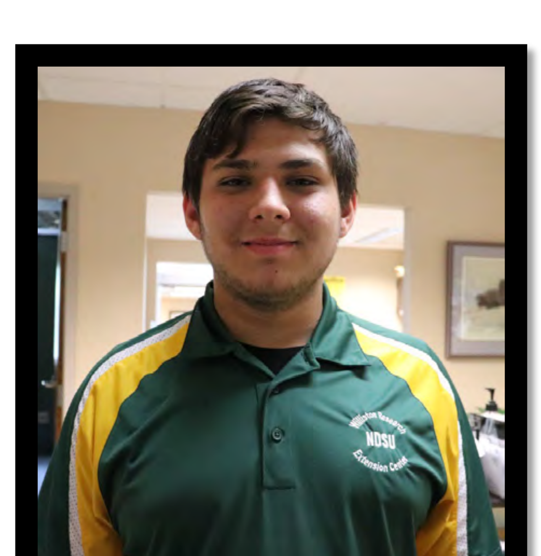

Gabe Hobbs
Part-Time Technician

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Irrigation Research Technician

NDSU | WILLISTON RESEARCH EXTENSION CENTER

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# Weather Information

## Weather Summary — Williston, ND

| Month | Precipitation 2023 | Precipitation Avg | Temperature 2023 | Temperature Avg | * |
|---|---|---|---|---|---|
| | - inches - | | - degrees F - | | # |
| Oct-Dec 2022 | 2.88 | 1.77 | | | |
| January-March | 0.93 | 1.18 | | | |
| April | 0.80 | 1.16 | 40. | 43.9 | 0 |
| May | 2.90 | 2.20 | 62. | 56.0 | 0 |
| June | 1.41 | 2.69 | 69. | 64.9 | 4 |
| July | 1.86 | 2.23 | 71. | 71.4 | 7 |
| August | 2.76 | 1.55 | 71. | 70.2 | 6 |
| September | 1.87 | 1.40 | 64. | 59.5 | 2 |
| April-July | 6.97 | 8.28 | | | |
| April-Sept | 11.6 | 11.23 | | | |
| Total- Oct 22-Sept | 15.41 | 14.19 | | | |

*Number of Days over 89° F
Last Spring Frost – April 30, 2023 (28.2° F)
First Fall Frost – October 6, 2023 (31.0° F)

## Weather Summary — Sidney, MT

| Month | Precipitation 2023 | Precipitation Avg | Temperature 2023 | Temperature Avg | * |
|---|---|---|---|---|---|
| | - inches - | | - degrees F - | | # |
| Oct-Dec 2022 | 3.04 | 1.01 | | | |
| January-March | 0.10 | 0.03 | | | |
| April | 0.31 | 1.12 | 40.4 | 44.2 | 0 |
| May | 3.47 | 2.21 | 60.4 | 56.0 | 0 |
| June | 1.38 | 2.68 | 68.2 | 64.7 | 3 |
| July | 1.20 | 2.03 | 69.0 | 70.2 | 8 |
| August | 2.77 | 1.45 | 70.0 | 68.8 | 8 |
| September | 1.12 | 1.35 | 62.5 | 58.2 | 3 |
| April-July | 6.36 | 8.04 | | | |
| April-Sept | 10.25 | 10.84 | | | |
| Total- Oct 22-Sept 23 | 13.39 | 11.88 | | | |

*Number of Days over 89° F
Last Spring Frost – May 2, 2023 (28.9° F)
First Fall Frost – October 6, 2023 (31.5° F)

## Off-Station Precipitation** North Dakota

| Site | April | May | June | July | Aug | Total |
|---|---|---|---|---|---|---|
| Nesson | 0.52 | 2.90 | 2.02 | 1.65 | 2.59 | 9.68 |

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

## Off-Station Precipitation** Montana

| Site | April | May | June | July | Aug | Total |
|---|---|---|---|---|---|---|
| Dagmar | 0.51 | 1.94 | 1.65 | 1.94 | 1.10 | 7.14 |
| Fallon | 0.88 | 3.05 | 5.60 | 0.28 | 2.89 | 12.70 |
| Geraldine | 2.31 | 1.95 | 3.23 | 0.24 | 0.38 | 8.11 |
| Poplar | 0.91 | 3.89 | 2.19 | 0.53 | 2.24 | 9.76 |
| Richland | 0.69 | 1.57 | 2.26 | 2.35 | 0.86 | 7.73 |

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

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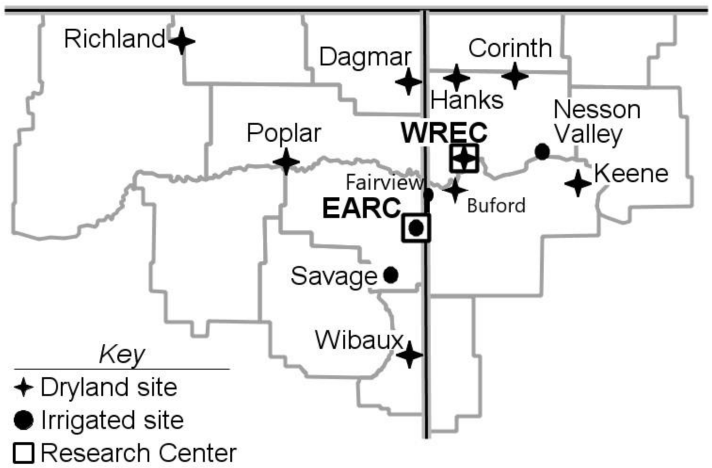
NDSU North Dakota State University ND Agricultural Experiment Station
NDSU Extension Service North Dakota State University
MONTANA STATE UNIVERSITY Montana Agricultural Experiment Station
MONTANA STATE UNIVERSITY EXTENSION

# Off-Station Cooperators ï Producers ï CES Agents

**<u>MONTANA</u>**
**SMALL GRAIN--PULSES:**
Poplar - Mark Swank - Agent Wendy Becker
Richland - Richard Fulton - Agent Shelley Mills

**<u>NORTH DAKOTA</u>**
**SMALL GRAIN:**
Trenton – Ken Kjos – Agent Kelly 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.

# Irrigation Research Disclosure - WREC

## Nesson Valley Irrigation Research and Development Project 2023

As I am sure most are aware that on August 1, 2023, a devastating storm ripped through the Nesson Valley and destroyed all the research on the 160-acre farm. All variety trial data and research projects were completely destroyed in this storm and not one project was salvaged. The variety trials did consist of a few new varieties but unfortunately there will be no data for these and if you are looking for irrigated data on variety trials, please refer to the 2022 Ag Research Update Report No. 28. The Eastern Ag Research Center will have some irrigated data in this 2023 update. As all of us know Mother Nature rules, and the NVIRDP looks forward to providing data to the region again in 2024.

# Spring Wheat Variety Descriptions

| Variety | Origin[1] | Year Released | DTH[2] (DAP) | Height[2] (in) | Resistance To[3] | | | | | | Quality Factors[2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lodging | Stem Rust | Leaf Rust | Foliar Disease | Bac. Leaf Streak | Head Scab | Test Weight | Grain Protein |
| AAC Starbuck VB* | Canada | 2020 | 50 | 23 | 4 | 1 | 6 | NA | 6 | 5 | 59.5 | 16.2 |
| AP Gunsmoke CL2 | Syngenta/Agripro | 2021 | 50 | 22 | 6 | 2 | 3 | 4 | 8 | 5 | 57.9 | 16.7 |
| AP Murdock | Syngenta/Agripro | 2019 | 50 | 22 | 4 | 2 | 5 | 4 | 6 | 6 | 58.1 | 16.3 |
| AP Smith | Syngenta/Agripro | 2021 | 52 | 19 | 2 | 1 | 3 | 3 | 5 | 6 | 58.4 | 16.1 |
| AR3530 | Armor Brand/Croplan | 2015 | 49 | 26 | 7 | 2 | 5 | NA | 5 | 6 | 59.1 | 14.7 |
| AR3915 | Armor Brand/Croplan | 2019 | 48 | 23 | 4 | NA | 2 | NA | 5 | 4 | 59.9 | 15.8 |
| Ascend-SD | SD | 2022 | 49 | 26 | 5 | 2 | 4 | NA | 5 | 4 | 58.4 | 14.3 |
| Bolles | MN | 2015 | 56 | 26 | 4 | 2 | 2 | 4 | 6 | 6 | 57.8 | 17.1 |
| Brawn-SD | SD | 2022 | 48 | 22 | 4 | NA | 2 | NA | 4 | 4 | 60.7 | 13.9 |
| CAG-justify | Champions Alliance Grp | 2021 | 52 | 22 | 6 | 2 | 2 | 5 | 6 | 5 | 56.7 | 15.5 |
| CAG-reckless | Champions Alliance Grp | 2021 | 51 | 23 | 5 | 2 | 2 | 6 | 6 | 5 | 58.3 | 15.1 |
| CDC Landmark VB | Canada | 2018 | 49 | 25 | 4 | NA | 5 | NA | 6 | 6 | 60.3 | 15.5 |
| CP3099a | Croplan | 2020 | 55 | 22 | 5 | 6 | 3 | 4 | 7 | 6 | 56.0 | 13.8 |
| CP3119a | Croplan | 2020 | 57 | 22 | 3 | NA | NA | 6 | 5 | 3 | 54.2 | 13.8 |
| CP3188 | Croplan | 2020 | 51 | 23 | 8 | 6 | 2 | 6 | 7 | 5 | 57.5 | 14.0 |
| CP3322 | Croplan | 2023 | 54 | 25 | 3 | NA | 3 | NA | 4 | 6 | 60.1 | 12.7 |
| Driver | SD | 2020 | 53 | 24 | 4 | 2 | 1 | 7 | 7 | 4 | 60.1 | 15.6 |
| Elgin-ND | NDSU | 2012 | 53 | 26 | 5 | 2 | 6 | NA | 7 | 5 | 57.7 | 16.2 |
| Glenn | NDSU | 2005 | 51 | 26 | 4 | 2 | 6 | 6 | 5 | 4 | 60.7 | 15.8 |
| Lang-MN | MN | 2017 | 54 | 24 | 4 | 2 | 2 | NA | 5 | 3 | 58.1 | 16.6 |
| Lanning | MT | 2017 | 53 | 23 | 3 | 2 | 7 | 4 | 5 | 6 | 59.6 | 15.4 |
| LCS Ascent | Limagrain | 2022 | 46 | 24 | 4 | 2 | 6 | NA | 7 | 4 | 59.9 | 13.7 |
| LCS Boom | Limagrain | 2023 | 47 | 23 | 4 | NA | 6 | NA | 6 | 7 | 60.6 | 14.6 |
| LCS Buster | Limagrain | 2020 | 55 | 22 | 4 | 1 | 4 | 4 | 4 | 4 | 57.2 | 14.2 |
| LCS Cannon | Limagrain | 2018 | 48 | 22 | 4 | 1 | 7 | 5 | 7 | 6 | 61.4 | 15.9 |
| LCS Dual | Limagrain | 2020 | 48 | 25 | 4 | 2 | 6 | NA | 7 | 6 | 59.3 | 13.4 |
| LCS Hammer AX | Limagrain | 2022 | 47 | 24 | 4 | 2 | 6 | NA | 7 | 6 | 58.8 | 13.7 |
| LCS Trigger | Limagrain | 2016 | 58 | 23 | 5 | 6 | 1 | 4 | 4 | 3 | 57.8 | 15.0 |
| MN-Rothsay | MN | 2022 | 51 | 22 | 3 | 2 | 6 | NA | 5 | 5 | 58.8 | 13.8 |
| MN-Torgy | MN | 2020 | 52 | 23 | 4 | 2 | 3 | 3 | 5 | 4 | 59.6 | 15.9 |
| MS Charger | Meridian Seeds | 2022 | 47 | 24 | 7 | 2 | 2 | NA | 7 | 5 | 59.3 | 12.4 |
| MS Cobra | Meridian Seeds | 2022 | 50 | 21 | 4 | 1 | 2 | 4 | 7 | 5 | 59.2 | 16.1 |
| MS Ranchero | Meridian Seeds | 2020 | 53 | 23 | 5 | 2 | 4 | 5 | 5 | 6 | 58.6 | 15.5 |
| ND Frohberg | NDSU | 2020 | 51 | 23 | 4 | 2 | 5 | 8 | 5 | 5 | 59.2 | 16.7 |
| ND Heron | NDSU | 2022 | 50 | 23 | 6 | 1 | 7 | NA | 7 | 4 | 60.2 | 16.6 |
| ND Thresher | NDSU | 2023 | 50 | 21 | 4 | 2 | 4 | NA | 4 | 4 | 58.7 | 15.0 |
| ND VitPro | NDSU | 2017 | 53 | 25 | 4 | 2 | 4 | 6 | 6 | 4 | 59.2 | 16.6 |
| PFS Buns | Peterson Farm Seeds | 2021 | 59 | 20 | 4 | 1 | 2 | NA | 4 | 6 | 56.5 | 15.0 |
| Shelly | MN | 2016 | 54 | 23 | 4 | 2 | 6 | 3 | 7 | 5 | 58.9 | 14.8 |
| SY 611 CL2 | Syngenta/Agripro | 2019 | 52 | 21 | 3 | 2 | 6 | 4 | 6 | 5 | 60.0 | 16.1 |
| SY Ingmar | Syngenta/Agripro | 2014 | 53 | 23 | 2 | 2 | 3 | 6 | 6 | 6 | 58.8 | 16.0 |

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| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SY Longmire | Syngenta/Agripro | 2019 | 52 | 23 | 5 | 2 | 6 | 4 | 6 | 6 | 60.1 | 16.4 |
| SY Mccloud | Syngenta/Agripro | 2019 | 52 | 23 | 4 | 2 | 5 | 7 | 7 | 6 | 61.0 | 16.6 |
| SY Valda | Syngenta/Agripro | 2015 | 53 | 23 | 4 | 2 | 2 | 7 | 6 | 5 | 58.3 | 15.4 |
| TCG-Heartland | 21st Century Genetics | 2019 | 51 | 22 | 3 | 2 | 3 | 4 | 7 | 6 | 60.6 | 16.6 |
| TCG-Spitfire | 21st Century Genetics | 2015 | 55 | 22 | 3 | 2 | 5 | 6 | 5 | 6 | 58.4 | 15.6 |
| TCG-Teddy | 21st Century Genetics | 2023 | 49 | 19 | 3 | NA | 4 | NA | 5 | 6 | 59.2 | 15.1 |
| TCG-Wildcat | 21st Century Genetics | 2020 | 53 | 21 | 3 | 2 | 5 | 6 | 7 | 6 | 59.4 | 15.5 |
| WB9590 | Westbred | 2017 | 48 | 22 | 3 | 2 | 3 | 8 | 8 | 7 | 59.7 | 14.2 |
| WB9606 | Westbred | 2020 | 50 | 24 | 4 | NA | 4 | NA | 6 | 6 | 60.9 | 14.3 |
| WB9719 | Westbred | 2018 | 55 | 23 | 4 | NA | 5 | NA | 5 | 6 | 60.1 | 16.2 |

[1]Refers 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.

[2]DTH - Days to head recorded as days after planting, plant height, and quality data are averaged over a period ranging from a single year to nine years. The duration depends on the number of years a specific variety is included into the WREC trial from 2015 onward.

[3]Resistance scores from 1-9, with 1 = resistant and 9 very susceptible, NA = not available. *VB = Variety Blend.

| **Spring Wheat Dryland Variety Trial - NDSU** | | | | | | | | | **WREC, Williston, ND 2023** |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Yield** | | |
| **Variety** | **Days to Head** (DAP+) | **Plant Height** (in) | **Lodging** (0 - 9*) | **Protein†** (%) | **Moisture‡** (%) | **Test Weight** (lb/bu) | **2023¥** (bu/a) | **2-Yr Avg** (bu/a) | **3-Yr Avg** (bu/a) |
| CP3188 | 50 | 24.0 | 0 | 13.1 | 8.8 | 58.3 | 35.3 | 37.3 | 31.0 |
| CAG-Reckless | 50 | 26.0 | 0 | 13.3 | 9.3 | 57.1 | 36.1 | 36.1 | 31.0 |
| SY611CL2 | 50 | 22.8 | 0 | 14.4 | 9.2 | 61.4 | 40.9 | 38.6 | 31.0 |
| CP3119A | 54 | 24.7 | 0 | 13.5 | 9.3 | 56.3 | 34.2 | 35.6 | 30.5 |
| Lanning | 50 | 23.0 | 0 | 14.1 | 9.6 | 59.7 | 34.1 | 34.4 | 30.1 |
| Driver | 51 | 26.9 | 0 | 13.8 | 8.1 | 61.0 | 38.9 | 35.5 | 30.0 |
| SY Longmire | 49 | 21.8 | 0 | 15.0 | 7.7 | 60.2 | 34.3 | 36.2 | 30.0 |
| CP3099A | 53 | 24.5 | 0 | 12.9 | 8.7 | 57.8 | 34.4 | 34.5 | 29.6 |
| AP Gunsmoke CL2 | 49 | 23.4 | 0 | 15.1 | 8.4 | 58.6 | 37.4 | 36.1 | 29.5 |
| TCG-Spitfire | 51 | 21.9 | 0 | 14.2 | 9.4 | 60.2 | 27.7 | 33.2 | 28.4 |
| MN-Torgy | 49 | 23.5 | 0 | 14.5 | 8.2 | 60.3 | 30.8 | 33.4 | 27.7 |
| AR 3530 | 49 | 26.0 | 0 | 14.7 | 8.1 | 59.1 | 32.2 | 32.8 | 27.1 |
| LCS Buster | 52 | 24.3 | 0 | 12.7 | 8.7 | 58.6 | 25.6 | 32.8 | 27.1 |
| TCG-Wildcat | 50 | 22.0 | 0 | 14.4 | 9.2 | 60.3 | 26.1 | 32.2 | 26.9 |
| MS Ranchero | 51 | 28.2 | 0 | 12.8 | 8.8 | 60.7 | 31.1 | 32.2 | 26.8 |
| AAC Starbuck VB | 48 | 26.1 | 0 | 15.0 | 8.5 | 60.4 | 27.6 | 30.4 | 26.7 |
| LCS Trigger | 56 | 23.8 | 0 | 13.7 | 8.6 | 58.8 | 25.9 | 31.2 | 26.4 |
| TCG-Heartland | 48 | 22.2 | 0 | 14.5 | 8.3 | 61.0 | 31.2 | 30.6 | 26.1 |
| SY McCloud | 49 | 23.1 | 0 | 15.0 | 8.3 | 61.0 | 25.5 | 30.1 | 26.0 |
| CAG-Justify | 49 | 24.0 | 0 | 13.4 | 7.9 | 57.6 | 28.8 | 31.3 | 25.9 |
| Glenn | 49 | 26.9 | 0 | 15.1 | 8.3 | 61.5 | 29.3 | 28.1 | 25.5 |
| LCS Cannon | 47 | 23.1 | 0 | 14.2 | 7.6 | 61.2 | 29.9 | 29.0 | 25.0 |
| SY Valda | 49 | 20.5 | 0 | 15.0 | 8.1 | 58.5 | 24.6 | 30.0 | 24.8 |
| ND Frohberg | 49 | 25.5 | 0 | 14.8 | 8.1 | 60.2 | 23.1 | 28.8 | 24.6 |
| AP Smith | 51 | 19.2 | 0 | 15.0 | 8.1 | 59.0 | 19.6 | 27.8 | 23.3 |
| MS Cobra | 49 | 22.2 | 0 | 15.1 | 8.9 | 60.0 | 21.9 | 27.4 | 23.0 |
| ND Vitpro | 49 | 23.2 | 0 | 15.1 | 7.7 | 58.0 | 20.7 | 24.8 | 22.3 |
| Bolles | 51 | 24.8 | 0 | 16.1 | 8.6 | 60.0 | 17.7 | 24.6 | 20.9 |
| MS Charger | 47 | 23.2 | 0 | 12.7 | 8.3 | 59.9 | 36.9 | 38.0 | - |
| LCS Ascent | 48 | 24.3 | 0 | 13.7 | 8.1 | 61.2 | 31.6 | 32.7 | - |
| LCS Hammer Ax | 49 | 23.0 | 0 | 13.9 | 8.0 | 59.1 | 27.4 | 32.1 | - |
| ND Heron | 47 | 24.7 | 0 | 14.9 | 8.2 | 60.7 | 33.1 | 31.8 | - |
| MN-Rothsay | 49 | 21.8 | 0 | 14.3 | 8.0 | 59.3 | 23.6 | 30.2 | - |
| Ascend-SD | 50 | 24.9 | 0 | 15.0 | 8.0 | 59.7 | 21.2 | 29.6 | - |
| Shelly | 50 | 20.6 | 0 | 14.0 | 8.5 | 59.9 | 26.2 | 29.1 | - |
| SY Ingmar | 51 | 21.9 | 0 | 15.0 | 8.3 | 60.3 | 21.2 | 29.0 | - |
| LCS Dual | 48 | 24.1 | 0 | 13.7 | 9.4 | 60.1 | 24.4 | 28.6 | - |
| Boost | 50 | 24.4 | 0 | 15.2 | 7.3 | 59.7 | 21.2 | 26.7 | - |
| Elgin-ND | 47 | 28.3 | 0 | 13.9 | 8.5 | 60.0 | 32.6 | 25.4 | - |
| PFS-Buns | 59 | 19.9 | 0 | 13.5 | 7.3 | 58.7 | 13.9 | 23.7 | - |
| AR 3915 | 48 | 23.2 | 0 | 15.8 | 8.5 | 59.9 | 27.4 | 22.6 | - |
| Lang-MN | 49 | 24.5 | 0 | 14.8 | 8.7 | 60.2 | 25.7 | 22.5 | - |
| CP3322 | 54 | 24.8 | 0 | 12.7 | 8.6 | 60.1 | 43.5 | - | - |
| WB9719 | 48 | 21.5 | 0 | 14.3 | 9.0 | 62.7 | 32.8 | - | - |
| CDC LandmarkVB | 49 | 24.9 | 0 | 15.5 | 8.7 | 60.3 | 32.8 | - | - |
| LCS Boom | 47 | 23.0 | 0 | 14.6 | 9.2 | 60.6 | 30.8 | - | - |
| WB 9590 | 48 | 21.7 | 0 | 14.2 | 8.2 | 59.7 | 28.3 | - | - |
| AC Lillian | 54 | 31.1 | 0 | 15.3 | 8.0 | 59.5 | 28.0 | - | - |
| CP3055 | 48 | 22.0 | 0 | 15.0 | 8.0 | 59.5 | 27.6 | - | - |
| AP Murdock | 48 | 23.1 | 0 | 14.3 | 7.9 | 58.0 | 21.1 | - | - |
| WB 9606 | 50 | 23.9 | 0 | 14.3 | 8.1 | 60.9 | 20.8 | - | - |
| Brawn-SD | 48 | 22.4 | 0 | 13.9 | 7.8 | 60.7 | 20.1 | - | - |
| TCG-Teddy | 49 | 19.2 | 0 | 15.1 | 7.9 | 59.2 | 18.1 | - | - |
| ND Thresher | 50 | 20.7 | 0 | 15.0 | 8.5 | 58.7 | 17.4 | - | - |
| **MEAN** | 49.8 | 23.61 | 0.0 | 14.36 | 8.40 | 59.73 | 28.01 | 30.88 | 27.04 |
| **C.V. (%)** | - | - | - | 4.25 | 9.39 | 1.23 | 27.87 | - | - |
| **LSD (5%)** | - | - | - | 0.99 | 1.28 | 1.19 | 12.64 | - | - |
| **LSD (10%)** | - | - | - | 0.83 | 1.07 | 0.99 | 10.58 | - | - |

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

¥: Hail storm on August 1, 2023. The WREC Farm had hail damage rated at 40%

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft
Soil Test (0-6 in.): P=37ppm, K=310ppm, pH=6.3, OM=2.0
(0-24 in.): N=25 lb/a
Applied Fertilizer: N=80 lb/a, P=26 lb/a, K=0 lb/a
Rainfall: 7.8 inches (4/26 - 8/16)

Elevation: 1902 ft
Previous crop: Flax
Planted: 4/26/2023
Harvested: 8/16/2023
Soil type: Williams-Bowbells loam
Plot size: 45 $ft^2$

**Irrigated Advanced Spring Wheat Trial - MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| AAC CONCORD | 40.7 | 166 | 61.6 | 14.5 | 98.3 |
| AP GUNSMOKE CL2 | 34.1 | 164 | 62.2 | 14.7 | 124.2 |
| CHOTEAU | 34.6 | 166 | 61.4 | 13.6 | 116.3 |
| CORBIN | 33.9 | 164 | 60.4 | 13.7 | 102.5 |
| CP3055 | 36.5 | 172 | 60.9 | 11.9 | 116.5 |
| CP3119A | 35.6 | 174 | 59.7 | 11.6 | 115.9 |
| CP3322 | 35.3 | 171 | 62.5 | 11.9 | 123.5 |
| DAGMAR | 37.8 | 163 | 62.2 | 15.8 | 124.2 |
| DUCLAIR | 35.6 | 163 | 60.9 | 13.7 | 117.3 |
| LANNING | 33.7 | 163 | 61.8 | 14.4 | 118.7 |
| LCS ASCENT | 33.7 | 161 | 62.2 | 13.8 | 120.6 |
| LCS BOOM | 33.1 | 160 | 63.2 | 14.3 | 122.2 |
| LCS HAMMER AX | 31.8 | 164 | 62.1 | 14.5 | 122.3 |
| McNEAL | 36.1 | 167 | 61.0 | 14.1 | 115.8 |
| MS COBRA | 34.0 | 164 | 62.3 | 14.1 | 122.1 |
| MS RANCHERO | 41.7 | 170 | 63.6 | 12.4 | 112.3 |
| MT 1809 | 35.0 | 165 | 61.9 | 13.8 | 125.8 |
| MT 1939 | 33.9 | 165 | 61.4 | 13.9 | 118.4 |
| MT 2030 | 35.6 | 164 | 61.7 | 14.1 | 123.1 |
| MT 2049 | 31.6 | 160 | 62.0 | 14.6 | 113.9 |
| MT 2050 | 35.7 | 166 | 61.8 | 14.2 | 122.3 |
| MT 2063 | 34.0 | 164 | 61.1 | 13.9 | 107.6 |
| MT 21016 | 35.0 | 164 | 61.7 | 14.5 | 122.5 |
| MT 21031 | 36.4 | 163 | 64.3 | 14.8 | 118.3 |
| MT 21037 | 35.2 | 163 | 60.9 | 14.2 | 120.3 |
| MT 21074 | 34.6 | 167 | 61.9 | 15.0 | 111.4 |
| MT 21104 | 35.8 | 166 | 62.7 | 13.9 | 124.0 |
| MT 21105 | 34.4 | 164 | 62.8 | 13.8 | 121.6 |
| MT 21148 | 33.5 | 166 | 63.1 | 14.8 | 106.5 |
| MT 21173 | 36.4 | 164 | 62.2 | 14.0 | 123.5 |
| MT 21174 | 38.6 | 163 | 61.6 | 13.6 | 121.3 |
| MT 21176 | 37.4 | 166 | 61.8 | 14.1 | 127.1 |
| MT 21186 | 35.8 | 164 | 60.7 | 15.1 | 125.8 |
| MT 21211 | 35.0 | 166 | 62.4 | 13.7 | 115.0 |
| MT 21214 | 36.6 | 165 | 62.2 | 14.6 | 124.1 |
| MT 21220 | 36.9 | 166 | 61.9 | 13.6 | 130.9 |
| MT 21224 | 36.6 | 164 | 62.5 | 14.4 | 119.0 |
| MT 21230 | 36.0 | 165 | 62.5 | 14.3 | 123.2 |
| MT 21247 | 36.0 | 165 | 61.4 | 14.6 | 126.5 |
| MT 21262 | 36.6 | 167 | 62.4 | 14.2 | 114.7 |
| MT 21313 | 37.9 | 163 | 61.4 | 14.1 | 118.9 |
| MT 21314 | 37.3 | 163 | 61.2 | 13.3 | 125.1 |
| MT 21352 | 37.4 | 161 | 61.8 | 15.3 | 122.2 |
| MT 21359 | 36.2 | 164 | 61.4 | 14.8 | 115.0 |
| MT 21384 | 36.7 | 163 | 61.6 | 14.5 | 122.7 |
| MT 21473 | 36.2 | 164 | 62.5 | 14.2 | 129.6 |
| MT 21484 | 36.4 | 164 | 62.4 | 15.2 | 131.5 |
| MT 21485 | 37.0 | 164 | 61.3 | 14.5 | 124.0 |
| MT 21487 | 37.1 | 164 | 62.3 | 14.9 | 129.5 |
| MT SIDNEY | 35.2 | 163 | 62.4 | 13.6 | 129.6 |
| NDHRS14-0134-C03 | 36.0 | 164 | 62.2 | 13.5 | 133.7 |
| NS PRESSER CLP | 38.1 | 169 | 61.5 | 13.2 | 119.5 |
| REEDER | 38.6 | 165 | 63.1 | 13.7 | 120.6 |
| ROCKER | 35.6 | 169 | 62.1 | 13.5 | 126.8 |
| SY INGMAR | 32.8 | 167 | 63.3 | 14.5 | 106.9 |
| SY LONGMIRE | 35.0 | 166 | 62.5 | 14.1 | 121.3 |
| SY ROCKFORD | 35.3 | 167 | 60.3 | 13.3 | 120.6 |
| SYN 183 | 31.5 | 163 | 63.7 | 14.6 | 122.4 |

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| | | | | | |
|---|---|---|---|---|---|
| SYN 211 | 30.8 | 167 | 62.8 | 13.6 | 116.1 |
| THATCHER | 44.6 | 170 | 61.7 | 13.8 | 97.8 |
| VIDA | 36.6 | 166 | 62.1 | 13.7 | 122.1 |
| W-2 | 37.9 | 164 | 60.5 | 13.5 | 104.3 |
| WB 173 | 32.2 | 166 | 65.3 | 13.8 | 122.2 |
| WB 211 | 32.5 | 165 | 62.8 | 13.3 | 128.0 |
| WB 222 | 27.8 | 161 | 60.6 | 16.0 | 105.4 |
| WB 9879 CLP | 36.9 | 167 | 61.3 | 13.6 | 117.2 |
| WB GUNNISON | 31.1 | 165 | 62.9 | 13.1 | 99.2 |
| Mean | 35.5 | 165 | 62.0 | 14.0 | 119.3 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 3.4 | 0.4 | 0.9 | 3.7 | 4.4 |
| LSD (0.05) | 2.0 | 1.1 | 0.9 | 0.8 | 8.5 |

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

† Grain yield adjusted to 12.0% moisture

N Available: 28.7 lb/ac

N added: 70 lb/ac

P2O5 Available: 15.7 ppm

P2O5 added: 26 lb/ac

Herbicide Application: Goldsky @ 16 oz/ac on 5/26/2023

Planted: 4/25/2023

Harvested: 8/11/2023

Previous crop: sugarbeet

Soil Type: Savage Silty Clay

Crop Year Precipitation: 15.26 inch

Irrigation (Sprinkler): 2.95 inch

Plot Width: 5 ft

**Dryland Spring Wheat Advance Yield Trial- MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| AAC CONCORD | 38.1 | 166 | 61.6 | 13.3 | 75.4 |
| AP GUNSMOKE CL2 | 29.4 | 165 | 61.7 | 13.3 | 86.7 |
| CHOTEAU | 31.5 | 166 | 60.7 | 12.6 | 77.6 |
| CORBIN | 27.7 | 164 | 59.5 | 12.6 | 71.5 |
| DAGMAR | 31.0 | 163 | 61.9 | 14.0 | 89.2 |
| DUCLAIR | 32.5 | 163 | 61.2 | 12.2 | 77.6 |
| LANNING | 29.3 | 162 | 62.5 | 13.6 | 90.0 |
| LCS ASCENT | 30.4 | 162 | 62.1 | 12.6 | 89.6 |
| LCS BOOM | 29.1 | 162 | 62.8 | 13.0 | 85.8 |
| LCS HAMMER AX | 29.0 | 164 | 62.0 | 12.1 | 88.5 |
| McNEAL | 32.2 | 168 | 61.4 | 13.7 | 82.2 |
| MS COBRA | 30.8 | 164 | 62.7 | 12.2 | 86.0 |
| MS RANCHERO | 33.2 | 165 | 62.6 | 12.4 | 83.0 |
| MT 1809 | 32.4 | 164 | 61.1 | 12.3 | 89.2 |
| MT 1939 | 29.1 | 164 | 62.5 | 13.0 | 88.0 |
| MT 2030 | 30.6 | 164 | 61.7 | 12.1 | 92.0 |
| MT 2049 | 28.0 | 160 | 61.0 | 12.8 | 82.6 |
| MT 2050 | 30.4 | 164 | 61.1 | 13.1 | 82.3 |
| MT 2063 | 28.7 | 164 | 61.5 | 13.3 | 81.8 |
| MT 21016 | 29.8 | 163 | 61.6 | 13.2 | 81.5 |
| MT 21031 | 32.0 | 164 | 63.1 | 13.0 | 83.1 |
| MT 21037 | 29.8 | 163 | 60.3 | 13.0 | 80.8 |
| MT 21074 | 31.5 | 167 | 63.6 | 12.7 | 82.5 |
| MT 21104 | 30.7 | 165 | 61.8 | 12.5 | 79.9 |
| MT 21105 | 30.6 | 165 | 62.7 | 12.8 | 90.0 |
| MT 21148 | 30.3 | 165 | 62.1 | 13.8 | 79.8 |
| MT 21173 | 29.8 | 164 | 61.6 | 12.6 | 78.6 |
| MT 21174 | 31.5 | 163 | 61.3 | 13.7 | 82.1 |
| MT 21176 | 30.8 | 166 | 60.5 | 13.1 | 85.1 |
| MT 21186 | 32.4 | 164 | 60.7 | 13.3 | 87.9 |
| MT 21211 | 29.4 | 165 | 61.3 | 13.7 | 74.9 |
| MT 21214 | 31.2 | 164 | 62.3 | 14.0 | 84.6 |
| MT 21220 | 30.7 | 167 | 62.0 | 12.6 | 90.7 |
| MT 21224 | 30.4 | 162 | 61.6 | 14.2 | 86.6 |
| MT 21230 | 31.2 | 166 | 61.9 | 12.5 | 88.3 |
| MT 21247 | 30.1 | 164 | 60.0 | 13.5 | 79.2 |
| MT 21262 | 31.0 | 165 | 62.1 | 13.8 | 71.2 |
| MT 21313 | 34.4 | 163 | 62.2 | 12.8 | 88.7 |
| MT 21314 | 31.9 | 162 | 61.5 | 13.1 | 87.9 |
| MT 21352 | 30.6 | 162 | 61.6 | 13.0 | 88.3 |
| MT 21359 | 32.4 | 164 | 61.8 | 13.5 | 82.4 |
| MT 21384 | 29.9 | 163 | 60.9 | 13.3 | 86.8 |
| MT 21473 | 31.9 | 164 | 61.9 | 12.9 | 88.0 |
| MT 21484 | 31.8 | 163 | 62.2 | 13.0 | 87.1 |
| MT 21485 | 31.1 | 163 | 61.3 | 13.3 | 84.5 |
| MT 21487 | 32.3 | 164 | 62.0 | 13.6 | 90.6 |
| MT SIDNEY | 31.2 | 163 | 61.6 | 12.1 | 86.5 |
| NDHRS14-0134-C03 | 30.3 | 163 | 60.3 | 12.8 | 86.5 |
| NS PRESSER CLP | 32.9 | 168 | 60.7 | 13.3 | 86.5 |
| REEDER | 30.1 | 164 | 61.8 | 13.5 | 79.4 |
| ROCKER | 29.5 | 168 | 63.2 | 13.3 | 81.2 |
| SY INGMAR | 28.9 | 169 | 63.4 | 13.9 | 71.4 |
| SY LONGMIRE | 28.7 | 166 | 62.5 | 12.8 | 81.0 |
| SY ROCKFORD | 29.9 | 168 | 60.8 | 11.8 | 83.3 |
| SYN 183 | 27.8 | 165 | 63.6 | 13.1 | 85.6 |
| SYN 211 | 26.6 | 166 | 61.8 | 13.5 | 83.0 |
| THATCHER | 39.0 | 168 | 60.4 | 12.9 | 60.6 |

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| | | | | | |
|---|---|---|---|---|---|
| VIDA | 31.0 | 165 | 61.5 | 12.3 | 86.3 |
| W-2 | 30.7 | 164 | 60.5 | 12.9 | 76.6 |
| WB 173 | 28.3 | 166 | 65.5 | 12.7 | 83.6 |
| WB 211 | 29.5 | 164 | 62.2 | 12.6 | 80.7 |
| WB 222 | 23.5 | 162 | 60.6 | 14.4 | 76.2 |
| WB 9879 CLP | 29.9 | 166 | 60.8 | 13.5 | 78.9 |
| WB GUNNISON | 28.2 | 165 | 62.7 | 12.3 | 76.9 |
| Mean | 30.6 | 164 | 61.7 | 13.0 | 83.0 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 4.7 | 0.6 | 1.2 | 4.4 | 6.6 |
| LSD (0.05) | 2.3 | 1.6 | 1.2 | 0.9 | 8.9 |

(Julian*) is a continuous count of days since January 1
† Grain yield adjusted to 12.0% moisture
N Available: 71.7 lb/ac
N added: 40 lb/ac
P2O5 Available: 21.2 ppm
P2O5 added: 26 lb/ac
Herbicide Application: Opensky @ 16 oz/ac on 5/25/2023

Planted: 4/18/2023
Harvested: 8/7/2023
Previous crop: fallow
Soil Type: Williams Clay Loam
Crop Year Precipitation: 12.70 inch
Plot Width: 5 ft

EARC Staff, Lily and Jace, taking height notes.

**Roosevelt County Dryland Spring Wheat - MSU** Poplar, MT 2023

| Variety | Plant Height (inch) | Test Weight (lb/bu) | Protein (%) | Sawfly Damage (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| BRENNAN | 26.8 | 64.4 | 15.1 | 5.0 | 54.1 |
| CP3055 | 26.6 | 57.2 | 14.5 | 1.7 | 45.7 |
| CP3119A | 23.8 | 56.5 | 14.5 | 0.0 | 42.0 |
| CP3322 | 26.8 | 58.7 | 14.9 | 0.0 | 42.9 |
| DAGMAR | 29.7 | 63.6 | 15.6 | 5.0 | 52.5 |
| DUCLAIR | 27.3 | 61.6 | 15.7 | 6.7 | 41.7 |
| LANNING | 29.9 | 61.2 | 15.5 | 8.3 | 50.0 |
| MT 1809 | 26.6 | 62.5 | 15.3 | 6.7 | 52.1 |
| MT 1939 | 28.1 | 62.4 | 14.4 | 8.3 | 50.1 |
| MT 2030 | 28.7 | 63.0 | 14.2 | 6.7 | 57.6 |
| MT 2049 | 27.4 | 62.0 | 14.2 | 10.0 | 49.8 |
| MT 2050 | 28.2 | 62.7 | 15.1 | 6.7 | 46.5 |
| MT 2063 | 28.1 | 63.7 | 15.2 | 8.3 | 44.2 |
| MT 21016 | 25.6 | 63.0 | 15.4 | 8.3 | 47.4 |
| MT 21037 | 26.8 | 62.1 | 15.3 | 5.0 | 47.0 |
| MT 21074 | 27.6 | 63.5 | 16.6 | 1.7 | 48.4 |
| MT 21104 | 28.3 | 63.6 | 15.2 | 5.0 | 45.5 |
| MT 21105 | 27.6 | 64.1 | 15.3 | 5.0 | 47.8 |
| MT SIDNEY | 26.1 | 63.9 | 14.9 | 8.3 | 48.8 |
| NS PRESSER CLP | 27.8 | 61.3 | 15.3 | 6.7 | 44.1 |
| REEDER | 27.7 | 63.2 | 15.2 | 10.0 | 46.5 |
| SY INGMAR | 27.0 | 62.8 | 15.5 | 5.0 | 47.6 |
| SY LONGMIRE | 28.0 | 63.7 | 14.5 | 8.3 | 46.2 |
| SY SOREN | 24.9 | 63.0 | 15.5 | 6.7 | 47.4 |
| VIDA | 27.4 | 63.1 | 14.4 | 6.7 | 55.9 |
| WB9879CLP | 28.5 | 62.8 | 15.6 | 3.3 | 45.5 |
| Mean | 27.4 | 62.3 | 15.1 | 5.9 | 48.0 |
| P-Value | 0.0003 | <0.0001 | 0.0011 | 0.002 | <0.0001 |
| CV (%) | 4.8 | 1.0 | 3.8 | 50.2 | 7.8 |
| LSD (0.05) | 2.1 | 1.0 | 1.0 | 4.9 | 6.1 |

(Julian*) is a continuous count of days since January 1 — Planted: 5/3/2023
† Grain yield adjusted to 12.0% moisture — Harvested: 8/4/2023
Fertilizer: 66.5 lbs/ac N; 24.7 lb/ac P2O5 — Previous crop: soybeans
Plot Width: 5 ft — Crop Year Precipitation: 9.75 inch

**Dryland Recrop Spring Wheat Trial- MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| BRENNAN | 24.1 | 163 | 62.8 | 14.8 | 61.7 |
| DAGMAR | 26.8 | 163 | 62.0 | 14.2 | 69.5 |
| DUCLAIR | 27.4 | 164 | 60.2 | 13.5 | 63.6 |
| LANNING | 25.6 | 165 | 63.0 | 13.4 | 68.2 |
| MT 1809 | 27.8 | 166 | 61.5 | 13.5 | 69.5 |
| MT 1939 | 25.5 | 166 | 60.8 | 13.1 | 69.8 |
| MT 2030 | 24.7 | 166 | 61.6 | 13.2 | 73.4 |
| MT 2049 | 25.5 | 162 | 61.5 | 13.9 | 64.0 |
| MT 2050 | 27.6 | 166 | 61.7 | 13.5 | 68.7 |
| MT 2063 | 28.2 | 166 | 62.0 | 12.9 | 68.7 |
| MT 21016 | 26.6 | 164 | 61.3 | 14.2 | 69.1 |
| MT 21037 | 27.4 | 166 | 61.2 | 14.1 | 67.7 |
| MT 21074 | 28.3 | 169 | 63.6 | 14.3 | 66.6 |
| MT 21104 | 29.9 | 167 | 62.9 | 13.0 | 74.0 |
| MT 21105 | 29.1 | 167 | 63.1 | 13.1 | 76.0 |
| MT SIDNEY | 27.2 | 166 | 63.0 | 12.8 | 70.5 |
| NS PRESSER CLP | 28.6 | 169 | 60.9 | 13.0 | 77.9 |
| REEDER | 27.3 | 166 | 62.9 | 13.4 | 69.4 |
| SY INGMAR | 24.7 | 166 | 63.4 | 13.8 | 65.8 |
| SY LONGMIRE | 26.9 | 168 | 63.3 | 13.3 | 68.9 |
| SY SOREN | 24.9 | 165 | 62.4 | 14.7 | 60.4 |
| VIDA | 28.0 | 168 | 62.0 | 12.8 | 71.5 |
| WB9879CLP | 28.2 | 168 | 61.6 | 13.0 | 75.5 |
| Mean | 27.0 | 166 | 62.1 | 13.6 | 69.2 |
| P-Value | 0.0058 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 6.4 | 0.6 | 0.9 | 2.4 | 4.7 |
| LSD (0.05) | 2.8 | 1.8 | 0.9 | 0.5 | 5.4 |

(Julian*) is a continuous count of days since January 1
† Grain yield adjusted to 12.0% moisture
N Available: 14 lb/ac
N added: 70 lb/ac
P2O5 Available: 14.3 ppm
P2O5 added: 26 lb/ac
Herbicide Application: Opensky @ 16 oz/ac on 5/25/2023

Planted: 4/24/2023
Harvested: 8/7/2023
Previous crop: peas
Soil Type: Williams Clay Loam
Crop Year Precipitation: 12.70 inch
Plot Width: 5 ft

**There are only three seasons for farmers;**
before harvest, harvest, and after harvest.

# Durum Variety Descriptions

| Variety | Origin[1] | Year | DTH[2] | Plant Height[2] (in) | Resistance to[3] | | | | | | Quality Factors[2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Lodging | Stem Rust | Leaf Rust | Foliar Disease | Bact. Leaf Streak | Scab | Test Weight | Grain Protein |
| AAC Stronghold | Canada | 2016 | 58 | 21 | 3 | NA | NA | NA | NA | NA | 60.5 | 18.5 |
| Alkabo | NDSU | 2005 | 55 | 22 | 2 | 1 | 1 | 5 | 7 | 6 | 59.1 | 16.4 |
| Carpio | NDSU | 2012 | 58 | 22 | 6 | 1 | 1 | 5 | 6 | 5 | 58.6 | 16.7 |
| CDC Defy | Canada | 2019 | 57 | 23 | 3 | NA | NA | NA | NA | NA | 61.5 | 18.1 |
| CDC Vantta | Canada | 2021 | 56 | 24 | 3 | NA | NA | NA | NA | NA | 61.7 | 16.5 |
| Divide | NDSU | 2005 | 58 | 24 | 4 | 1 | 1 | 5 | 7 | 5 | 58.6 | 16.9 |
| Joppa | NDSU | 2013 | 56 | 23 | 5 | 1 | 1 | 5 | 7 | 5 | 59.1 | 16.5 |
| Maier | NDSU | 1998 | 57 | 23 | 4 | 1 | 1 | 5 | NA | 8 | 58.6 | 18.1 |
| Mountrail | NDSU | 1998 | 57 | 22 | 5 | 1 | 1 | 5 | 7 | 8 | 58.2 | 16.9 |
| MT Blackbeard | MT | 2022 | 54 | 28 | 4 | 1 | 1 | 5 | NA | 5 | 61.7 | 16.8 |
| MT Raska | MT | 2022 | 51 | 24 | 2 | 1 | 1 | 5 | NA | 5 | 62.1 | 17.0 |
| ND Grano | NDSU | 2017 | 57 | 22 | 5 | 1 | 1 | 8 | 7 | 6 | 59.2 | 16.9 |
| ND Riveland | NDSU | 2017 | 56 | 24 | 4 | 1 | 1 | 5 | 6 | 5 | 59.0 | 16.6 |
| ND Stanley | NDSU | 2021 | 55 | 22 | 3 | 1 | 1 | 5 | 6 | 5 | 61.2 | 17.0 |
| Strongfield | Canada | 2004 | 57 | 23 | 5 | 1 | 1 | 6 | NA | 8 | 58.5 | 18.1 |

[1]Refers to developer: Canada represents developer from that country; MT = Montana State University; NDSU = North Dakota State University.

[2]DTH - Days to head recorded as days after planting, plant height, and quality data are averaged over a period ranging from a single year to nine years. The duration depends on the number of years a specific variety is included into the WREC trial from 2015 onward.

[3]Resistance scores from 1-9, with 1 = resistant and 9 = very susceptible. NA = Not adequately tested. Foliar Disease = reaction to Tan Spot and Septoria Leaf Spot complex.

**Roosevelt County Dryland Durum - MSU** Poplar, MT 2023

| Variety | Plant Height | Test Weight | Protein | Sawfly Damage | Grain YieldÀ |
|---|---|---|---|---|---|
| | (inch) | (lb/bu) | (%) | (%) | (bu/ac) |
| Alzada | 25.3 | 62.3 | 14.1 | 8.3 | 39.1 |
| Carpio | 26.5 | 60.7 | 15.5 | 8.3 | 33.2 |
| Divide | 30.6 | 62.4 | 15.1 | 6.7 | 34.4 |
| Joppa | 29.5 | 62.6 | 15.0 | 10.0 | 34.2 |
| Lustre | 30.3 | 62.2 | 14.9 | 3.3 | 34.2 |
| Mountrail | 28.6 | 62.4 | 16.0 | 8.3 | 32.0 |
| MT Blackbeard | 29.5 | 60.9 | 15.2 | 6.7 | 33.6 |
| MT Raska | 23.8 | 64.8 | 14.6 | 1.7 | 43.4 |
| MTD18148 | 22.4 | 63.4 | 15.0 | 13.3 | 43.1 |
| MTD19011 | 29.7 | 62.5 | 15.6 | 6.7 | 35.6 |
| ND Grano | 30.6 | 62.9 | 15.7 | 10.0 | 33.9 |
| ND Riveland | 32.4 | 61.5 | 15.7 | 5.0 | 34.8 |
| Mean | 28.3 | 62.4 | 15.2 | 7.4 | 35.9 |
| P-Value | <0.0001 | <0.0001 | 0.351 | 0.0013 | 0.0144 |
| CV (%) | 7.1 | 0.7 | 3.9 | 34.8 | 10.7 |
| LSD (0.05) | 3.4 | 0.8 | 1.0 | 4.3 | 6.5 |

(Julian*) is a continuous count of days since January 1
† Grain yield adjusted to 12.0% moisture
Fertilizer: 66.5 lb/ac N; 24.7 lb/ac P2O5
Plot Width: 5 ft

Planted: 5/3/2023
Harvested: 8/8/2023
Previous crop: soybean
Crop Year Precipitation: 9.75 inch

Bill and crew taking biomass samples.

| Variety | Days to Head (DAP+) | Plant Height (in) | Lodging (0 - 9*) | Protein† (%) | Moisture‡ (%) | Test Weight (lb/bu) | Yield 2023¥ (bu/a) | Yield 2-Yr Avg (bu/a) | Yield 3-Yr Avg (bu/a) |
|---|---|---|---|---|---|---|---|---|---|
| Carpio | 52 | 24.7 | 0 | 16.6 | 10.6 | 61.7 | 27.4 | 32.3 | 27.7 |
| Alkabo | 52 | 26.4 | 0 | 16.3 | 10.6 | 61.8 | 32.8 | 32.8 | 27.0 |
| ND Riveland | 53 | 29.0 | 0 | 17.1 | 10.0 | 61.2 | 26.7 | 32.2 | 26.6 |
| Mountrail | 53 | 27.3 | 0 | 16.8 | 10.5 | 60.9 | 27.9 | 31.8 | 26.5 |
| ND Grano | 53 | 26.1 | 0 | 16.8 | 10.5 | 61.8 | 28.1 | 31.2 | 25.9 |
| Strongfield | 52 | 24.5 | 0 | 17.3 | 10.1 | 61.1 | 31.4 | 31.1 | 25.8 |
| Joppa | 54 | 28.3 | 0 | 16.3 | 9.9 | 62.3 | 26.9 | 28.3 | 24.1 |
| ND Stanley | 51 | 25.1 | 0 | 16.8 | 10.4 | 62.3 | 28.6 | 29.2 | 24.0 |
| Maier | 54 | 26.8 | 0 | 17.6 | 10.5 | 62.2 | 24.9 | 27.8 | 23.0 |
| Divide | 55 | 28.2 | 0 | 16.5 | 10.1 | 60.6 | 23.5 | 26.9 | 22.4 |
| CDC Defy | 53 | 28.5 | 0 | 16.9 | 10.3 | 61.5 | 33.0 | 24.0 | - |
| AAC Stronghold | 53 | 27.2 | 0 | 17.2 | 10.2 | 62.0 | 34.4 | 23.2 | - |
| DT2009 | 53 | 28.2 | 0 | 17.3 | 10.4 | 61.4 | 33.3 | - | - |
| MT Blackbeard | 54 | 28.1 | 0 | 16.8 | 10.3 | 61.7 | 29.1 | - | - |
| CDC Vantta | 56 | 24.4 | 0 | 16.5 | 10.4 | 61.7 | 26.6 | - | - |
| MT Raska | 51 | 24.0 | 0 | 17.0 | 10.4 | 62.1 | 25.1 | - | - |
| **MEAN** | 53.1 | 26.57 | 0.0 | 16.82 | 10.32 | 61.65 | 28.73 | 32.05 | 27.37 |
| **C.V. (%)** | - | - | - | 2.54 | 4.08 | 1.06 | 9.76 | - | - |
| **LSD (5%)** | - | - | - | 0.71 | NS | 1.09 | 5.81 | - | - |
| **LSD (10%)** | - | - | - | 0.59 | 0.58 | 0.91 | 3.86 | - | - |

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

¥: Hail storm on August 1, 2023. The WREC Farm had hail damage rated at 40%

Location: WREC; Latitude 48° 8' N; Longitude 103° 44' W; Elevation 2105 ft
Soil Test (0-6 in.): P=37ppm, K=310ppm, pH=6.3, OM=2.0%
(0-24 in.): N=25 lb/a
Applied Fertilizer: N=80 lb/a, P=26 lb/a, K=0 lb/a
Rainfall: 7.3 inches (4/26 - 8/8)

Elevation: 1902 ft
Previous crop: Flax
Planted: 4/26/2023
Harvested: 8/8/2023
Soil type: Williams-Bowbells loam
Plot size: 45 $ft^2$

**Dryland Recrop Durum - MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| Alzada | 27.3 | 166 | 62.1 | 13.2 | 56.8 |
| Carpio | 31.5 | 172 | 62.6 | 13.9 | 54.9 |
| Divide | 34.4 | 171 | 62.6 | 13.5 | 56.7 |
| Joppa | 31.1 | 170 | 62.6 | 13.4 | 56.3 |
| Lustre | 32.9 | 172 | 62.2 | 13.6 | 58.3 |
| Mountrail | 32.9 | 172 | 63.2 | 13.6 | 55.2 |
| MT Blackbeard | 35.6 | 172 | 63.0 | 13.3 | 57.3 |
| MT Raska | 25.5 | 166 | 63.9 | 13.9 | 61.1 |
| MTD18148 | 21.8 | 167 | 62.1 | 13.2 | 59.2 |
| MTD19011 | 32.7 | 170 | 62.9 | 13.3 | 58.1 |
| ND Grano | 32.9 | 171 | 63.5 | 13.8 | 55.4 |
| ND Riveland | 33.2 | 170 | 61.9 | 14.3 | 53.0 |
| Mean | 31.0 | 170 | 62.7 | 13.6 | 56.9 |
| P-Value | <0.0001 | <0.0001 | 0.0002 | 0.0544 | 0.2048 |
| CV (%) | 4.3 | 0.6 | 0.7 | 2.8 | 5.4 |
| LSD (0.05) | 2.3 | 1.7 | 0.7 | 0.7 | 5.2 |

(Julian*) is a continuous count of days since January 1
† Grain yield adjusted to 12.0% moisture
N Available: 14 lb/ac
N added: 70 lb/ac
P2O5 Available: 14.3 ppm
P2O5 added: 26 lb/ac
Herbicide Application: Opensky @ 16 oz/ac on 5/25/2023

Planted: 4/24/2023
Harvested: 8/8/2023
Previous crop: peas
Soil Type: Williams Clay Loam
Crop Year Precipitation: 12.70 inch
Plot Width: 5 ft

Bill and Thomas training on new combine.

**Dryland Statewide Durum - MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| Alzada | 31.2 | 164 | 61.5 | 11.9 | 75.5 |
| Carpio | 36.6 | 170 | 63.2 | 12.3 | 74.4 |
| Divide | 36.5 | 167 | 62.5 | 12.6 | 76.6 |
| Joppa | 33.3 | 168 | 63.3 | 12.0 | 79.3 |
| Lustre | 35.4 | 169 | 61.9 | 11.1 | 75.7 |
| Mountrail | 33.9 | 169 | 62.8 | 11.7 | 80.7 |
| MT Blackbeard | 39.1 | 170 | 63.4 | 12.7 | 74.7 |
| MT Raska | 30.3 | 164 | 63.5 | 11.9 | 82.4 |
| MTD18148 | 28.6 | 165 | 61.5 | 12.5 | 77.1 |
| MTD19011 | 35.8 | 168 | 62.6 | 12.6 | 76.9 |
| MTD19077 | 37.7 | 168 | 62.7 | 12.9 | 77.3 |
| MTD19089 | 38.3 | 171 | 63.1 | 11.3 | 73.3 |
| MTD19103 | 33.7 | 167 | 62.8 | 11.2 | 75.4 |
| MTD19109 | 36.9 | 171 | 62.8 | 11.2 | 72.8 |
| MTD19115 | 36.0 | 168 | 63.6 | 10.7 | 80.6 |
| MTD19209 | 38.3 | 171 | 63.4 | 12.3 | 79.5 |
| MTD19241 | 37.1 | 168 | 62.7 | 12.5 | 78.7 |
| MTD19349 | 37.1 | 170 | 62.1 | 11.7 | 78.3 |
| MTD19499 | 35.3 | 170 | 61.7 | 11.5 | 72.7 |
| MTD19507 | 36.7 | 167 | 62.1 | 12.1 | 80.5 |
| MTD19511 | 31.5 | 169 | 62.3 | 10.5 | 77.6 |
| MTD19529 | 38.3 | 169 | 61.8 | 11.7 | 72.5 |
| MTD19611 | 36.1 | 168 | 63.9 | 13.1 | 77.4 |
| MTD19617 | 37.3 | 169 | 63.3 | 13.1 | 75.1 |
| MTD19623 | 37.1 | 168 | 62.3 | 11.6 | 76.8 |
| MTD19653 | 36.0 | 170 | 64.5 | 11.7 | 75.1 |
| MTD19703 | 37.3 | 703 | 63.2 | 12.2 | 78.0 |
| ND Grano | 37.5 | 136 | 63.2 | 12.9 | 74.8 |
| ND Riveland | 38.2 | 169 | 62.9 | 11.0 | 70.7 |
| YUM-816-065 | 31.2 | 165 | 60.5 | 10.9 | 73.1 |
| Mean | 35.6 | 185 | 62.7 | 11.9 | 76.5 |
| P-Value | 0.0015 | 0.4806 | <0.0001 | 0.0467 | 0.0055 |
| CV (%) | 8.3 | 91.5 | 0.6 | 8.1 | 4.3 |
| LSD (0.05) | 4.8 | 276.9 | 0.6 | 1.6 | 5.4 |

(Julian*) is a continuous count of days since January 1 Planted: 4/18/2023
† Grain yield adjusted to 12.0% moisture Harvested: 8/8/2023
N Available: 71.7 lb/ac Previous crop: fallow
N added: 40 lb/ac Soil Type: Williams Clay Loam
P2O5 Available: 21.2 ppm Crop Year Precipitation: 12.70 inch
P2O5 added: 26 lb/ac Plot Width: 5 ft
Herbicide Application: Opensky @ 16 oz/ac on 5/25/2023

“Cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, and they are tied to their country and wedded to its liberty and interests by the most lasting bonds.”

- Thomas Jefferson

**Irrigated Statewide Durum - MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| Alzada | 30.7 | 164 | 60.1 | 14.2 | 84.7 |
| Carpio | 42.4 | 170 | 63.7 | 13.2 | 107.4 |
| Divide | 41.7 | 170 | 63.1 | 14.5 | 99.8 |
| Joppa | 40.9 | 168 | 63.6 | 14.0 | 105.8 |
| Lustre | 40.7 | 171 | 62.6 | 13.5 | 113.9 |
| Mountrail | 39.4 | 169 | 63.4 | 13.0 | 114.7 |
| MT Blackbeard | 45.0 | 172 | 64.0 | 13.9 | 111.5 |
| MT Raska | 30.2 | 165 | 63.9 | 13.6 | 104.5 |
| MTD18148 | 28.0 | 167 | 61.5 | 14.0 | 96.6 |
| MTD19011 | 40.7 | 168 | 62.5 | 13.9 | 102.1 |
| MTD19077 | 42.3 | 171 | 63.0 | 14.6 | 101.1 |
| MTD19089 | 39.8 | 171 | 62.7 | 15.3 | 94.8 |
| MTD19103 | 40.0 | 168 | 62.5 | 13.8 | 93.9 |
| MTD19109 | 41.2 | 171 | 63.2 | 12.4 | 104.3 |
| MTD19115 | 39.8 | 168 | 62.8 | 13.2 | 103.4 |
| MTD19209 | 43.0 | 172 | 64.1 | 13.6 | 108.9 |
| MTD19241 | 40.4 | 169 | 62.8 | 13.9 | 101.3 |
| MTD19349 | 41.6 | 171 | 62.9 | 13.4 | 109.5 |
| MTD19499 | 39.2 | 168 | 60.9 | 14.4 | 92.7 |
| MTD19507 | 39.4 | 167 | 62.5 | 14.5 | 106.1 |
| MTD19511 | 36.9 | 168 | 61.9 | 12.9 | 103.1 |
| MTD19529 | 39.4 | 168 | 62.2 | 13.8 | 99.1 |
| MTD19611 | 39.2 | 167 | 63.2 | 14.9 | 100.7 |
| MTD19617 | 39.4 | 170 | 64.0 | 14.7 | 96.8 |
| MTD19623 | 40.3 | 168 | 62.1 | 13.3 | 90.0 |
| MTD19653 | 39.2 | 170 | 63.8 | 14.9 | 103.6 |
| MTD19703 | 40.8 | 169 | 63.4 | 14.1 | 112.5 |
| ND Grano | 41.3 | 170 | 64.3 | 14.0 | 115.5 |
| ND Riveland | 44.8 | 170 | 63.2 | 13.9 | 111.1 |
| YUM-816-065 | 30.8 | 164 | 59.8 | 13.1 | 83.5 |
| Mean | 39.3 | 169.0 | 62.8 | 13.9 | 102.4 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | 0.002 | <0.0001 |
| CV (%) | 3.6 | 0.6 | 0.7 | 5.3 | 7.4 |
| LSD (0.05) | 2.3 | 1.7 | 0.7 | 1.2 | 12.3 |

(Julian*) is a continuous count of days since January 1 Planted: 4/25/2023
† Grain yield adjusted to 12.0% moisture Harvested: 8/9/2023
N Available: 28.7 lb/ac Previous crop: sugarbeet
N added: 70 lb/ac Soil Type: Savage Silty Clay
P2O5 Available: 15.7 ppm Crop Year Precipitation: 15.26 inch
P2O5 added: 26 lb/ac Irrigation (sprinkler): 2.95 inch
Herbicide Application: Goldsky @ 16 oz/ac on 5/26/2023 Plot Width: 5 ft

# Hard Red Winter Wheat Variety Descriptions

| Variety | Agent or Origin[1] | Year | Height[2] (in) | DTH[2] | Winter Hardi-ness[3] | Resistant to[4] | | | | | | Quality Factors[2] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Lodging | Stripe Rust | Leaf Rust | Stem Rust | Scab | Tan Spot | Test Weight | Grain Protein |
| AAC Goldrush | AAFC | 2021 | 25 | 158 | 3 | 3 | NA | 6 | 4 | NA | NA | 58.8 | 14.9 |
| AAC Vortex | AAFC | 2021 | 24 | 162 | 2 | 2 | NA | NA | NA | 4 | 8 | 59.5 | 14.1 |
| AAC Wildfire | AAFC | 2015 | 23 | 163 | 2 | 3 | 1 | 4 | 8 | 4 | 6 | 58.4 | 13.3 |
| AC Emerson | Meridian | 2011 | 24 | 161 | 3 | 2 | 1 | 6 | 1 | 3 | 5 | 59.5 | 15.1 |
| AP Bigfoot | Agripro | 2020 | 21 | 159 | 6 | 4 | NA | 7 | NA | 7 | 4 | 60.2 | 12.2 |
| Draper | SD | 2019 | 21 | 166 | NA | NA | 4 | 7 | 4 | 4 | 5 | 61.0 | 12.8 |
| Jerry | ND | 2001 | 23 | 158 | 3 | 5 | 8 | 4 | 1 | 8 | 8 | 58.6 | 13.7 |
| Keldin | WB | 2011 | 23 | 160 | 6 | 4 | 2 | 3 | 3 | 5 | 6 | 59.9 | 13.4 |
| MS Iceman | Meridian | 2021 | 20 | 167 | NA | NA | 7 | 8 | 5 | 6 | 8 | 61.8 | 12.8 |
| MS Maverick | Meridian | 2020 | 21 | 159 | 5 | 4 | 1 | 6 | 5 | 8 | 5 | 60.1 | 12.5 |
| MS Sundown | Meridian | 2022 | 24 | 152 | 4 | 6 | NA | NA | NA | 5 | NA | 58.5 | 12.8 |
| ND Noreen | ND | 2020 | 23 | 159 | 3 | 4 | 3 | 3 | 1 | 3 | 4 | 60.3 | 13.5 |
| Northern | MT | 2015 | 21 | 160 | 4 | 4 | 1 | 8 | 1 | 8 | 6 | 59.2 | 13.8 |
| Ray | MT | 2018 | 25 | 171 | NA | NA | 1 | 8 | NA | 6 | 6 | 58.9 | 14.1 |
| SD Andes | SD | 2020 | 23 | 162 | 2 | 2 | 1 | 8 | NA | 5 | 3 | 61.3 | 12.4 |
| SD Midland | SD | 2021 | 24 | 162 | 3 | 4 | 1 | 8 | NA | 6 | 4 | 60.1 | 12.1 |
| SY Monument | Agripro | 2014 | 21 | 156 | 4 | 4 | 3 | 3 | 1 | 8 | 8 | 58.2 | 12.7 |
| SY Wolverine | Agripro | 2019 | 21 | 156 | 5 | 5 | NA | 7 | NA | 8 | 3 | 59.7 | 12.7 |
| WB 4309 | WB | 2019 | 21 | 159 | 5 | 6 | NA | 8 | NA | 6 | 5 | 59.6 | 12.5 |
| WB4510CLP | WB | 2020 | 23 | 168 | 5 | 4 | 2 | NA | NA | 6 | 8 | 62.4 | 12.8 |
| Winner | SD | 2019 | 22 | 159 | 4 | 5 | 5 | NA | NA | 4 | 8 | 60.7 | 12.5 |

[1]Refers to developer: 1AAFC = Agriculture & Agri-Food Canada; MN = University of Minnesota; MT = Montana State University; ND = North Dakota State University; SD = South Dakota State University; WB = WestBred.

[2]DTH - Days to head recorded as Julian days, plant height, and quality data are averaged over a period ranging from a single year to nine years. The duration depends on the number of years a specific variety is included into the WREC trial from 2015 onward.

[3]Relative winter hardiness rating: 1 = excellent, 10 = no survival. These values are subject to change as additional information becomes available.

[4]Resistance scores from 1-9, with 1 = resistant and 9 = very susceptible. NA = Not adequately tested.

**Winter Wheat Variety Trial - NDSU** **WREC, Williston, ND 2023**

| Variety/Line | Height | Days to Heading | Protein | Winter Survival | Test Weight | Yield | |
|---|---|---|---|---|---|---|---|
| | | | | | | 2023 | 3-Yr. Avg. |
| | (in) | (Julian+) | (%) | (%) | (lb/bu) | (bu/ac) | (bu/ac) |
| AAC Vortex | 24 | 153 | 13.8 | 99.0 | 58.1 | 38.1 | - |
| AAC Wildfire | 24 | 160 | 12.4 | 99.0 | 58.7 | 39.6 | 33.5 |
| AC Emerson | 24 | 156 | 14.7 | 99.0 | 59.4 | 31.4 | 26.0 |
| AP Bigfoot | 22 | 151 | 12.9 | 99.0 | 59.3 | 27.9 | - |
| Goldrush | 24 | 155 | 13.5 | 99.0 | 58.6 | 37.0 | - |
| Jerry | 25 | 153 | 13.2 | 99.0 | 57.9 | 29.8 | 25.5 |
| Keldin | 25 | 153 | 12.1 | 99.0 | 60.1 | 36.5 | 30.0 |
| MS Maverick | 23 | 151 | 12.9 | 99.0 | 59.6 | 32.1 | - |
| MS Sundown | 24 | 152 | 12.8 | 99.0 | 58.5 | 33.1 | - |
| ND Noreen | 25 | 152 | 13.7 | 99.0 | 60.5 | 36.5 | 32.7 |
| Northern | 22 | 157 | 13.1 | 99.0 | 59.5 | 33.7 | 29.7 |
| SD Andes | 22 | 153 | 12.6 | 99.0 | 60.4 | 33.5 | 31.2 |
| SD Midland | 25 | 154 | 12.5 | 99.0 | 59.4 | 35.6 | - |
| SY Monument | 23 | 152 | 12.7 | 99.0 | 58.9 | 33.1 | 27.0 |
| SY Wolverine | 23 | 151 | 13.3 | 99.0 | 59.8 | 25.6 | 20.6 |
| WB4309 | 22 | 152 | 12.9 | 99.0 | 58.5 | 28.6 | 26.0 |
| Winner | 23 | 151 | 12.4 | 99.0 | 59.4 | 33.8 | 26.2 |
| Mean | 23.5 | 153.2 | 12.9 | 99.0 | 59.1 | 33.7 | - |
| CV % | 3.3 | 0.4 | 2.1 | 0.0 | 0.2 | 4.7 | - |
| LSD 0.05 | 1.2 | 1.6 | 0.6 | NS | 0.4 | 3.7 | - |
| LSD 0.1 | 1.6 | 1.3 | 0.5 | NS | 0.3 | 3.1 | - |

+ Days after January 1, 2022

Location: WREC; Latitude: 48.13357; Longitude: -103.73970

Previous crop: Flax; Soil type: Williams-Bowbells Loam. Altitude: 2105 ft

Planted: 9/19/2022 Harvested: 7/26/2023

Soil test (0-6 in): P= 29 ppm; K=345 ppm; pH= 6.1; and OM= 2.2%.

Soil test (0-24 in): $NO_3N$= 5 lb/ac.

Fertilizers applied (lb/a): N = 42.8; P = 23.52; K = 0.

Yield and test weight were adjusted to 13.5% moisture and protein was adjusted to 12% moisture.

Data includes only released varieties. Experimental lines are not included. Statistics reflect the entire trial.

**Dryland Intrastate Winter Wheat Evaluation - MSU**

EARC, Sidney, MT 2022-2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|
| AAC Coldfront | 29.0 | 158 | 61.0 | 9.7 | 102.5 |
| AAC Wildfire | 31.0 | 160 | 60.6 | 9.7 | 100.2 |
| Amplify SF | 27.0 | 156 | 61.9 | 10.7 | 90.5 |
| AP Bigfoot | 24.5 | 155 | 60.4 | 9.8 | 89.2 |
| AP Solid | 25.3 | 156 | 62.9 | 10.8 | 89.8 |
| AP18 AX | 24.5 | 152 | 60.2 | 9.1 | 103.8 |
| Balance | 26.1 | 157 | 60.5 | 10.5 | 84.0 |
| Bobcat | 25.1 | 159 | 61.3 | 10.2 | 92.0 |
| Brawl CL Plus | 25.6 | 152 | 61.2 | 11.3 | 82.4 |
| CP7017AX | 24.0 | 155 | 60.6 | 9.7 | 91.3 |
| CP7909 | 24.9 | 151 | 60.1 | 9.3 | 93.8 |
| CPX7266AX | 26.5 | 155 | 60.8 | 9.9 | 86.0 |
| Flathead | 26.2 | 155 | 61.6 | 9.9 | 91.6 |
| Fortify SF | 28.1 | 154 | 61.1 | 9.5 | 99.3 |
| FourOsix | 25.6 | 156 | 60.4 | 9.8 | 96.6 |
| Judee | 28.2 | 157 | 61.9 | 10.1 | 86.9 |
| Keldin | 29.0 | 159 | 61.7 | 9.7 | 101.1 |
| Kivari AX | 27.2 | 155 | 61.1 | 8.9 | 96.9 |
| LCS Eclipse AX | 28.5 | 157 | 56.7 | 10.0 | 76.9 |
| LCS Helix AX | 25.1 | 155 | 61.6 | 9.3 | 87.8 |
| LCS Steel AX | 28.0 | 157 | 60.6 | 8.6 | 102.7 |
| Loma | 26.4 | 159 | 60.5 | 10.1 | 98.8 |
| Milestone | 26.5 | 159 | 59.8 | 9.9 | 92.2 |
| MS Maverick | 26.4 | 156 | 61.6 | 10.0 | 101.2 |
| MS Sundown | 27.6 | 152 | 60.3 | 9.8 | 98.6 |
| MT WarCat | 26.2 | 159 | 60.3 | 10.0 | 95.0 |
| MT2019 | 24.9 | 157 | 60.2 | 9.1 | 104.3 |
| MTAX21187 | 27.6 | 155 | 60.0 | 9.9 | 99.8 |
| MTCL19151 | 25.1 | 155 | 59.9 | 9.9 | 104.1 |
| MTCL2010 | 24.8 | 155 | 59.8 | 9.9 | 102.0 |
| MTCS20151 | 28.6 | 158 | 61.3 | 10.1 | 99.5 |
| MTCS20156 | 26.8 | 159 | 61.2 | 10.4 | 89.2 |
| MTCS20158 | 24.9 | 158 | 61.4 | 10.9 | 97.3 |
| MTFH19132 | 28.0 | 156 | 58.5 | 9.6 | 97.8 |
| MTFH20170 | 28.0 | 156 | 61.1 | 10.1 | 98.2 |
| MTS1908 | 28.5 | 160 | 61.3 | 9.6 | 95.5 |
| MTS2068 | 28.3 | 160 | 61.5 | 10.3 | 93.9 |
| MTS2197 | 23.5 | 157 | 61.8 | 9.8 | 89.5 |
| MTV2164 | 28.0 | 156 | 60.5 | 9.8 | 102.2 |
| Northern | 27.6 | 157 | 60.6 | 10.0 | 101.1 |
| Ramsay | 28.7 | 159 | 61.4 | 9.8 | 99.6 |
| StandClear CLP | 28.9 | 157 | 61.6 | 10.6 | 97.2 |
| SY Clearstone 2CL | 29.3 | 159 | 60.8 | 9.9 | 86.5 |
| SY Wolverine | 23.8 | 153 | 60.2 | 9.9 | 95.7 |
| Warhorse | 27.8 | 158 | 60.3 | 10.9 | 89.7 |
| WB4422 | 26.6 | 156 | 62.1 | 10.5 | 95.9 |
| WB4483 | 27.6 | 159 | 59.9 | 10.0 | 94.4 |
| WB4727 | 26.5 | 157 | 58.2 | 9.5 | 90.4 |
| Yellowstone | 30.6 | 157 | 61.7 | 9.9 | 101.5 |
| Mean | 26.9 | 157 | 60.7 | 9.9 | 95.0 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 3.8 | 0.5 | 0.7 | 4.8 | 5.5 |
| LSD (0.05) | 1.6 | 1.3 | 0.7 | 0.8 | 8.5 |

(Julian*) is a continuous count of days since January 1 — Planted: 9/28/22

† Grain yield adjusted to 12.0% moisture — Harvested: 8/7/2023

N Available: 22 lb/ac — Previous crop: fallow

N added: 74 lb/ac — Soil Type: William Clay Loam

P2O5 available: 23 ppm — Crop year precip: 12.7 inch

P2O5 applied: 20lb/ac — Plot Width: 5 ft

Herbicide Application: Opensky @ 16 oz/ac on 5/25/2023

"The future belongs to the few of us still wanting to get our hands dirty."
Roland Tiangco

# Wheat Variety Comparisons, Williston, ND 2023

Gautam Pradhan, Tyler Tjelde, Justin Jacobs, Jesper Nielsen

The gross return per acre was based on three-year average yield and protein (2021, 2022, 2023) from dryland varietal trials, and the market price obtained in the first week of December 2023 from grain elevators in and around Williston.

Spring Wheat

| Variety | 3 Yr Avg. Yield | 3 Yr Avg. Protein | Market Price | Gross Return | + or - ND Heron |
|---|---|---|---|---|---|
| | bu/a | % | ($/bu) | $/a | $/a |
| AAC Starbuck VB | 26.7 | 16 | 6.79 | 181.37 | -5.70 |
| AP Gunsmoke CL2 | 29.5 | 17 | 6.79 | 200.04 | 12.98 |
| AP Smith | 23.3 | 16 | 6.79 | 158.51 | -28.55 |
| Bolles | 20.9 | 18 | 6.79 | 141.69 | -45.37 |
| CAG-Justify | 25.9 | 16 | 6.79 | 175.54 | -11.52 |
| CAG-Reckless | 31.0 | 15 | 6.67 | 206.62 | 19.56 |
| CP3099A | 29.6 | 14 | 6.55 | 193.74 | 6.68 |
| CP3119A | 30.5 | 14 | 6.55 | 199.77 | 12.71 |
| CP3188 | 31.0 | 14 | 6.55 | 203.13 | 16.07 |
| Driver | 30.0 | 15 | 6.67 | 200.22 | 13.16 |
| Glenn | 25.5 | 16 | 6.79 | 172.97 | -14.09 |
| Lanning | 30.1 | 15 | 6.67 | 200.82 | 13.76 |
| LCS Buster | 27.1 | 14 | 6.55 | 177.48 | -9.58 |
| LCS Cannon | 25.0 | 16 | 6.79 | 170.02 | -17.04 |
| LCS Trigger | 26.4 | 15 | 6.67 | 176.15 | -10.91 |
| MN-Torgy | 27.7 | 15 | 6.67 | 184.71 | -2.35 |
| MS Cobra | 23.0 | 16 | 6.79 | 155.91 | -31.15 |
| MS Ranchero | 26.8 | 15 | 6.67 | 178.67 | -8.39 |
| ND Frohberg | 24.6 | 16 | 6.79 | 167.36 | -19.70 |
| **ND Heron** | 27.5 | 16 | 6.79 | 187.06 | **0.00** |
| ND VitPro | 22.3 | 16 | 6.79 | 151.25 | -35.81 |
| SY 611 CL2 | 31.0 | 15 | 6.67 | 206.61 | 19.55 |
| SY Longmire | 30.0 | 16 | 6.79 | 203.46 | 16.40 |
| SY McCloud | 26.0 | 16 | 6.79 | 176.36 | -10.71 |
| SY Valda | 24.8 | 16 | 6.79 | 168.59 | -18.47 |
| TCG-Heartland | 26.1 | 16 | 6.79 | 176.90 | -10.16 |
| TCG-Spitfire | 28.4 | 15 | 6.67 | 189.63 | 2.57 |
| TCG-Wildcat | 26.9 | 15 | 6.67 | 179.55 | -7.51 |

Durum

| Variety | 3 Yr Avg. Yield | 3 Yr Avg. Protein | Market Price | Gross Return | + or - ND Riveland |
|---|---|---|---|---|---|
| | bu/a | % | ($/bu) | $/a | $/a |
| Alkabo | 27.0 | 16.4 | 9.25 | 249.95 | 3.81 |
| Carpio | 27.7 | 16.4 | 9.25 | 256.33 | 10.19 |
| Divide | 22.4 | 16.7 | 9.25 | 207.55 | -38.59 |
| Joppa | 24.1 | 16.3 | 9.25 | 222.95 | -23.19 |
| Maier | 23.0 | 17.4 | 9.25 | 213.02 | -33.12 |
| Mountrail | 26.5 | 16.8 | 9.25 | 245.29 | -0.85 |
| ND Grano | 25.9 | 17.0 | 9.25 | 239.65 | -6.49 |
| **ND Riveland** | 26.6 | 16.7 | 9.25 | 246.14 | **0.00** |
| ND Stanley | 24.0 | 17.0 | 9.25 | 221.88 | -24.26 |
| Strongfield | 25.8 | 17.4 | 9.25 | 238.98 | -7.16 |

## Barley Variety Descriptions

| Variety | Origin[1] | Use[2] | Year Released | DTH[3] (DAP) | Height[3] (in) | Resistance To[4] Lodging | Stem Rust | Spot-form Net Blotch | Spot Blotch | Net Blotch | Quality Factors[3] Test Weight | Grain Protein |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Two-Row** | | | | | | | | | | | | |
| AAC Synergy | Canada | M/F | 2015 | 62 | 21 | 4 | 4 | 3 | 4 | 4 | 48.8 | 13.8 |
| ABI Cardinal | BARI | M/F | 2019 | 65 | 19 | 4 | NA | NA | 4 | 6 | 47.5 | 12.7 |
| Brewski | NDSU | M | 2021 | 63 | 21 | 4 | NA | NA | 4 | 4 | 46.4 | 12.3 |
| CDC Fraser | Canada | M/F | 2016 | 65 | 18 | 2 | NA | NA | 4 | 4 | 47.0 | 13.7 |
| CDC Prairie | Canada | | 2021 | 63 | 17 | 3 | NA | NA | 5 | NA | 50.0 | 14.8 |
| Conlon | NDSU | M/F | 1996 | 56 | 21 | 5 | 8 | 4 | 6 | 3 | 50.6 | 14.1 |
| Explorer | Secobra | M | NA | 65 | 17 | 3 | NA | NA | 8 | 4 | 50.0 | 13.5 |
| Winston | Acker-mann | F | 2021 | 60 | 16 | 1 | NA | NA | 8 | 6 | 48.8 | 15.1 |
| **Six-Row** | | | | | | | | | | | | |
| ND Treasure | NDSU | F | 2023 | 53 | 17 | 1 | NA | NA | 3 | 8 | 46.5 | 14.0 |
| Tradition | BARI | M/F | 2003 | 56 | 20 | 3 | 8 | 6 | 3 | 7 | 49.3 | 14.4 |

[1]Refers to developer: Ackermann = Sastzucht Ackermann, Germany; BARI = Busch Ag Resources Inc.; Canada represents developers from that country; NDSU = North Dakota State University; Secobra = Secobra Recherches France.

[2]F = Feed; M =Malt.

[3]DTH - Days to head recorded as days after planting, plant height, and quality data are averaged over a period ranging from a single year to nine years. The duration depends on the number of years a specific variety is included into the WREC trial from 2015 onward.

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

**Barley Dryland Variety Trial - NDSU** **WREC, Williston, ND 2023**

| Variety | Days to Head (DAP+) | Plant Height (in) | Lodging (0 - 9*) | Protein† (%) | Moisture‡ (%) | Plump % (>6/64) | Test Weight (lb/bu) | Yield 2023¥ (bu/a) | Yield 2-Yr Avg‡ (bu/a) | Yield 3-Yr Avg¥ (bu/a) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Two-rowed** | | | | | | | | | | |
| Explorer | 56.3 | 14 | 2 | 15.3 | 7.3 | 95 | 49.5 | 32.0 | 36.8 | 33.1 |
| CDC Fraser | 62.7 | 17 | 1 | 14.9 | 7.3 | 94 | 49.0 | 20.1 | 28.9 | 24.7 |
| Conlon | 52.7 | 18 | 2 | 14.9 | 7.1 | 96 | 50.8 | 21.9 | 24.5 | 24.0 |
| MT Boy Handy | 57.7 | 17 | 2 | 13.5 | 7.1 | 94 | 50.1 | 26.5 | - | - |
| KWS Willis | 57.3 | 17 | 2 | 13.8 | 7.1 | 95 | 49.3 | 25.7 | - | - |
| CDC Durango | 58.0 | 16 | 1 | 15.5 | 7.3 | 95 | 50.9 | 22.0 | - | - |
| Winston | 59.7 | 16 | 2 | 15.1 | 7.4 | 96 | 48.8 | 21.0 | - | - |
| Fire Foxx | 57.3 | 16 | 1 | 14.9 | 7.3 | 92 | 48.7 | 20.7 | - | - |
| CDC Prairie | 62.7 | 17 | 2 | 14.8 | 6.9 | 86 | 50.0 | 17.8 | - | - |
| CDC Renegade | 58.7 | 21 | 2 | 14.9 | 7.0 | 88 | 49.7 | 13.8 | - | - |
| **Six-rowed** | | | | | | | | | | |
| Tradition | 53.3 | 18 | 2 | 15.3 | 7.4 | 84 | 48.5 | 22.1 | 32.0 | 29.9 |
| ND Treasure | 52.7 | 17 | 1 | 14.0 | 7.7 | 89 | 46.5 | 26.9 | - | - |
| **MEAN** | 57.42 | 17.0 | 1.7 | 14.75 | 7.24 | 92.0 | 49.32 | 22.54 | 30.55 | 27.92 |
| **C.V. (%)** | - | - | - | 6.92 | 4.24 | 1.8 | 0.99 | 20.92 | - | - |
| **LSD (5%)** | - | - | - | 0.85 | 1.06 | 2.7 | 0.83 | 7.99 | - | - |
| **LSD (10%)** | - | - | - | 0.70 | 0.88 | 2.3 | 0.69 | 6.61 | - | - |

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

¥: Hail storm on August 1, 2023. The WREC Farm had hail damage rated at 40%

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

Soil Test (0-6 in.): P=32ppm, K=275ppm, pH=6.1, OM=1.9%

(0-24 in.): N=10 lb/a

Applied Fertilizer: N=80 lb/a, P=26 lb/a, K=0 lb/a

Rainfall: 7.3 inches (4/26 - 8/7)

Elevation: 1902 ft

Previous crop: Flax

Planted: 4/26/2023

Harvested: 8/7/2023

Soil type: Williams-Bowbells loam

Plot size: 45 $ft^2$

**Irrigated Offstation Barley-MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Lodging (%) | Plump >6/64 (%) | Regular > 5/64 (%) | Test Weight (lb/bu) | Protein (%) | Grain YieldÂ (bu/ac) |
|---|---|---|---|---|---|---|---|---|
| 2IM14-8212 | 32.9 | 169 | 25 | 94 | 5 | 51.1 | 11.2 | 137.2 |
| 2IM16-0154 | 32.5 | 166 | 27 | 92 | 7 | 52.2 | 11.0 | 124.5 |
| ABI Eagle | 31.4 | 169 | 8 | 87 | 11 | 50.7 | 11.3 | 128.8 |
| AC Metcalfe | 36.4 | 167 | 47 | 91 | 8 | 52.0 | 12.0 | 121.8 |
| BC Ellinor | 29.8 | 170 | 5 | 91 | 8 | 47.2 | 10.7 | 123.2 |
| BC Leandra | 26.4 | 173 | 3 | 93 | 7 | 49.5 | 10.9 | 133.9 |
| BC Lexy | 28.0 | 171 | 3 | 92 | 7 | 48.7 | 11.4 | 116.5 |
| Buzz | 31.6 | 163 | 5 | 96 | 3 | 51.6 | 11.7 | 103.9 |
| CDC Copeland | 37.3 | 170 | 92 | 94 | 6 | 52.0 | 11.5 | 90.8 |
| Hockett | 31.4 | 168 | 37 | 94 | 5 | 53.0 | 11.9 | 127.6 |
| LCS Odyssey | 28.0 | 172 | 7 | 93 | 6 | 48.6 | 11.1 | 121.0 |
| LCS Opera | 28.5 | 174 | 3 | 81 | 16 | 46.5 | 10.5 | 115.6 |
| LG Diablo | 28.3 | 173 | 2 | 93 | 6 | 47.2 | 10.5 | 126.3 |
| Merit 57 | 35.2 | 169 | 30 | 63 | 8 | 51.6 | 11.0 | 144.5 |
| MT Boy Howdy | 32.3 | 164 | 10 | 96 | 3 | 52.0 | 10.1 | 131.2 |
| MT Endurance | 33.1 | 165 | 10 | 96 | 3 | 51.2 | 11.1 | 125.0 |
| MT17M01908 | 35.2 | 163 | 17 | 97 | 3 | 52.2 | 11.1 | 121.2 |
| MT17M05808 | 33.7 | 166 | 62 | 91 | 8 | 50.3 | 11.7 | 119.8 |
| MT18M06008 | 31.0 | 160 | 8 | 95 | 4 | 51.7 | 11.6 | 106.0 |
| MT18M06011 | 31.2 | 159 | 8 | 93 | 6 | 51.6 | 11.2 | 103.0 |
| MT19_M061_19 | 33.9 | 166 | 10 | 94 | 5 | 51.4 | 11.8 | 125.5 |
| MT19_M064_04 | 34.8 | 168 | 88 | 88 | 10 | 48.4 | 10.2 | 111.2 |
| MT19_M067_02 | 31.5 | 164 | 28 | 96 | 3 | 50.7 | 10.9 | 106.1 |
| MT19_M095_04 | 30.7 | 163 | 43 | 94 | 5 | 52.2 | 11.2 | 121.5 |
| Voyager | 35.6 | 167 | 13 | 93 | 6 | 51.8 | 12.3 | 113.1 |
| Mean | 32.0 | 167 | 24 | 91 | 6 | 50.6 | 11.2 | 120.0 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | 0.0835 | <0.0001 | <0.0001 | 0.0003 | 0.1727 |
| CV (%) | 4.7 | 0.5 | 68.5 | 10.3 | 26.9 | 1.2 | 4.7 | 14.7 |
| LSD (0.05) | 2.5 | 1.5 | 26.6 | 15.5 | 2.8 | 1.0 | 0.9 | 29.0 |

(Julian*) is a continuous count of days since January 1
† Grain yield adjusted to 12.0% moisture
N Available: 28.7 lb/ac
N added: 50 lb/ac
P2O5 Available: 15.7 ppm
P2O5 added: 18.5 lb/ac
Herbicide Application: Huskie FX @ 18oz/ac & Axial Bold @ 15oz/ac on 5/26/2023

Planted: 4/17/2023
Harvested: 8/8/2023
Previous crop: sugarbeet
Soil Type: Savage Silty Clay
Crop Year Precipitation: 15.26 inch
Irrigation (sprinkler): 2.95 inch
Plot Width: 5 ft

Calla and Thomas planting cereal plots.

**Irrigated Intrastate Barley Evaluation - MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Lodging (%) | Plump >6/64 (%) | Regular >5/64 (%) | Test Weight (lb/bu) | Protein (%) | Grain YieldÂ (bu/ac) |
|---|---|---|---|---|---|---|---|---|
| AC Metcalfe | 37.9 | 167 | 35 | 91 | 8 | 52.4 | 12.4 | 120.7 |
| Buzz | 32.7 | 163 | 5 | 96 | 3 | 51.9 | 11.8 | 112.5 |
| FHB-2017-59-2 | 35.8 | 163 | 52 | 94 | 5 | 53.6 | 12.1 | 137.9 |
| Havener | 34.6 | 269 | 73 | 72 | 22 | 56.6 | 12.3 | 110.2 |
| Haxby | 32.7 | 165 | 47 | 92 | 7 | 53.4 | 12.1 | 128.9 |
| Hockett | 32.8 | 166 | 52 | 93 | 6 | 51.3 | 11.6 | 120.7 |
| Merit 57 | 37.0 | 168 | 30 | 88 | 10 | 51.0 | 11.8 | 138.0 |
| MT Boy Howdy | 35.2 | 165 | 10 | 93 | 6 | 51.5 | 11.0 | 133.5 |
| MT Endurance | 33.6 | 164 | 15 | 95 | 4 | 50.5 | 11.6 | 120.6 |
| MT17M01908 | 32.9 | 163 | 17 | 97 | 3 | 52.5 | 11.1 | 124.6 |
| MT17M04801 | 33.6 | 165 | 43 | 93 | 6 | 51.6 | 11.4 | 136.1 |
| MT17M05808 | 32.9 | 166 | 57 | 92 | 7 | 49.4 | 11.6 | 124.7 |
| MT18H02702 | 32.9 | 169 | 27 | 83 | 14 | 58.2 | 13.2 | 104.0 |
| MT18M06008 | 32.3 | 159 | 18 | 94 | 5 | 51.0 | 11.5 | 109.6 |
| MT18M06009 | 30.7 | 159 | 10 | 96 | 4 | 51.2 | 11.5 | 117.7 |
| MT18M06011 | 31.9 | 159 | 23 | 94 | 5 | 51.9 | 11.7 | 103.7 |
| MT18M10106 | 36.1 | 168 | 53 | 94 | 5 | 51.7 | 10.4 | 129.4 |
| MT18M10207 | 36.5 | 163 | 8 | 96 | 3 | 52.1 | 12.2 | 124.9 |
| MT18M11002 | 39.0 | 167 | 67 | 87 | 11 | 51.8 | 11.8 | 126.5 |
| MT18M11004 | 36.2 | 168 | 53 | 87 | 10 | 51.2 | 12.2 | 134.1 |
| MT18M11106 | 34.1 | 167 | 73 | 92 | 7 | 51.5 | 11.2 | 128.0 |
| MT19_H09_09 | 36.9 | 171 | 90 | 57 | 33 | 59.5 | 15.3 | 79.9 |
| MT19_H11_04 | 35.2 | 171 | 85 | 80 | 16 | 55.8 | 13.8 | 101.3 |
| MT19_H11_05 | 36.7 | 168 | 58 | 74 | 21 | 55.7 | 13.9 | 98.2 |
| MT19_H11_17 | 35.8 | 169 | 52 | 82 | 16 | 58.4 | 14.4 | 107.3 |
| MT19_H12_12 | 32.9 | 164 | 82 | 42 | 42 | 60.3 | 14.0 | 65.9 |
| MT19_H14_11 | 34.5 | 168 | 38 | 82 | 15 | 60.1 | 14.0 | 97.3 |
| MT19_M022_10 | 29.8 | 170 | 3 | 92 | 7 | 49.1 | 11.4 | 115.6 |
| MT19_M034_16 | 33.3 | 170 | 43 | 92 | 6 | 51.5 | 11.4 | 140.9 |
| MT19_M045_11 | 33.7 | 166 | 13 | 90 | 9 | 51.0 | 12.5 | 115.6 |
| MT19_M055_03 | 31.8 | 164 | 7 | 91 | 7 | 51.5 | 11.3 | 108.8 |
| MT19_M060_06 | 34.6 | 165 | 78 | 83 | 14 | 49.6 | 11.7 | 99.4 |
| MT19_M061_19 | 33.5 | 165 | 18 | 96 | 4 | 51.0 | 12.0 | 126.5 |
| MT19_M064_04 | 33.9 | 169 | 87 | 88 | 11 | 48.4 | 11.0 | 112.2 |
| MT19_M067_02 | 29.7 | 164 | 22 | 96 | 3 | 51.0 | 11.3 | 110.2 |
| MT19_M071_21 | 31.2 | 165 | 12 | 93 | 5 | 51.7 | 11.3 | 106.4 |
| MT19_M080_13 | 32.3 | 161 | 8 | 95 | 4 | 50.9 | 11.6 | 126.1 |
| MT19_M095_04 | 31.0 | 163 | 28 | 94 | 5 | 51.0 | 11.7 | 127.3 |
| MT19_M098_17 | 33.6 | 168 | 10 | 91 | 7 | 51.4 | 11.7 | 101.1 |
| MT20_H092_03 | 35.3 | 170 | 13 | 65 | 28 | 55.7 | 13.9 | 91.1 |
| MT20_H092_13 | 37.4 | 167 | 8 | 82 | 14 | 60.6 | 15.1 | 92.5 |
| MT20_M006_08 | 29.9 | 161 | 2 | 97 | 3 | 50.3 | 12.1 | 81.9 |
| MT20_M008_04 | 32.3 | 164 | 25 | 93 | 6 | 51.2 | 11.2 | 135.7 |
| MT20_M033_01 | 34.4 | 165 | 25 | 93 | 6 | 50.2 | 12.2 | 129.5 |
| MT20_M033_14 | 34.6 | 165 | 22 | 92 | 7 | 50.1 | 12.1 | 114.3 |
| MT20_M044_06 | 30.7 | 161 | 5 | 95 | 4 | 51.2 | 11.1 | 104.9 |
| MT20_M047_16 | 33.3 | 164 | 13 | 96 | 3 | 51.6 | 11.5 | 108.8 |
| MT20_M050_03 | 34.1 | 164 | 13 | 92 | 6 | 51.7 | 11.7 | 99.3 |
| MT20_M052_13 | 31.6 | 161 | 38 | 92 | 6 | 51.1 | 11.6 | 110.6 |
| MT20_M053_02 | 35.7 | 164 | 72 | 84 | 13 | 49.5 | 12.4 | 106.5 |
| MT20_M054_05 | 29.5 | 161 | 3 | 96 | 4 | 51.7 | 11.2 | 100.0 |
| MT20_M062_04 | 30.2 | 160 | 5 | 94 | 4 | 53.2 | 11.6 | 114.6 |
| MT20_M063_01 | 29.5 | 161 | 20 | 93 | 5 | 51.2 | 11.2 | 114.3 |
| MT20_M073_12 | 27.3 | 165 | 8 | 86 | 12 | 49.4 | 11.2 | 101.7 |
| MT20_M074_02 | 33.3 | 167 | 88 | 88 | 11 | 50.0 | 10.8 | 116.0 |
| MT20_M102_03 | 36.1 | 169 | 27 | 93 | 6 | 49.7 | 11.5 | 134.1 |
| MT20_M117_10 | 33.5 | 166 | 32 | 88 | 9 | 49.8 | 11.1 | 126.9 |
| MT20_M118_02 | 33.2 | 168 | 45 | 92 | 7 | 51.7 | 11.4 | 137.3 |
| MT20_M118_15 | 30.1 | 165 | 65 | 93 | 6 | 51.1 | 11.2 | 139.9 |
| MT20_M120_05 | 35.3 | 164 | 8 | 96 | 4 | 51.3 | 11.7 | 112.0 |
| MT20_M124_07 | 32.5 | 167 | 72 | 94 | 5 | 49.8 | 12.1 | 129.1 |
| MT21_094_04 | 34.8 | 165 | 72 | 85 | 12 | 48.4 | 12.2 | 103.9 |
| MT21_094_06 | 34.9 | 164 | 53 | 90 | 8 | 50.2 | 11.8 | 112.8 |
| MT21_094_08 | 31.9 | 166 | 63 | 86 | 11 | 51.1 | 12.1 | 107.5 |
| Mean | 33.5 | 167 | 36 | 89.0 | 9.0 | 52.1 | 12.0 | 114.9 |
| P-Value | <0.0001 | 0.2741 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 5.3 | 13.0 | 52.0 | 3.6 | 27.3 | 1.7 | 4.0 | 6.3 |
| LSD (0.05) | 2.9 | 35.1 | 30.2 | 5.2 | 4.0 | 1.4 | 0.8 | 11.7 |

(Julian*) is a continuous count of days since January 1
† Grain yield adjusted to 12.0% moisture
N Available: 28.7 lb/ac
N added: 50 lb/ac
P2O5 Available: 15.7 ppm
P2O5 added: 18.5 lb/ac
Herbicide Application: Huskie FX @18 oz/ac & Axial Bold @ 15 oz/ac on 5/26/2023

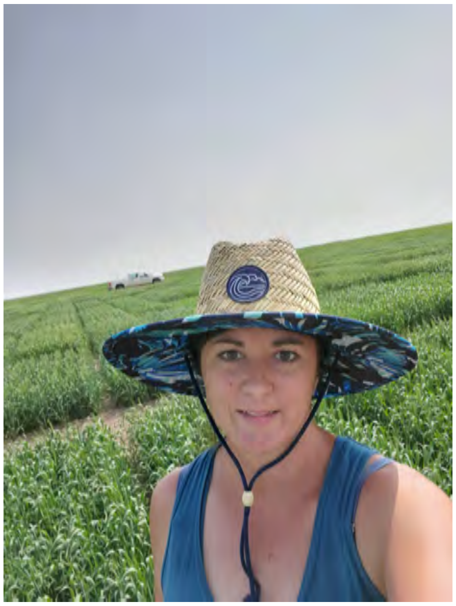
Planted: 4/25/23
Harvested: 8/8/2023
Previous crop: sugar beet
Soil Type: Savage Silty Clay
Crop Year Precipitation: 15.26 inch
Irrigation (sprinkler): 2.95 inch
Plot Width: 5 ft

**Dryland Forage Barley - MSU** EARC, Sidney, MT 2023

| Variety | Plant Height (inch) | Days to Heading (Julian*) | Test Weight (lb/bu) | Protein (%) | Forage Yield (ton/ac) | Grain YieldÀ (bu/ac) |
|---|---|---|---|---|---|---|
| Haymaker | 31.6 | 167 | 48.7 | 13.1 | 3.7 | 74.5 |
| Lavina | 28.3 | 166 | 49.0 | 11.9 | 4.2 | 88.2 |
| MT Cowgirl | 29.8 | 167 | 49.4 | 12.2 | 3.5 | 79.3 |
| MT16F01601 | 30.4 | 165 | 49.9 | 13.1 | 3.7 | 83.8 |
| MT17F02410 | 27.4 | 169 | 48.8 | 12.4 | 3.6 | 81.6 |
| MT18F00503 | 28.6 | 168 | 48.4 | 12.2 | 3.7 | 76.6 |
| MT18F00507 | 31.9 | 167 | 46.9 | 12.4 | 4.3 | 74.6 |
| MT18F00607 | 31.5 | 171 | 47.5 | 12.9 | 3.6 | 80.0 |
| MT18F00803 | 29.3 | 168 | 45.3 | 12.0 | 4.2 | 80.0 |
| MT19_F01_01 | 29.5 | 165 | 49.3 | 13.6 | 3.6 | 73.2 |
| MT19_F04_02 | 31.2 | 167 | 47.6 | 13.0 | 4.2 | 80.5 |
| MT20_F097_01 | 33.1 | 167 | 48.2 | 12.8 | 4.3 | 79.5 |
| MT20_F098_01 | 27.7 | 167 | 49.0 | 11.2 | 4.3 | 82.9 |
| MT20_F098_24 | 28.1 | 167 | 50.2 | 12.1 | 4.5 | 81.3 |
| MT20_F099_02 | 32.5 | 165 | 51.8 | 13.1 | 3.9 | 83.4 |
| MT20_F099_05 | 29.1 | 167 | 51.4 | 13.6 | 4.1 | 86.4 |
| MT20_F108_13 | 28.3 | 168 | 49.7 | 12.6 | 3.5 | 79.6 |
| MT20_F109_04 | 29.0 | 167 | 48.8 | 11.6 | 4.4 | 84.9 |
| MT20_F109_08 | 29.3 | 169 | 49.5 | 11.6 | 4.2 | 86.5 |
| MT20_F109_22 | 29.8 | 167 | 48.2 | 12.4 | 4.2 | 87.0 |
| MT20_F110_04 | 29.7 | 168 | 50.4 | 12.2 | 3.5 | 80.8 |
| MT20_F110_12 | 31.8 | 167 | 50.0 | 12.7 | 3.8 | 74.8 |
| MT20_F110_17 | 29.5 | 167 | 50.6 | 12.4 | 5.9 | 76.4 |
| MT20_F110_19 | 30.6 | 166 | 50.9 | 12.6 | 4.0 | 81.8 |
| MT20_F111_15 | 31.2 | 166 | 48.5 | 12.9 | 4.3 | 80.7 |
| Mean | 30.0 | 167 | 49.1 | 12.5 | 4.0 | 80.7 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | 0.1018 | 0.8159 | <0.0001 |
| CV (%) | 3.7 | 0.5 | 1.4 | 6.8 | 25.4 | 4.7 |
| LSD (0.05) | 1.8 | 1.2 | 1.1 | 1.4 | 1.7 | 6.2 |

(Julian*) is a continuous count of days since January 1
† Grain yield adjusted to 12.0% moisture
N Available: 71.7 lb/ac
N added: 20 lb/ac
P2O5 Available: 21.2 ppm
P2O5 added: 26 lb/ac
Herbicide Application: Huskie FX @ 18oz/ac & Axial Bold @ 15oz/ac on 5/25/2023

Planted: 4/17/2023
Harvested: 7/31/2023
Previous crop: fallow
Soil Type: Williams Clay Loam
Crop Year Precipitation: 12.70 inch
Plot Width: 5 ft



Calla Kowatch-Carlson in cereal plots

## Oat Variety Descriptions

| Variety | Origin[1] | Year Released | Grain Color | Height (in)[2] | DTH[2] | Straw Strength | Resistance To[3] | | | Quality Factors | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Stem Rust | Crown Rust | Barley Yellow Dwarf | Test Weight[2] | Grain Protein[4] |
| AAC Douglas | AAFC | 2019 | White | 27 | 53 | NA | NA | MR/MS | MS | 39.5 | M |
| Beach | NDSU | 2004 | White | 29 | 53 | M. STRG | S/VS | MR/MS | MS/S | 42.6 | M |
| CDC Minstrel | Canada | 2006 | White | 34 | 51 | M. STRG | S/VS | S/VS | S/VS | 40.8 | M |
| CS Camden | Canterra | 2016 | White | 29 | 53 | STRONG | S/VS | MS/S | NA | 39.6 | M |
| Deon | MN | 2013 | Yellow | 30 | 55 | STRONG | S/VS | R/MR | R/MR | 42.0 | M |
| HiFi | NDSU | 2001 | White | 29 | 55 | STRONG | MR/MS | S/VS | R/MR | 40.8 | M |
| Jury | NDSU | 2012 | White | 31 | 54 | M. STRG | R | S/VS | MR/MS | 42.0 | M |
| Killdeer | NDSU | 2000 | White | 27 | 52 | STRONG | S/VS | MS/S | MR/MS | 41.3 | M |
| Leggett | Canada | 2005 | White | 28 | 54 | STRONG | MR | R | S/VS | 41.7 | M |
| MN-Pearl | MN | 2019 | White | 34 | 47 | NA | NA | S | MR/MS | 37.8 | M/L |
| ND Heart | NDSU | 2020 | White | 28 | 53 | STRONG | MR | MS/S | MR/MS | 40.1 | H |
| Newburg | NDSU | 2011 | White | 30 | 54 | MEDIUM | R | S/VS | MR/MS | 41.8 | M |
| Otana | MT | 1977 | White | 31 | 55 | STRONG | S/VS | S/VS | S/VS | 40.6 | H |
| Paul | NDSU | 1994 | Hull less | 30 | 56 | STRONG | R | MR/MS | R/MR | 48.2 | M |
| Rockford | NDSU | 2008 | White | 29 | 54 | STRONG | S/VS | S/VS | MR/MS | 42.1 | M |
| SD Buffalo | SDSU | 2021 | White | 36 | 44 | STRONG | NA | MS/S | NA | 38.4 | M |
| Warrior | SDSU | 2018 | White | 28 | 54 | STRONG | MS/S | R | NA | 41.9 | M |

[1]Refers to developer: AAFC = Agriculture & Agri-Food Canada; MN = University of Minnesota; MT = Montana State University; NDSU = North Dakota State University; SDSU = South Dakota State University.

[2]DTH - Days to head recorded as days after planting, plant height, and test weight are averaged over a period ranging from a single year to eight years. The duration depends on the number of years a specific variety is included into the WREC trial from 2015 onward.

[3]R=Resistant; MR=Moderately Resistant; MS=Moderately Susceptible; S=Susceptible; VS=Very Susceptible; NA=Not Available.

[4]H=High; M=Medium; L=Low.

## 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 | Tolerance[6] BB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cardinal | MT/NDSU | Yes | N | High Lino | V Good | V Good | High | Fair | Medium | T | MT |
| Chickadee | STI | Yes | N | High Lino | V Good | V Good | High | Good | Medium | T | MT |
| Hybrid 1601 | STI | Yes | STP | High Oleic | V Good | V Good | Medium | Good | M Late | MT | MT |
| Hybrid 200 | STI | Yes | N | High Oleic | V Good | V Good | V High | Fair | Medium | MT | NA |
| Hybrid 446 | STI | Yes | N | High Oleic | V Good | V Good | V High | Fair | Medium | MT | NA |
| MonDak | MT/NDSU | Yes | N | High Oleic | Good | V Good | High | Fair | M Early | T | MT |
| Montola 2003 | MT/NDSU | Yes | N | High Oleic | V Good | V Good | M High | Good | M Early | MT | MT |
| Morlin | MT/NDSU | Yes | STP | High Lino | V Good | Good | Medium | Good | M Late | T | T |
| Nutrasaff | MT/NDSU | Yes | RED | High Lino | Good | Good | Medium | High | Medium | T | MT |
| Rubis Red | MT | Yes | N | High Lino | Good | Good | V High | Low | Medium | MS | NA |
| STI 1201 | STI | Yes | STP | High Oleic | Good | Good | M High | Good | Medium | MT | NA |
| STI 1401 | STI | Yes | STP | High Oleic | Good | Good | M High | High | Medium | MT | NA |

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

[3]N = Normal; RED = Reduced; STP = Striped.

[4]Lino = Linoleic.

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

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


Jim Staricka collecting soil samples.

**Statewide Canola Variety Trial** EARC, Sidney, MT 2023

| Variety | Stand Count plants/ft$^2$ | Plant Height (cm) | Days to Flowering (Julian*) | Flea Beetle Damage % | Test Weight (lb/bu) | Oil (%) | Grain YieldÀ (lb/ac) |
|---|---|---|---|---|---|---|---|
| BY 6211TF | 11.5 | 40.6 | 171 | 28 | 54.5 | 44.3 | 2316.5 |
| BY 6217TF | 11.7 | 49.0 | 177 | 18 | 53.2 | 42.7 | 1544.9 |
| CP7130LL | 12.5 | 47.6 | 172 | 6 | 53.8 | 43.2 | 2516.3 |
| CP7250LL | 11.5 | 46.2 | 176 | 23 | 53.9 | 42.4 | 2171.6 |
| CP9221TF | 12.2 | 37.3 | 170 | 8 | 53.6 | 43.5 | 2340.6 |
| CP9978TF | 12.5 | 40.4 | 170 | 13 | 54.1 | 45.4 | 2625.6 |
| DK902TF | 11.2 | 37.1 | 170 | 50 | 54.1 | 44.5 | 2188.0 |
| DKTF99SC | 11.8 | 43.3 | 171 | 53 | 54.6 | 43.7 | 2435.6 |
| DKTFLL21SC | 11.3 | 38.1 | 170 | 65 | 54.0 | 44.6 | 2002.8 |
| InVigor L233P | 12.2 | 42.9 | 170 | 14 | 54.1 | 43.4 | 2611.0 |
| InVigor L340PC | 11.7 | 44.7 | 172 | 34 | 53.9 | 41.8 | 2201.0 |
| InVigor L343PC | 12.5 | 45.7 | 172 | 14 | 53.4 | 44.0 | 2698.0 |
| InVigor L345PC | 11.5 | 50.0 | 173 | 31 | 53.4 | 42.6 | 2064.9 |
| InVigor L350PC | 11.5 | 46.1 | 176 | 29 | 52.8 | 42.8 | 1823.1 |
| InVigor LR354PC | 12.3 | 49.6 | 174 | 10 | 53.2 | 43.7 | 2328.4 |
| NC155 TF | 10.7 | 38.4 | 170 | 48 | 55.4 | 41.8 | 1768.0 |
| NC471 TF | 10.5 | 43.0 | 171 | 34 | 54.5 | 43.1 | 2042.3 |
| NC527CR TF | 12.0 | 42.3 | 170 | 21 | 53.8 | 43.8 | 2282.8 |
| NCC101S | 9.8 | 34.8 | 172 | 88 | 54.4 | 36.0 | 1217.6 |
| NCC1825/8-S | 11.5 | 41.2 | 170 | 23 | 55.5 | 42.2 | 2488.1 |
| StarFlex | 11.2 | 38.7 | 171 | 58 | 54.2 | 45.3 | 2185.9 |
| Mean | 11.6 | 42.7 | 172 | 32 | 54.0 | 43.1 | 2183.5 |
| P-Value | 0.0008 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| CV (%) | 7.0 | 5.5 | 0.7 | 55.7 | 0.8 | 2.2 | 12.2 |
| LSD (0.05) | 1.1 | 3.3 | 1.6 | 24.9 | 0.6 | 1.3 | 377.3 |

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

† Grain yield adjusted to 12.0% moisture

N Available: 22 lb/ac

N added: 80 lb/ac

P2O5 Available: 15 ppm

P2O5 added: 26 lb/ac

Pesticide Applied: Mustang Maxx @ 4.3 oz/ac on 5/23, 5/30, 6/6

Herbicide Applied: Sonalan 10 G @ 9.5 lbs./ac on 10/19/2022

Planted: 5/5/23

Harvested: 8/7/23

Previous crop: sugarbeet

Soil Type: Savage Silty Clay

Crop Year Precipitation: 15.26 inch

Irrigation (sprinkler): 3.2 inch

Plot Width: 5 ft

| Variety (Relative Maturity) | Days to Maturity (DAP)[1] | Plant Height (in) | Test Weight (lb/bu) | Seed Oil % | Seed Protein % | Adjusted Grain Yield (lb/a) |
|---|---|---|---|---|---|---|
| CP00926X (0.09) | 111 | 39.0 | 58.9 | 20.3 | 26.8 | 2722 |
| CP0337X (0.3) | 109 | 39.3 | 58.7 | 21.3 | 25.6 | 2606 |
| GH0384XF (0.3) | 116 | 38.4 | 57.4 | 21.2 | 27.9 | 3048 |
| GH0502XF (0.5) | 114 | 38.2 | 57.6 | 20.2 | 27.9 | 2951 |
| Mean | 113 | 38.7 | 58.1 | 20.7 | 27.1 | 2832 |
| P-Value | N/A | 0.47 | <0.0001 | 0.0003 | 0.001 | 0.056 |
| LSD (0.05) | N/A | NS | 0.4 | 0.5 | 1.1 | NS |
| CV (%) | N/A | 2.8 | 0.4 | 1.5 | 2.6 | 7.9 |

Location: EARC; Sidney, MT
Previous crop: Spring Wheat
Planted: 5-24-2023
Harvested: 9-18-2023
Applied fertilizers in lb/a: 10-26-0 at planting
Soil type: Savage Silty Clay Loam
Yield, Protein and Oil adjusted to 13% moisture content
DAP[1] = Days after planting
Rainfall: 10.3 inches
Irrigation: 4.6 inches
Herbicide: Outlook @ 12 oz/a & Powermax @ 24 oz/a on 5-25
Insecticide: Lambda Cy @ 2oz/a & Vantacor @ 1.5 oz/a on 7-29

Edson Ncube, Plant Pathology Research Specialist, WREC

**Dryland Lentil Variety Evaluation - MSU** **Richland, MT 2023**

| Variety | Plant Height | Test Weight | 1000 Seed Weight | Adjusted Grain Yield |
|---|---|---|---|---|
| | (in) | (lb/bu) | (g) | (lb/a) |
| Avondale | 13.4 | 61.7 | 45.5 | 950 |
| CDC Greenstar | 15.0 | 57.4 | 65.4 | 767 |
| CDC Impala CL | 11.6 | 64.7 | 19.9 | 620 |
| CDC Impress CL | 13.7 | 59.6 | 50.2 | 759 |
| CDC Imvincible CL | 13.4 | 63.6 | 28.9 | 725 |
| CDC Kermit | 11.7 | 63.6 | 28.3 | 790 |
| CDC Maxim CL | 13.1 | 62.6 | 35.1 | 805 |
| CDC Richlea | 12.6 | 60.6 | 48.1 | 1069 |
| CDC Viceroy | 11.1 | 63.9 | 29.1 | 644 |
| LC14600088R | 13.6 | 60.5 | 51.2 | 985 |
| NDL090170L | 14.2 | 59.6 | 67.9 | 930 |
| NDL090185R | 13.6 | 60.8 | 48.2 | 784 |
| NDL090204R | 12.5 | 61.6 | 51.1 | 601 |
| Sage | 12.4 | 63.1 | 32.3 | 846 |
| Mean | 13.0 | 61.6 | 43.4 | 807 |
| P-Value | 0.056 | <0.0001 | <0.0001 | 0.02 |
| LSD (0.05) | NS | 0.6 | 2.2 | 257.2 |
| CV (%) | 11.8 | 0.6 | 3.6 | 22.3 |

Location: Richland, MT
Previous crop: Spring Wheat
Planted: 5-18-2023
Harvested: 8-24-2023
Applied fertilizers in lb/a: None
Soil type: Farnuf Loam
Yield adjusted to 13% moisture content
Rainfall: 7.0+ inches
Herbicide: Fall-Valor, Preplant-RoundUp & Sharpen

**Note:** Trials experienced wind and hail damage in two separate stroms at the end of July

Amy tilling alleyways

**Irrigated Lentil Variety Evaluation - MSU** **Sidney, MT 2023**

| Variety | Days to Flower (DAP)[1] | Plant Height (in) | Test Weight (lb/bu) | 1000 Seed Weight (g) | Adjusted Grain Yield (lb/a) |
|---|---|---|---|---|---|
| Avondale | 49 | 14.4 | 63.3 | 50.8 | 3579 |
| CDC Greenstar | 52 | 13.4 | 60.4 | 72.8 | 2924 |
| CDC Impala CL | 55 | 14.6 | 65.3 | 30.5 | 3085 |
| CDC Impress CL | 51 | 13.8 | 62.3 | 52.9 | 3177 |
| CDC Imvincible CL | 54 | 13.6 | 64.6 | 32.9 | 3244 |
| CDC Kermit | 57 | 14.9 | 65.3 | 30.8 | 3496 |
| CDC Maxim CL | 50 | 14.5 | 64.3 | 42.2 | 3357 |
| CDC Richlea | 50 | 13.8 | 61.7 | 54.6 | 3394 |
| CDC Viceroy | 55 | 13.4 | 65.0 | 33.2 | 2985 |
| LC14600088R | 50 | 14.0 | 62.3 | 60.3 | 3707 |
| NDL090185R | 50 | 14.2 | 62.1 | 53.7 | 3340 |
| NDL090204R | 58 | 13.4 | 63.8 | 54.2 | 2593 |
| Sage | 48 | 11.9 | 64.4 | 36.8 | 2387 |
| Mean | 52 | 13.8 | 63.4 | 46.6 | 3174 |
| P-Value | <0.0001 | 0.0499 | <0.0001 | <0.0001 | 0.0070 |
| LSD (0.05) | 1.5 | 1.5 | 0.4 | 1.6 | 647.6 |
| CV (%) | 2.0 | 7.7 | 0.4 | 2.4 | 14.3 |

Location: EARC; Sidney, MT
Previous crop: Sugarbeet
Planted: 4-26-2023
Harvested: 7-29-2023
Applied fertilizers in lb/a: None
Soil type: Savage Silty Clay Loam
Rainfall: 10.3 inches
Irrigation: 2 inches
Yield adjusted to 13% moisture content
DAP[1] = Days after planting
Herbicide: Panther @ 2 oz/a on 10-19-22; Outlook @ 10 oz/a on 4-26-2023

## Field Pea Variety Descriptions

| Variety | Origin | Vine Habit[1] | Growth Habit | Vine Length | Relative Maturity | Seed Size | Resistance to Powdery Mildew[3] |
|---|---|---|---|---|---|---|---|
| **Yellow Cotyledon** | | | | | | | |
| AAC Chrome | Canada | SL | NA | Medium | Medium | M Large | R |
| AAC Julius | Canada | NA | NA | Medium | Medium | Small | R |
| AC Agassiz | Canada | SL[1] | SD[2] | Tall | Medium | Medium | R |
| CDC Amarillo | CDC | SL | SD | Medium | Medium | Medium | R |
| CDC Inca | Meridian | NA | NA | NA | Medium | Medium | R |
| CDC Spectrum | UOS CDC | SL | NA | Tall | Medium | M Large | R |
| DS Admiral | Danisco Seed | SL | SD | Tall | Medium | Large | R |
| Hyline | Great Northern AG | SL | NA | Medium | Medium | Medium | R |
| ND Dawn | NDSU | SL | SD | Medium | Medium | Large | NA |
| Salamanca | Great Northern AG | SL | SD | Medium | Early | Medium | MS |
| **Green Cotyledon** | | | | | | | |
| Aragorn | Progene | SL | SD | M Short | M Early | M Large | NA |
| Arcadia | Pulse USA | SL | SD | Medium | Early | Small | MS |
| CDC Striker | UOS CDC | SL | SD | Medium | Medium | M Large | S |
| Shamrock | Great Northern AG | SL | NA | NA | Late | NA | S |

[1] SL=semi-leafless. [2] SD=semi-dwarf.

[3]MS = Moderately Sensitive; NA = Not Available, R = Resistant; S = Sensitive.

A dry March, a wet April and a cool May fill barn and cellar and bring much hay.

**Irrigated Green Dry Pea Variety Evaluation - MSU** **Richland, MT 2023**

| Variety | Plant Height | Test Weight | 1000 Seed Weight | Protein | Adjusted Grain Yield |
|---|---|---|---|---|---|
| | (in) | (lb/bu) | (g) | (%) | (lb/a) |
| Aragorn | 20.5 | 63.4 | 224 | 24.6 | 1683 |
| B202318 | 21.6 | 66.3 | 222 | 21.9 | 1825 |
| Banner | 21.0 | 65.8 | 224 | 21.7 | 1709 |
| Fairway | 20.2 | 63.5 | 180 | 25.6 | 2007 |
| Ginny 2 | 20.4 | 65.0 | 217 | 24.1 | 1919 |
| Hampton | 20.5 | 64.0 | 221 | 26.1 | 2175 |
| MS-22G1 | 22.8 | 64.5 | 216 | 24.4 | 2656 |
| NDP150412G | 20.7 | 66.4 | 190 | 26.3 | 1700 |
| Passion | 18.4 | 65.2 | 231 | 23.1 | 1826 |
| PG 8318 | 27.6 | 65.9 | 209 | 24.6 | 2773 |
| Pro 171-7665 | 20.6 | 65.8 | 245 | 23.0 | 1443 |
| Pro 181-7124 | 20.1 | 64.5 | 236 | 24.0 | 1782 |
| Shamrock | 20.8 | 66.3 | 211 | 25.4 | 2194 |
| Mean | 21.1 | 65.1 | 217 | 24.2 | 1976 |
| P-Value | 0.0263 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| LSD (0.05) | 4.1 | 0.5 | 10.5 | 1.1 | 348.6 |
| CV (%) | 13.5 | 0.5 | 3.4 | 3.1 | 12.3 |

**Irrigated Yellow Dry Pea Variety Evaluation - MSU** **Richland, MT 2023**

| Variety | Plant Height | Test Weight | 1000 Seed Weight | Protein | Adjusted Grain Yield |
|---|---|---|---|---|---|
| | (in) | (lb/bu) | (g) | (%) | (lb/a) |
| 5206 | 26.2 | 65.3 | 216 | 24.5 | 2354 |
| AAC Beyond | 21.9 | 64.8 | 187 | 24.6 | 2287 |
| AAC Carver | 26.0 | 64.6 | 217 | 23.2 | 2347 |
| AAC Chrome | 18.8 | 64.8 | 220 | 23.6 | 2341 |
| AAC Julius | 23.4 | 64.7 | 209 | 23.9 | 2184 |
| AAC Profit | 21.9 | 65.1 | 228 | 24.0 | 2450 |
| Boost | 22.1 | 64.3 | 219 | 25.0 | 2507 |
| CDC Inca | 29.0 | 65.3 | 219 | 24.1 | 2854 |
| CDC Spectrum | 23.4 | 64.8 | 219 | 24.4 | 2384 |
| CP5222Y | 22.1 | 66.2 | 269 | 23.3 | 1919 |
| CP5244Y | 21.5 | 66.2 | 225 | 24.1 | 1603 |
| DS-Admiral | 24.0 | 65.0 | 237 | 24.0 | 2016 |
| Goldenwood | 14.7 | 66.4 | 165 | 27.3 | 1821 |
| Hyline | 22.3 | 64.7 | 221 | 23.0 | 1978 |
| LG Sunrise | 25.1 | 65.2 | 230 | 23.3 | 1859 |
| MS ProStar | 21.1 | 64.3 | 227 | 25.3 | 2038 |
| MS Winterberry | 12.4 | 64.7 | 185 | 23.9 | 2390 |
| ND Dawn | 22.8 | 65.3 | 244 | 24.0 | 2088 |
| NDP140510Y | 24.0 | 65.3 | 206 | 23.9 | 2470 |
| NDP150231Y | 24.2 | 64.8 | 194 | 24.5 | 2437 |
| Orchestra | 21.3 | 66.2 | 264 | 26.0 | 2123 |
| Payback | 14.9 | 65.9 | 162 | 25.3 | 1910 |
| PG 8927 | 24.4 | 65.1 | 234 | 24.2 | 2452 |
| PG Cash | 24.9 | 65.6 | 234 | 24.8 | 2425 |
| Pizzazz | 22.6 | 66.5 | 301 | 24.0 | 2090 |
| Pro 143-6230 | 21.8 | 64.0 | 206 | 23.9 | 1875 |
| Pro 173-7406 | 22.1 | 65.2 | 236 | 23.9 | 1914 |
| PS17100008 | 18.6 | 66.5 | 255 | 23.6 | 2225 |
| PS17100022 | 16.1 | 66.5 | 243 | 23.9 | 2389 |
| Salamanca | 27.1 | 64.6 | 237 | 23.0 | 2277 |
| Mean | 22.0 | 65.3 | 224 | 24.2 | 2198 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| LSD (0.05) | 3.3 | 0.5 | 9.3 | 0.8 | 317.1 |
| CV (%) | 10.5 | 0.5 | 3.0 | 2.3 | 10.3 |

Location: Richland, MT
Previous crop: Spring Wheat
Planted: 5-17-2023
Harvested: 8-9-2023
Applied fertilizers in lb/a: None
Soil type: Farnuf Loam
Rainfall: 7.0+ inches
DAP[1] = Days after planting
Yield adjusted to 13% moisture content
Protein presented on a dry matter basis
Herbicide: Fall-Valor, Preplant-RoundUp & Sharpen
**Note:** Trials experienced wind and hail damage in two separate stroms at the end of July

**Irrigated Green Dry Pea Variety Evaluation - MSU** **Sidney, MT 2023**

| Variety | Days to Flower | Plant Height | Test Weight | 1000 Seed Weight | Protein | Adjusted Grain Yield |
|---|---|---|---|---|---|---|
| | (DAP)[1] | (in) | (lb/bu) | (g) | (%) | (lb/a) |
| 6232-4 | 56 | 29.7 | 64.9 | 244 | 22.6 | 5418 |
| Aragorn | 48 | 23.4 | 63.1 | 228 | 25.3 | 997* |
| Hampton | 49 | 22.3 | 62.7 | 238 | 25.9 | 5042 |
| NDP150412G | 49 | 23.2 | 64.3 | 226 | 26.7 | 5233 |
| Mean | 51 | 24.7 | 63.8 | 234 | 25.1 | 4173 |
| P-Value | N/A | 0.0037 | <0.0001 | 0.04 | <0.0001 | <0.0001 |
| LSD (0.05) | N/A | 3.7 | 0.6 | 13.0 | 0.5 | 722.0 |
| CV (%) | N/A | 9.8 | 0.6 | 3.7 | 1.3 | 11.2 |

**Irrigated Yellow Dry Pea Variety Evaluation - MSU** **Sidney, MT 2023**

| Variety | Days to Flower | Plant Height | Test Weight | 1000 Seed Weight | Protein | Adjusted Grain Yield |
|---|---|---|---|---|---|---|
| | (DAP)[1] | (in) | (lb/bu) | (g) | (%) | (lb/a) |
| 6087-11 | 55 | 30.1 | 64.1 | 249 | 25.5 | 5311 |
| 6124-7 | 53 | 28.3 | 64.3 | 273 | 24.5 | 5463 |
| 6138-1 | 52 | 30.2 | 65.2 | 249 | 26.0 | 5472 |
| AAC Carver | 49 | 26.4 | 64.4 | 256 | 21.2 | 5989 |
| AAC Profit | 52 | 28.5 | 63.5 | 253 | 24.7 | 5957 |
| CDC Inca | 53 | 27.2 | 64.6 | 251 | 23.8 | 5523 |
| CP5222Y | 49 | 24.5 | 64.7 | 303 | 26.2 | 5701 |
| CP5244Y | 48 | 26.4 | 65.3 | 262 | 24.1 | 5762 |
| DS-Admiral | 49 | 23.6 | 64.4 | 255 | 23.6 | 5300 |
| LG Sunrise | 49 | 28.4 | 64.5 | 247 | 21.8 | 5234 |
| LGPN4184 | 50 | 26.0 | 64.2 | 265 | 25.6 | 5750 |
| LGPN4185 | 48 | 25.5 | 64.0 | 277 | 25.5 | 5662 |
| ND Dawn | 49 | 25.1 | 64.7 | 258 | 22.7 | 5349 |
| NDP140510Y | 49 | 26.1 | 64.6 | 224 | 22.7 | 5489 |
| NDP150231Y | 51 | 25.6 | 64.2 | 234 | 26.5 | 5258 |
| Orchestra | 49 | 25.9 | 64.0 | 313 | 27.6 | 5875 |
| PG 8927 | 51 | 28.0 | 63.9 | 284 | 25.2 | 5356 |
| PG Cash | 49 | 25.8 | 64.5 | 292 | 25.6 | 5498 |
| PS17100008 | 49 | 22.5 | 64.5 | 285 | 24.1 | 3325* |
| PS17100022 | 49 | 28.3 | 66.2 | 302 | 24.8 | 5461 |
| Mean | 50 | 26.6 | 64.5 | 267 | 24.6 | 5422 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| LSD (0.05) | 1.0 | 2.4 | 0.6 | 9.7 | 0.7 | 913.6 |
| CV (%) | 1.5 | 6.4 | 0.6 | 2.6 | 1.9 | 11.9 |

Location: EARC; Sidney, MT — Previous crop: Sugarbeet
Planted: 4-25-2023 — Harvested: 7-27-2023
Applied fertilizers in lb/a: None — Soil type: Savage Silty Clay Loam
Rainfall: 10.3 inches — Irrigation: 2 inches
Yield adjusted to 13% moisture content — DAP[1] = Days after planting
Protein presented on a dry matter basis
Herbicide: Panther @ 2 oz/a on 10-19-22; Varisto @ 21 oz/a and Cleanse @ 6 oz/a on 5-31-23
* Entries experienced significant lodging and subsequent loss to pigeons

**Irrigated Dry Bean Variety Evaluation - MSU** **Sidney, MT 2023**

| Variety (Type) | Days to Maturity (DAP)[1] | Plant Height (in) | Adjusted Grain Yield (lb/a) |
|---|---|---|---|
| Cowboy (Pinto) | 89 | 20.4 | 2842 |
| Othello (Pinto) | 84 | 17.9 | 1681 |
| USDA Rattler (Pinto) | 92 | 19.9 | 3372 |
| Viper (Red) | 88 | 21.3 | 2376 |
| Mean | 88 | 19.9 | 2568 |
| P-Value | N/A | 0.0004 | <0.0001 |
| LSD (0.05) | N/A | 1.2 | 488.3 |
| CV (%) | N/A | 3.9 | 12.3 |

Location: EARC; Sidney, MT

Previous crop: Spring Wheat

Planted: 6-6-2023

Harvested: 9-3-2023

Applied fertilizers in lb/a: 10-26-0 at planting

Yield adjusted to 13% moisture content

Rainfall: 10.3 inches

Irrigation: 4.6 inches

Herbicide: Outlook @ 12 oz/a & Powermax @ 24 oz/a on 5-25

Insecticide: Lambda Cy @ 2oz/a & Vantacor @ 1.5 oz/a on 7-29

DAP[1] = Days after planting

**Note:** Hail storm on 8/29 did minimal damage to USDA Rattler, significant damage to Othello and moderate damage to Cowboy and Viper.

"Farming isn't for everyone, but hay it's in my jeans".
– Anonymous

**Dryland Chickpea Variety Evaluation - MSU** — **Richland, MT 2023**

| Variety | Plant Height (in) | Test Weight (lb/bu) | Seed sizes greater than 22/64 inches (%) | Adjusted Grain Yield (lb/a) |
|---|---|---|---|---|
| CDC Anna | 15.8 | 60.2 | 0.8 | 1633 |
| CDC Consul | 18.6 | 60.7 | 15.9 | 1677 |
| CDC Cory | 18.2 | 57.8 | 13.3 | 1742 |
| CDC Frontier | 17.7 | 60.8 | 42.2 | 1893 |
| CDC Leader | 15.6 | 61.4 | 48.3 | 1614 |
| CDC Orion | 14.4 | 59.4 | 69.7 | 1811 |
| CDC Palmer | 16.1 | 60.8 | 66.4 | 1761 |
| CDC Sunset | 19.6 | 59.5 | 12.9 | 1194 |
| Kasin | 22.0 | 61.4 | 7.0 | 1061 |
| Myles | 14.5 | 58.4 | 0.0 | 1277 |
| Nash | 18.0 | 58.2 | 81.3 | 1204 |
| ND Crown | 21.4 | 60.6 | 72.9 | 1690 |
| NDC160236 | 17.7 | 60.7 | 71.2 | 1777 |
| New Hope | 20.4 | 60.0 | 44.2 | 1088 |
| Royal | 14.5 | 57.8 | 72.3 | 426 |
| Sawyer | 15.9 | 60.5 | 54.9 | 1596 |
| Sierra | 15.9 | 58.8 | 80.1 | 1133 |
| Mean | 17.4 | 59.9 | 44.3 | 1446 |
| P-Value | <0.0001 | <0.0001 | <0.0001 | <0.0001 |
| LSD (0.05) | 2.1 | 1.1 | 9.6 | 322 |
| CV (%) | 8.7 | 1.3 | 15.2 | 15.7 |

Previous crop: Spring Wheat
Harvested: 9-13-2023
Soil type: Farnuf Loam
Rainfall: 7.0+ inches

**Irrigated Chickpea Variety Evaluation - MSU** — **Sidney, MT 2023**

| Variety | Days to Flower (DAP)[1] | Plant Height (in) | Test Weight (lb/bu) | Seed sizes greater than 22/64 in (%) | Adjusted Grain Yield (lb/a) |
|---|---|---|---|---|---|
| CDC Anna | 51 | 21.4 | 64.1 | 0.0 | 4092 |
| CDC Consul | 52 | 21.2 | 64.4 | 0.1 | 3717 |
| CDC Cory | 52 | 20.8 | 61.8 | 0.1 | 4244 |
| CDC Frontier | 52 | 21.9 | 65.0 | 1.4 | 4234 |
| CDC Leader | 52 | 17.4 | 63.7 | 17.6 | 4227 |
| CDC Orion | 51 | 17.9 | 62.7 | 40.9 | 4165 |
| CDC Sunset | 52 | 22.2 | 63.6 | 0.4 | 3846 |
| Myles | 51 | 19.5 | 61.4 | 0.0 | 3459 |
| Nash | 52 | 19.0 | 62.3 | 72.1 | 3046 |
| ND Crown | 52 | 21.9 | 64.1 | 38.3 | 3852 |
| NDC160236 | 52 | 22.7 | 64.3 | 7.9 | 4275 |
| Royal | 53 | 19.5 | 62.4 | 73.1 | 3079 |
| Sawyer | 52 | 18.2 | 62.6 | 16.9 | 3336 |
| Sierra | 53 | 17.1 | 61.5 | 63.4 | 2878 |
| Mean | 52 | 20.1 | 63.1 | 23.7 | 3746 |
| P-Value | <0.0001 | 0.0001 | <0.0001 | <0.0001 | <0.0001 |
| LSD (0.05) | 0.7 | 2.6 | 0.6 | 4.9 | 337 |
| CV (%) | 0.9 | 9.0 | 0.6 | 14.4 | 6.3 |

Location: EARC; Sidney, MT
Planted: 4-26-2023
Applied fertilizers in lb/a: None
Rainfall: 10.3 inches
Herbicide: Panther @ 2 oz/a on 10-19-22; Outlook @ 10 oz/a on 4-26-2023
Fungicide: Miravis Top at 13.7 oz/a on 6-16 & 7-16; and Miravis Neo at 14 oz/a on 7-1

Previous crop: Sugarbeet
Harvested: 8-16-2023
Soil type: Savage Silty Clay Loam
Irrigation: 2 inches
DAP[1] = Days after planting
Yield adjusted to 13% moisture content

Farming isn't a battle against nature, but a partnership with it.
it is respecting the basics of nature in action and ensuring that they continue.

# Irrigation Research at Nesson Valley 2023

Justin Jacobs, NDSU – Williston Research Extension Center

Weather Summary - Nesson Valley, ND+

| | Precipitation | | Temperature | | |
|---|---|---|---|---|---|
| Month | 2023 | Avg‡ | 2023 | Avg‡ | Days above 89° |
| | ---inches--- | | -------degrees F°------- | | |
| Oct-Dec. 2022 | 1.88 | 1.27 | | | |
| April | 0.52 | 0.71 | 36.6 | 40.0 | 0 |
| May | 2.90 | 2.39 | 59.2 | 53.8 | 0 |
| June | 2.02 | 2.87 | 67.7 | 63.9 | 2 |
| July | 1.65 | 2.11 | 67.9 | 69.6 | 8 |
| August | 2.59 | 1.44 | 68.5 | 67.6 | 4 |
| September | 1.49 | 1.95 | 61.5 | 58.2 | 2 |
| April-July | 7.09 | 8.09 | 57.9 | 56.8 | 10 |
| April-Sept | 11.17 | 11.47 | 60.2 | 58.8 | 16 |
| Total- (Oct 2021 - September 2022) | 13.05 | | | | |

Last spring frost = May 19, 2023 (31.4°)

First fall frost = October 6, 2023 (31.0°)

+ NDAWN Hofflund site
‡ Average since January 1, 2006

Agriculture is an unpredictable occupation. There is no way to identify what some of the issues may be for the coming year. In fact, it seems like we encounter one issue in one year, so we make corrections for the following year to alleviate the impact of that previous problem only to never encounter that problem again and instead be hit with another issue entirely! This is the cycle of farming and each year we make the decision to go ahead with the season and the unpredictable problems. We place seed in the ground with the hope and expectation that it will grow into a fruitful plant by the end of the year. We base our livelihood on that seed in the ground. The decisions we make surround that seed in the ground. How do we manage our operation in order to provide the best outcome for that seed waiting in the ground? Yet, despite all of our best efforts, the unpredictable nature of agriculture may alter those efforts in the blink of an eye.

In 2023, this is exactly what happened. We began the year by cultivating the ground and preparing for crops at a somewhat later than normal date due to snow that did not want to melt. However, once the snow melted it seemed like the planting season began and ended with a blur. Some of the crops previously grown at Nesson Valley were cut from the program in 2023 due to a shortage of labor and an increase in participation of helping the dryland program get their trials planted. The primary crops were still grown; spring wheat, durum, canola, soybean, dry edible beans, and corn. The crops that were cut from this season included some of the specialty crops like barley, oats, flax, pea, safflower, and sunflower. The season started with somewhat regular rainfall in May, but was cut short in June and part of July. The linear irrigation systems were kept busy with watering despite several issues that caused multiple headaches. Along with limited precipitation in the early summer, we encountered above average heat early on in the growing season. This caused our small grain plots to go to head earlier than anticipated. Despite the small grain plots looking less than desirable for the coming harvest season, the soybeans, dry beans, and corn all looked phenomenal. In fact, the plots looked like they might provide numbers similar to the record numbers of 2022. However, the promise of an exciting harvest season was cut short by a hail storm on August 1 that completely wiped Nesson Valley out.

Despite the sudden and somewhat miserable end to the growing season for 2023, there were several things to be excited about for the future of Nesson Valley. For instance, the Williston Research and Extension Center was awarded 1.7 million dollars to build a heated shop and conference center at the Nesson Valley location. This addition will create many new possibilities for the coming years. This will allow us to be better prepared for the growing season when the weather allows us to start putting seed in the ground.

Although we encounter many unpredictable events in agriculture, we continue to cling to that hope of the seed in the ground and the potential that it may bring. Using this as a reminder, we will continue to provide valuable research for the irrigated portion of north west North Dakota for years to come.

Irrigated Soybean plots that were looking fantastic prior to the August 1 hail storm.

The aftermath of the dry yellow peas that were days away from harvest.

Dry edible bean plots that were stripped clean of all leaves and pods.

Corn with no leaf material left.

## Optimal Irrigation Strategies for Sustainable Soybean Yield under Semiarid Conditions of Northern Great Plains

Gautam Pradhan, Tyler Tjelde, and James Staricka
(Funding agency: North Dakota Soybean Council)

### Background

In irrigated agriculture, the amount and timing of irrigation play a crucial role in obtaining a sustainable higher yield with a minimum adverse effect on the environment. Insufficient irrigation results in lesser crop yield than the genetic potentiality of a given variety, while excessive irrigation escalates pumping costs, hastens the depletion of water resources, induces nutrient leaching, and contributes to environmental pollution. Soybean is the second largest irrigated crop in ND preceded by corn. There is a lack of information on the timing and amount of irrigation needed for soybean under the semiarid conditions of the Western ND.

### Objectives of the research project

The overall goal of this project is to determine the optimum amount and timing of irrigation for enhanced soybean yield, quality, and water productivity. The secondary objectives are to assess the effect of irrigation treatments on soil health manifested by changes in soil physical and chemical properties, and on the manifestation of soybean diseases including but not limited to white mold.

### Materials and Methods

- A glyphosate-tolerant soybean variety ND 17009GT was seeded at the Nesson Valley Irrigation Site, Ray, ND (Longitude: -103.1061564, Latitude: 48.1634933) on May 24, 2023, under randomized complete block design with four replications. The seeding rate was 195,000 PLS/ac with Row to Row distance of 30 in and a gross plot size of 59' X 50'.
- There were 12 irrigation treatments:
    1. Full irrigation (I)
    2. Deficit irrigation during vegetative [(VE – V(n)] stage (Wv)
    3. Deficit irrigation during flowering [R1-R2] stage (Wf)
    4. Deficit irrigation during pod development [R3-R4] stage (Wp)
    5. Deficit irrigation during seed filling [R5-R6] stage (Ws)
    6. Deficit irrigation during maturity [R7-R8] stage (Wm)
    7. Deficit Irrigation during vegetative + flowering stages (Wvf)
    8. Deficit irrigation during vegetative + pod development stages (Wvp)
    9. Deficit irrigation during vegetative + seed filling stages (Wvs)
    10. Deficit irrigation during vegetative + maturity stages (Wvm)
    11. Deficit irrigation during seed filling + maturity stages (Wsm), and
    12. Rainfed (R)
- Soil water contents at six different depths (from 6" to 36") were recorded using a neutron probe.
- Unmanned aircraft systems equipped with multispectral, thermal, or RGB cameras were flown over the experimental field at different dates to assess canopy temperature (CT), normalized difference vegetation index (NDVI), and normalized difference Red Edge (NDRE).

### Outcomes

The aerial imagery captured on July 25, 2023, highlighted discernible differences in soybean growth across various treatments. Figure 1 presents representative aerial images depicting four distinct irrigation regimes. Notably, optimal growth was observed under full irrigation (I), with a slight decrease noted under deficit irrigation during the flowering stage (wf). Growth was significantly impeded under deficit irrigation during the vegetative stage (Wv), and soybeans subjected to rainfed conditions (R) exhibited a detrimental impact on growth. The anticipation to observe the influence of these growth patterns on grain yield and quality was unfortunately disrupted by a hailstorm on the evening of August 1, 2023, as illustrated in Figure 2, resulting in the complete destruction of the entire crop.

a) Full Irrigation (I)  b) Rainfed ®  c. Deficit Irrigation during flowering stage (Wf)  d. Deficit irrigation during vegetative stage (Wv)

Figure 1. Aerial image depicting soybean growth under different irrigation regime. (Aerial imagery captured on July 25, 2023 by Gautam Pradhan).

Figure 2. Devastating effect of hail storm on soybean that occurred on August 1, 2023. (Aerial imagery captured on August 2, 2023 by Gautam Pradhan).

# Maximizing Agricultural Efficiency: Exploring the Benefits of Chickpea and Flax Intercropping

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## INTRODUCTION

Intercropping is an old, low-input, and eco-friendly cropping system that cultivates multiple crop species concurrently. Increased biodiversity in an intercropping system can lead to greater resource use, reduced harmful biotic agents, and higher resource conservation and soil health, especially for legume-based intercropping. Specific competition or facilitation between component crops may occur in an intercropping system. The species grows faster at the early growth stage and is more competitive for available resources, called dominant crops. Intercrops are most productive when minimum competition and maximum facilitation occur between crop components. Previous studies reported that competition of component crops could be affected by crop species, cultivars, sowing date, sowing ratio, and row configurations.

Intercropping legume-oilseeds has received great attention recently due to increased demand for legumes and oilseeds. The benefits of legume-oilseeds intercrop have been reported that include increased yield, reduced nitrogen fertilizer consumption, improved soil nutrient accumulation, and decreased pest pressure. Competition between pulse crop and oilseed has been investigated in pea-canola intercrop, soybean-sunflower intercrop, and pea-flax intercrop regarding pant density, sowing time, and row configuration. These studies suggested that oilseeds are stronger competitors than pulse crops, and the agronomic practice can manipulate the competition between component crops.

Evaluation of vegetative growth and yield production of chickpea cultivars in a chickpea-flax intercropping system is vital to minimize the competition and maximum productivity in the Northern Great Plain. This study aims to (i) evaluate the vegetative growth and relative competition of 16 chickpea cultivars in a chickpea-flax intercropping system and (ii) assess the biomass, seed yield, seed protein, N-uptake, and land use efficiency of intercropping one flax with 16 chickpea cultivars.

## MATERIALS AND METHODS

Two field experiments were conducted at the Eastern Agriculture Research Center (EARC) (47◦73′ N, 104◦15′ W; 594 m asl) in Sidney, MT, in the 2021 and 2022 seasons. Sixteen chickpea cultivars and breeding lines were intercropped with flax (Table 1). Sowing dates were May 7 in both years, while harvesting dates were August 17, 2021, and August 31, 2022, respectively. A above ground biomass sample was cut by hand for determining shoot length, pod number per plant, seed weight, shoot weight, and shoot nitrogen (N) on August 2, 2021, and August 19, 2022, respectively.
The experiment was a randomized complete block design with four replications. Chickpea cultivars were planted with or without flax in the field. The seeding rate of mono-crop chickpea and mono-crop flax was 40 seeds $m^{-2}$ and 730 seeds $m^{-2}$, respectively. Intercropping chickpea-flax was planted in alternate rows at 40 seeds $m^{-2}$ and 365 seeds $m^{-2}$, respectively. The plot dimensions were 1.5 m x 6 m and the distance between the chickpea and the flax was 13.5 cm. Chickpea seeds were treated with Obvius Fungicide (BASF Corporation, Research Triangle Park, NC) at 0.18 g a.i. $kg^{-1}$ seed and Cruiser 5FS Insecticide (Syngenta Crop Protection, Inc., Greensboro, NC) at a rate of 0.5 g a.i. $kg^{-1}$ seed before planting. At planting, it was inoculated with a commercial rhizobial inoculant (Primo GX2 Verdesian Life Sciences, Cary, NC). Data were analyzed using several statistical techniques. The land equivalent ratio (LER) was calculated to assess the relative competitive and land use of intercrops compared with sole crops. The LER represents the land area required by sole crops to produce the yields of component species obtained in a unit area of intercrop.

**Table 1.** Description of chickpea cultivar/lines evaluated.

| No. | Cultivar/line | Chickpea Type | Breeder |
|---|---|---|---|
| G1 | CDC Anna | Desi | CDC, Canada |
| G2 | CDC Frontier | Kabuli | CDC, Canada |
| G3 | CDC Leader | Kabuli | CDC, Canada |
| G4 | CDC Orion | Kabuli | CDC, Canada |
| G5 | CDC Palmer | Kabuli | CDC, Canada |
| G6 | Myles | Desi | USDA-ARS |
| G7 | Nash | Kabuli | USDA-ARS |
| G8 | NDC160037 | Kabuli | NDSU, USA |
| G9 | NDC160133 | Kabuli | NDSU, USA |
| G10 | NDC160138 | Kabuli | NDSU, USA |
| G11 | NDC160186 | Kabuli | NDSU, USA |
| G12 | NDC160194 | Kabuli | NDSU, USA |
| G13 | ND Crown | Kabuli | NDSU, USA |
| G14 | Royal | Kabuli | USDA-ARS |
| G15 | Sawyer | Kabuli | USDA-ARS |
| G16 | Sierra | Kabuli | USDA-ARS |

## RESULTS

### LER, TOI, and NER based on seed yield

The land equivalent ratio (LER) is the most commonly used index to assess the land use of intercrops compared with sole crops. The LER represents the land area required by sole crops to produce the yields of component species obtained in a unit area of intercrop. An LER larger than one means that intercropping is more efficient in land use than sole cropping. Contrary to the LER, which is a sum of dimensionless ratios, the net effect of intercropping is expressed in terms of a yield difference per unit area. Here, we will express the net effect as a yield ratio (total yield observed)/(total yield expected) to make it more easily comparable to the LER. This net effect ratio (NER) reflects the relative yield when intercropping two crop species, compared with the weighted average of the sole crop yields where the species proportions in the mixture serve as weights. Transgressive overyielding is relevant when the objective is to maximize the production of calories, protein, forage, biomass, or bioenergy per unit area. As a metric for transgressive overyielding, we propose the ratio of total intercrop yield over the highest sole crop yield of the component species (i.e., Transgressive overyielding index; TOI).

The results showed that LERc, LERf, LER, TOI, and NER in terms of seed yield varied among cultivars ($P \leq 0.05$, Figure 2). LER based on grain yield was affected by intercropping treatment ($P<0.01$, Figure 2). Cultivar had significant effect on LERf based on grain yield (Figure 2). Tweleve chickpea cultivars and breeding lines have LERc higher than 0.5 with an average of 0.560 in 2021, while in 2022 all cultivars and breeding lines have LERc higher than 0.5 with an average of 0.790. The highest LERc was observed for G7 (Nash, 0.635), and the lowest was displayed for G16 (Siera, 0.413) in 2021, while in 2022 the highest LERc was observed for G3 (CDC Leader, 0.861)and the lowest was displayed for G6 (Myles, 0.651). The highest LERf was observed when intercropped with G1 (CDC Anna, 0.680), and the lowest was displayed when intercropped with G15 (Sawyer, 0.467) in 2021, while in 2022 the highest LERf was observed when intercropped with G1 (CDC Anna, 0.614)and the lowest was displayed when intercropped with G11(NDC160186, 0.268).

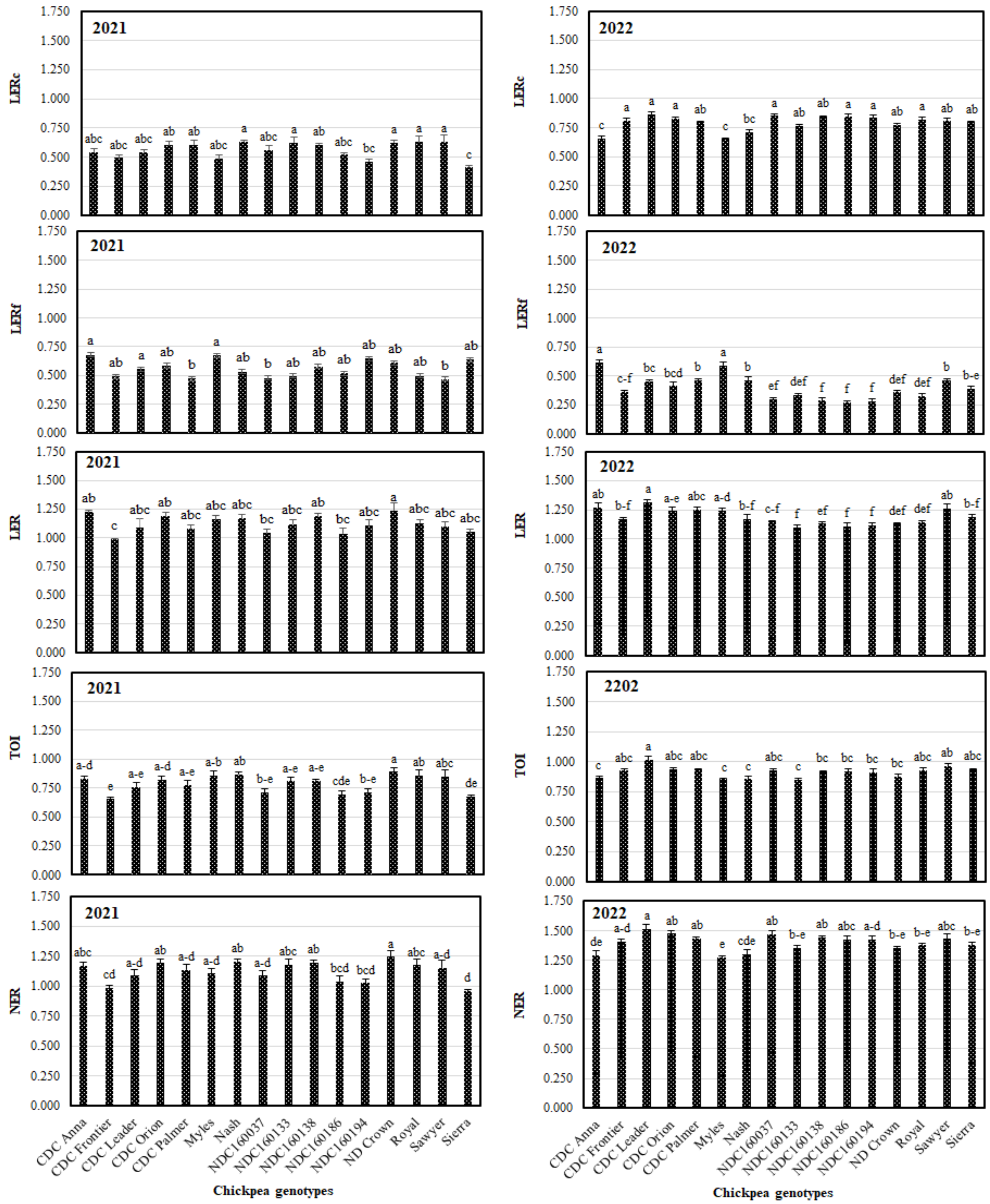



**Figure 2.** The land equivalent ratio of chickpea (LERc), land equivalent ratio of flax (LERf), land equivalent ratio of both crops chickpea and flax (LER), Transgressive overyielding index (TOI), and Net effect ratio (NER) of 16 chickpea cultivar/line seed yield intercropped with flax grown in two years of 2021 and 2022. Bars represent standard errors (SE) of 16 chickpea cultivar/line seed yield means. The vertical bars with different letters are significantly different from each other at $P \leq 0.05$ according to Tukey's HSD (honestly significant difference) test.In 2021 season, intercropping produced 1627.3 kg ha$^{-1}$ of chickpea

and 630.9 kg ha$^{-1}$ of flax, which represented 12.1% more seed yield than expected. Intercropping saved 3.8 – 23.6% (on average 12.7%) of the required land compared with production of the same species in sole crops. In 2022 season, intercropping produced 3934.1 kg ha$^{-1}$ of chickpea and 602.8 kg ha$^{-1}$ of flax, which represented 39.7% more seed yield than expected . Intercropping saved 10.0 – 31.4% (on average 18.7%) of the required land compared with production of the same species in sole crops.

**CONCLUSION**

Agricultural diversification proves beneficial for agronomic, environmental, and dietary purposes. Our research, based on two field experiments, affirms that cultivating two species i.e., chickpea and flax simultaneously in the same plot (intercropping) significantly conserves land compared to single crops, particularly when aiming to produce a diverse range of crop products. Therefore, intercropping has the potential to enhance crop production diversity and promote more sustainable cropping systems. Our study confirms the considerable potential of intercropping in advancing sustainable agricultural production and supporting varied diets.

# Horticulture Program at Williston Research Extension Center

Rojee Chipalu Pradhan

***"The glory of gardening: hands in the dirt, head in the sun, heart with nature. To nurture a garden is to feed not just the body, but the soul."* – *Alfred Austin***

As a Horticulture Research Specialist at Williston Research and Extension Center, I implemented the horticulture program in dryland as well as in irrigated areas. Every year is different in terms of human resources and environment. This year I had a wonderful team to fulfill my project goals as well as got volunteering from two Master Gardeners (Photo 11 and 12). Despite all challenges, we were able to maintain the WREC horticulture garden and landscapes at their absolute best. A hail storm that occurred in the evening of August 1st massively damaged most of flowers, tomatoes, peppers and squashes. The total seasonal rainfall from January 1 to October 31, 2023 was 13.46 inches. There is a sprinkler system to water the plants on frequent interval. The last spring frost occurred on May 3, 2023, and the first fall-killing frost on October 10, 2023. As a result, the growing season was 158 days long, which is comparatively one week shorter than previous year. (Source https://ndawn.ndsu.nodak.edu)

## WREC Garden

The Williston Research Extension Center has a big garden and portion of garden is dedicated to All-America Selection Display Garden, Certified Pollinator Garden, Daylily Collection Bed, small High Tunnel and areas of small fruits. Over the years we did lot of research in small fruits such as Juneberry, Raspberry, Grapes and Haskap.

### A. All-America Selections Display Garden

The Williston Research Extension Center garden has been an All-America Selection (AAS) public display garden for more than a decade. All-America Selection is a national, non-profit plant trialing organization in North America founded in 1932. The AAS Mission Statement is "to promote new garden varieties with superior performance judged in impartial trials in North America" (https://allamericaselections.org/about). The display garden project was started with stem cuttings of different varieties of Geranium from the beginning of December 2022. AAS flower and vegetable seeds were seeded in the Horticulture lab under the light shelves (Photos1-3) from the beginning of March to the first week of May 2023. Before transplanting in the ground, they need to be acclimatized to natural environments. For this we kept the seedlings outside everyday gradually increasing hours of exposure in sun (Photos 4 and 5) for about two to three weeks. The seeding date was based on the growing requirements of a variety given in a seed packet. Some varieties required at least ten weeks before they were suitable for transplanting outside. The list of AAS winners' flowers and vegetables grown in the garden are given in Tables 1 and 2. In addition to the All-America Selection varieties, other annual flowers and vegetables were also planted in the display garden. The vegetable and flower seedlings were transplanted in the garden from the end of May until middle of June. Whereas some seeds were sown directly in the fourth week of May such as peas, lettuce, corn, bean, and cucumber, etc. The AAS winners produced around 747 lbs. of fresh vegetables (193 lbs. tomatoes, 144 lbs. winter squash, 91 lbs. pumpkin, and 75 lbs. pepper (Photo 10) and 70 lbs. fruits (watermelon and strawberry). We received flower and vegetable seeds from All-America Selections around September/October 2022 and live plants (flower) in April 2023. AAS sent us vegetable and flower varieties that won national or regional competitions in recent and previous years. People interested in gardening can visit their website (https://allamericaselections.org) for cultivar information, gardening tips, the latest winners as well as recipes, and landscape ideas.


Photo:1. Different flower seeds grown under light shelves using heating mat. Photo 2. Seedlings were transplanted into six cubes. Photo 3. Vegetable and flower seedling under light shelves from seeding to 4 to 6 weeks old. Photo 4 & 5. Acclimatization of seedling outside horticulture lab. Photo 6. Seedlings are transplanted in garden. Photo 7 & 9. AAS flowers and vegetables with AAS variety markers. Photo 8. AAS Display Garden Sign Board. Photo by Rojee Chipalu Pradhan.

**Table 1. List of AAS winners' flowers planted in display garden in 2023**

| | |
|---|---|
| **2023 Winners** | Marigold, Big Duck Orange |
| Coleus, Premium Sun Coral Candy | Marigold, Big Duck Yellow |
| Snapdragon, DoubleShot™ Orange Bicolor | Marigold, Garuda Deep Gold |
| Salvia, Blue by You | Nasturtium, Baby Rose |
| **2022 Winners** | Petunia, Wave® Carmine Velour |
| Begonia, Viking™ Explorer Rose on Green | Vinca Mega Bloom Polka Dot |
| Celosia, Flamma Orange | Zinnia, Holi Scarlet |
| Petunia, Bee's Knees | **2018 Winners** |
| Sunflower, Concert Bell | Canna, South Pacific Orange |
| Verbena, Vanity | Marigold, Super Hero Spry |
| **2021 Winners** | Ornamental Pepper, Onyx Red |
| Zinnia, Profusion Red Yellow Bicolor | Zinnia, Queeny Lime Orange |
| **2020 Winners** | **2017 Winners** |
| Rudbeckia, Amarillo Gold | Geranium, Calliope® Medium Dark Red |
| **2019 Winners** | **2016 Winner** |
| Begonia, Viking™ XL Red on Chocolate | Geranium, Brocade Fire |
| Marigold, Big Duck Gold | **2013 Winner** |
| | Canna, South Pacific Scarlet |

**Table 2. List of AAS winners' vegetables planted in display garden in 2023**

| | |
|---|---|
| **2023 Winners** | **2018 Winners** |
| Pepper, Jalapeno San Joaquin | Corn, Sweet American Dream |
| Squash, Sweet Jade | Pak Choi, Asian Delight |
| **2022 Winners** | Pepper, Cayenne Red Ember |
| Eggplant, Icicle | Tomato, Cocktail Red Racer |
| Lettuce, Bauer | Tomato, Valentine |
| Pepper, Buffy | |
| Pepper, Dragonfly | |
| Pepper, Quickfire | **2017 Winners** |
| Tomato, Pink Delicious | Bean, Pole Seychelles |
| Tomato, Purple Zebra | Okra, Candle Fire |
| **2021 Winners** | Pepper, Chili Pie |
| Squash, Goldilocks | Pepper, Sweetie Pie |
| **2020 Winners** | Squash, Honeybaby |
| Cucumber, Green Light | Tomato, Midnight Snack |
| Pea, Snack Hero | Tomato, Patio Choice Yellow |
| Pumpkin, Blue Prince | Watermelon, Gold in Gold |
| Tomato, Apple Yellow | |
| Tomato, Celano | **2016 Winners** |
| Tomato, Chef's Choice Bicolor | Pepper, Escamillo |
| Tomato, Early Resilience | Pumpkin, Pepitas |
| Watermelon, Mambo | Strawberry, Delizz |
| **2019 Winners** | **2015 Winner** |
| Pepper, Just Sweet | Squash, Bossa Nova |
| Potato, Clancy | Basil, Dolce Fresca |
| Tomato, Fire Fly | Basil, Persian |
| Tomato, Mountain Rouge | **2014 Winner** |
| Tomato, Red Torch | Tomato, Fantastico |
| Tomato, Sparkly XSL | |


Photo 10**.** Harvested produce from garden. Photo by Rojee Chipalu Pradhan.

## B. Historic Daylily Collection

Photo11. Daylily collection. Photo by Rojee Chipalu Pradhan.

The World Collection of Daylilies was established in the Williston Research Extension Center dryland station in 2004. Over the years, different cultivars of Daylilies have been added to the collection area. The Daylily plants were relocated in 2018 to another area to maintain plant distance, and landscape fabric was used to reduce weed infestation. Some varieties of Daylily received from NDSU, Fargo in the fall of 2019, were transplanted in May 2020. All the Daylilies from the old bed were completely relocated to the new bed in 2020. The Daylily collection area has been maintained by watering once a week, regular hand weeding, and fertilization. There are around 124 different cultivars of Daylily in our collection.

### C. Certified Pollinator Garden


The certified pollinator garden was established in 2016. The objectives of Master Gardener Certified Pollinator Garden are to provide Master Gardeners with volunteering opportunities, to build a habitat that will nourish pollinators, and to create a public teaching garden that Master Gardeners and Extension Agents can jointly utilize. These activities encourage members of the general public to build home pollinator gardens. Different pollinator-friendly annual flowers were planted in the pollinator garden in 2023. This garden was maintained by regular watering, and hand weeding. This year one master gardener volunteer exclusively helped me in maintaining the maintain pollinator garden. I really appreciate her time and efforts.

### D. Small Fruits

There are few plants of sour cherry, juneberries, four varieties of raspberry and twelve different varieties of Haskap in the garden. We harvested around 254 lbs. of small fruits and giveaway to community members.

### E. High tunnel

The WREC constructed a high tunnel for horticultural research in 2006 with renovations done in 2013. Over the year we used high tunnel to grow lot of vegetables. High tunnel plastic was ripped due to high wind on 2021. This year we repaired the high tunnel frame and put new plastic cover on it. I really want to give big thanks to WREC agronomy team, soil scientist, and horticulture team for their help in repairing the high tunnel.

High tunnel repair team Photo by Rojee

## Landscape Management

One of the major tasks of the horticulture program is to manage the landscaping area around The Ernie French Center. The surrounding areas had new plantings in 2015 that highlight the ever-increasing hardy plant selections for western North Dakota. In addition to the existing all the perennial plants, different cultivars of annual flowers were planted in the landscape to enhance the embellishment of the periphery of the office building. These landscape and lawn area were regularly maintained by running sprinklers, applying nutrients, deadheading, and mowing lawn on weekly basis. Some glimpses of landscapes are given below.


Perennial and annual flowers around The Ernie French Center building. Photo by Rojee.

## Collaboration, Outreach Activities, and Dissemination of Information

The activities and findings of the projects were delivered to the target audiences by presenting at:

- **Horticulture Field Day**: Field days is a big event to interact with local community members. This year a Horticulture Field Day was held on July 13, 2023. During field days we always invite the experts from NDSU campus for presentations. There were four presentations: Conifer Issues in Western North Dakota by Dr. Joseph Zeleznik, Forester School of Natural Resources sciences, NDSU; Growing raspberries and strawberries in Northern ND by Dr. Tom Kalb, Extension Horticulturist, Plant Sciences; Weed management in Garden by Kelly Leo, Extension Agent, Williams County, NDSU, a garden tour and presentation about All Americas Selections-Flowers and Vegetables and pollinator garden by Rojee Chipalu Pradhan, Horticulture Research Specialist, WREC.



Horticulture Field day presentation. Photo by Diana Jaszczak.



Horticulture garden tour. Photo by Diana Jaszczak.

- **Garden Tour**: Williston Research Extension Center Garden is a public display garden; hence individuals and groups are welcomed to take a garden tour. In 2023, we gave a group tour to leadership Williston, Williston state college students, and students of Trenton summer school at different days.

- **Presentation:** I gave presentation on horticulture program at Williston Research Extension Center, to Leadership Williston and Williston state college students.

- **Spring Tree and Garden Workshop:** This workshop was organized by- NDSU Extension in Williams County. I gave a presentation as well as hands on training on seed starting indoors, seeding pinching and pruning.

### 2023 North Dakota Exotic Woodboring/Bark Beetle Survey:

Every year, the North Dakota Department of Agriculture conducts a North Dakota Exotic Woodboring/Bark Beetle Survey in the shelter belt trees of the Williston Research Extension Center. There were five different traps on five trees (different tree species such as Ash, Pine, Spruce, Oak etc.). These traps were installed on May 10, 2023, and removed on September 8, 2023. Lures were replaced according to scheduled instructions. Every two weeks, I collected insects and shipped to the ND Department of Agriculture.

Exotic wood borer trap hanging in WREC Tree. Photo by Rojee Chipalu Pradhan.

### Community service:

This year also, I gave away seedlings of peppers, tomatoes, and squash to our community members. The local community also received small fruits and vegetables harvested from our WREC garden.

**Master Gardener**: Diana Jaszczak helped in maintaining pollinator garden throughout the season and Lisa Zunich helped in transplanting seedlings in display garden.

Photo 11. Horticulture team left to right: Drake Healy, Rojee Chipalu Pradhan, Gabriel Hobbs, and Neveah McElderly (no picture)

Photo 12. Left to right: Master gardener Diana Jaszczak, Rojee Chipalu Pradhan.

Begonia Viking™ Explorer Rose on Green

Marigold Big Duck Gold

Celosia Flamma Orange

***"Gardening is the art that uses flowers and plants as paint, and the soil and the sky as canvas."* - Elizabeth Murray**

# Increasing the competitiveness of local fruit production with tunnel grown strawberry in North Dakota.

Rojee Chipalu Pradhan, Tyler Tjelde, James Staricka, Ortiz Samuel

Strawberry (*Fragaria x ananassa*) plant belongs to the Rosaceae family and is native to the temperate regions of the Northern Hemisphere. Strawberry is an herbaceous perennial plant with a fibrous root system. They are high in soluble fiber, vitamin C, folate, potassium, and antioxidants. This study will increase consumer knowledge about adapted strawberry cultivars and demonstrate the benefits of using tunnels for berry production. The trial was established in collaboration with Dr. Harlene Hatterman-Valenti, Professor, High-Value Crop Production, NDSU, Fargo. This project was partially funded by the USDA-AMS Specialty Crop Block Grant Program and terminated on June 30, 2023.

## Materials and Methods

**2021**:

The experiment was conducted at the WREC Nesson Valley Research and Development site to examine the production of strawberries under open field, low tunnel and high tunnel. Six different day neutral strawberry cultivars (Table 1 and Photo 16) were planted in June 2021 in randomized block design with four replications. Each treatment plot had five plants. Some strawberries plant did not survive for different reasons. So, we replanted strawberry plant in October 2021.

Table 1. Strawberry cultivars and descriptions.

| S.N. | Cultivar Name | Plant Habit | Fruit Size | Fruit Firmness | Fruit Color |
|---|---|---|---|---|---|
| 1. | Albion | 8-10” | Large/ Very Large | Very firm | Red in color |
| 2. | Evie II | 14” | Large | Medium | Red in color |
| 3. | Fort Laramie | 8–10” | Large to VL | Firm | Bright scarlet |
| 4. | Portola | 6-9” | Large/ | Firm | Lighter in color |
| 5. | San Andreas | 6-8” | Large/VL | Firm | Slightly lighter Red than Albion |
| 6. | Seascape | 12-18” | Large | Firm | Brilliantly Red |

**2022:**

Most of the strawberry plant could not overwinter; nearly two percent of plants survived. Hence, we again purchased new strawberry plants in May 2022. Bare root strawberry plants, immediately on arrival, were planted in three inches pots and raised under light shelves. These plants were transplanted in June 23, 2022 (Photo 1). Each planting hole was fertilized with one fourth cup of starter fertilizer (N:P:K:S:Z = 12:40:0:10:1) before planting. Fortnightly, Miracle Gro All Purpose Plant Food was applied at the rate of one tablespoon in a gallon of water until beginning of October. Some of strawberry plants (around 30 percent) could not survive. The survival rates of San Andreas and Fort Laramie was around 40 percent whereas the survival rates of Evie II, Portola and Seascapes was more than 70 percent. Therefore, we re-transplanted all the cultivars in September 27, 2022 except Seascape. In the beginning of November, we covered all the strawberry plants by straw up to three inches and row covers. (Photo 5 to 7).


Photo 1 & 3. Strawberry planted under open field and low tunnel (June, 2022). Photo 2 & 4. temperature data loggers installed in open field and high tunnel in 2022. Photo by Rojee.


Photo 5-7. Strawberry plant cover with straw and row covers in open field, low tunnel and high tunnel in November 2022. Photo by Rojee.

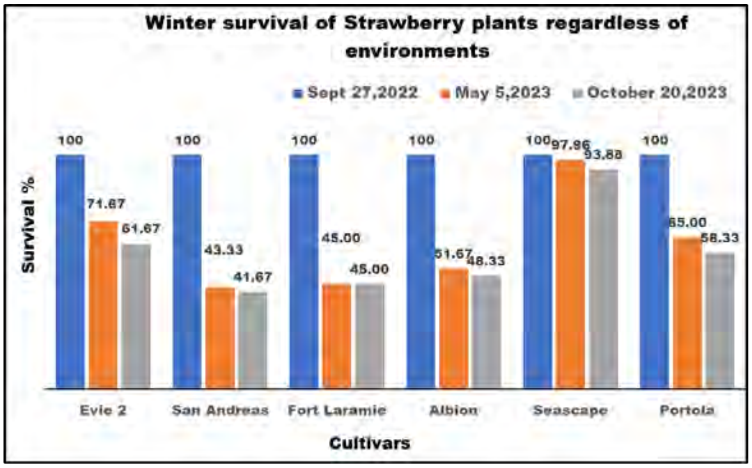
## 2023:

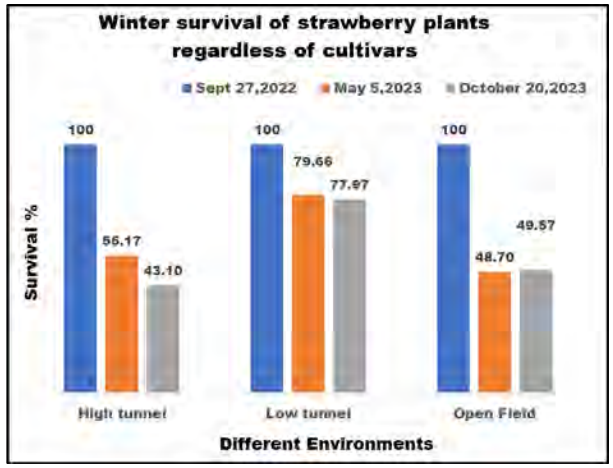
We removed all the straw and row covers in high tunnel in the first week of April. At that time there was almost two feet of snow in open field. Some row covers were blown away by wind around April 15. We removed remaining row covers and straw in the last week of April. We took the survival note. Every week, growth parameters (no of runners, growth stage) were measured and ripe berries were harvested. Fortnightly, the runners were removed and Miracle Gro All Purpose Plant Food was applied at the rate of one tablespoon in a gallon of water until September 30$^{th}$. The yield parameters include number of fruits and the weight of marketable and unmarketable fruits. The criteria for unmarketable fruits are mainly fruit weight (<7 gram), deform shape, and damaged fruit (eaten by bird, goffer, mice, flies, frost damage, etc.). Strawberries were harvested and weighed from each plant separately. Brix and pH were measured from berries (each plant) from open field, low tunnel and high tunnel on three Julian days of the year (167, 209 and 275). Julian days is a continuous count of days since January 1. Brix percentage was quantified using a DiFluid Pocket Refractometer (Shenzhen Digitizing Fluid Technology) and pH by Checker Portable pH Meter (Hanna Instruments) Photo 8.


Photo 8. Brix and pH value recorded using DiFluid pocket refractometer and Checker portable pH. Photo by Rojee.

## Results and Discussions

**Winter Survival:** Winter survival of strawberry plants is given in Figures 1 & 2 and photo 9 to 11. Regardless of cultivars, survival rate was around 80% in low tunnel, followed by high tunnel 55%, and open field 49%. On September 2022 we replanted strawberry in low tunnel (24%), high tunnel (33%) and open field (43%). Most of the replanted plants could not survive the winter. Over the course of the growing season, other plants also died. Overall, the variety San Andreas had lowest survival around 42 percent and Sea scape had the highest around 94 percent survival.




Figures 1 and 2. Winter survival of strawberry plant in different environments.

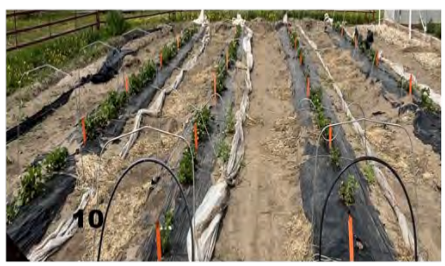
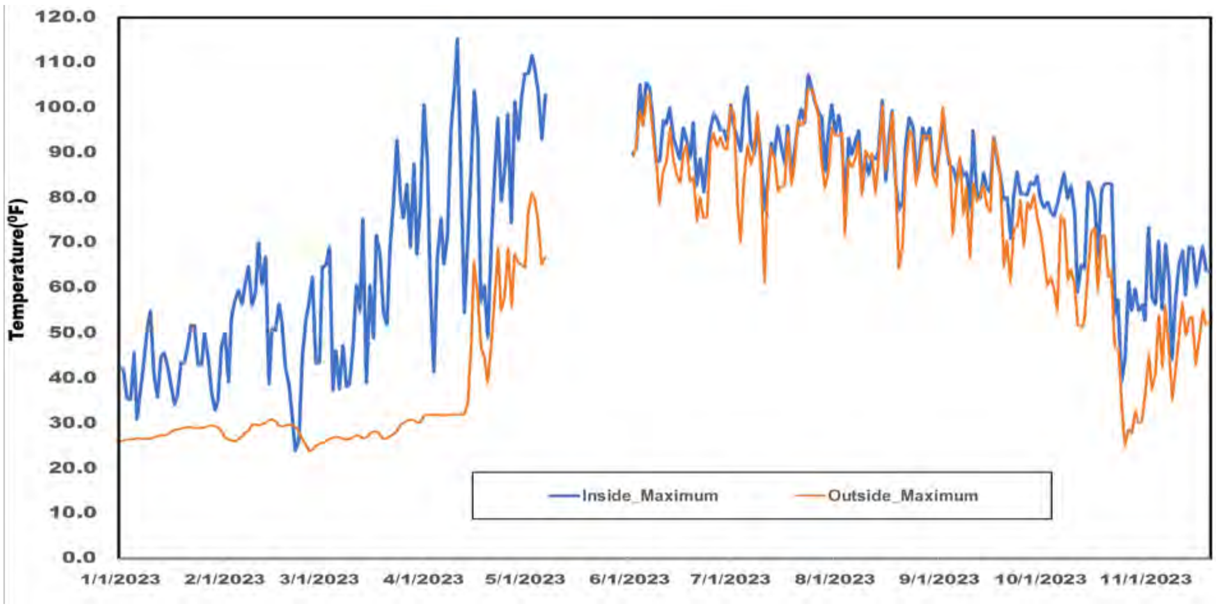



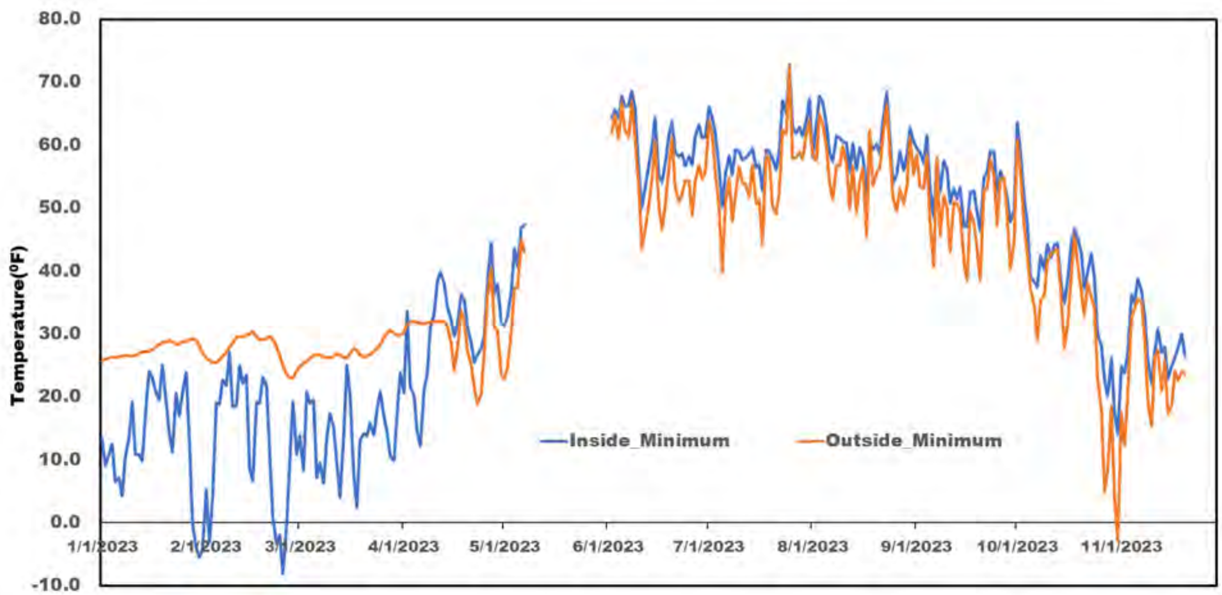


Photo 9-11. Winter survival of strawberry plant in different environments. Photo taken on May 23, 2023 by Rojee.

**Temperature:** Daily recorded temperatures from Jan 1, 2023 to November 20, 2023 are given in figures three and four. There was no data recorded from May 8 to June 1 due to equipment malfunction. The data logger outside the field was covered with row cover and snow until April 15, 2023. There were no/little differences in maximum and minimum temperature outside until April 15 because the censors were under the snow and row covers. Whereas inside the high tunnel there was a lot of differences between minimum and maximum temperature. The minimum temperature recorded was negative 8.1 ˚F in February 24 and maximum temp 115.4 °F in April 15. There was an average five degrees difference between open field and high tunnel in minimum and maximum temperature from June to September, but in the month of October and the difference for maximum temperature was around 15 degrees. The first minimum temperature of <32 °F was recorded in October 7 and 15 in outside and high tunnel, respectively.




Figures 3. Daily Maximum temperature inside (high tunnel) and outside.




Figures 4. Daily Minimum temperature inside (high tunnel) and outside.

**Growth, Yield and berry quality:** There was a difference in plant growth, yield, and berry qualities in three different environments as well as in cultivars.

**Plant stand**: As I mentioned earlier, around 60 percent plant survived regardless of cultivar and environment during winter. Strawberry plants started producing berries from end of May. The first harvesting started from June 16 in few plots, and continued until second week of October in open field and until first week of November in high tunnel. A hail storm that occurred in the evening of August 1st massively damaged strawberry plants located outside of high tunnel (Photo 12 & 13). Surprisingly, all the strawberry plants recovered from the damage (Photo 14 &15) and, I was able to harvest strawberry from first week of September to second week of October (until first fall frost) in open field and low tunnel. Storm ripped and blew away the plastic cover on low tunnel, so there was no environmental difference between open field and low tunnel.


Photo 12 & 13. Hail Damaged strawberry plants (Photo taken on August 2). Photo 14 & 15. Recovered strawberry plants (photo taken on August 23). Photo by Rojee.

### Quality parameters

**Brix**: Brix is a unit of measurement for the sugar concentration in a fruit juice. Fruit juice contains other soluble solids which affects the brix measurement. Hence, it is also referred as soluble solid content. There was a significant difference among strawberry cultivars and between two Julian days for brix percentage *(P value <0.05)*. Regardless of environment and Julian days Fort Laramie had highest soluble solid content and Evie II had the lowest (Figure 5). The Brix percentage in berries ranged from 5.8 to 7.39%. Regardless of environment and cultivar fruits harvested on 209th Julian days had higher brix percentage (Figure 6).

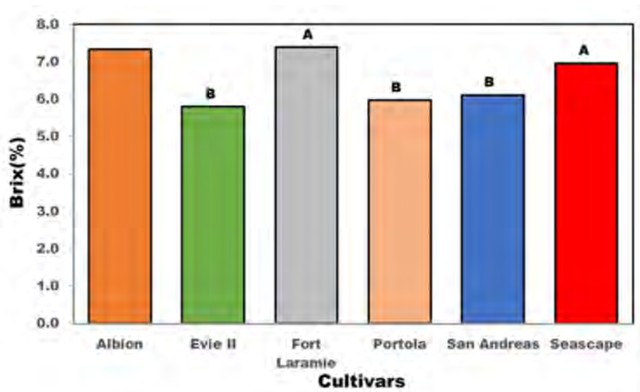



Figure 5. Brix percentage in various cultivars.

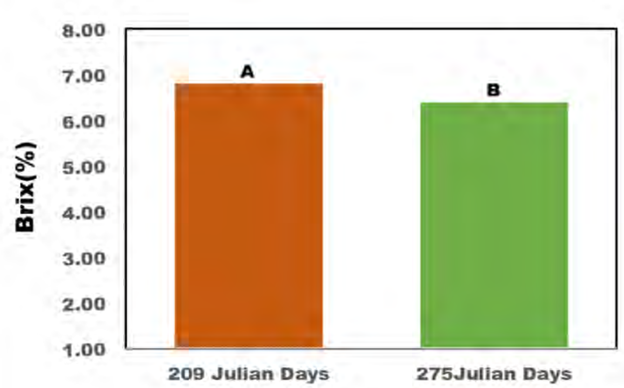



Figure 6. Brix percentage in different Julian days.

**pH:** pH is used to determine the acidity level in fruit juice. There was a significant difference among strawberry cultivars and between two Julian days for pH level *(P value <0.05)*. Regardless of environment and Julian days Fort Laramie had the highest pH and Seascape had the lowest (Figure 7). The pH in berries ranged from 3.12 to 3.42. Regardless of environment and cultivar the 275th Julian days had higher pH Figure 8.

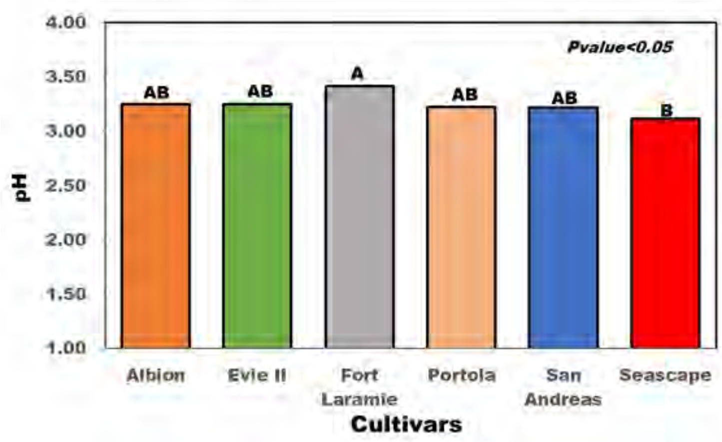



Figure 7. pH value in strawberry cultivars.

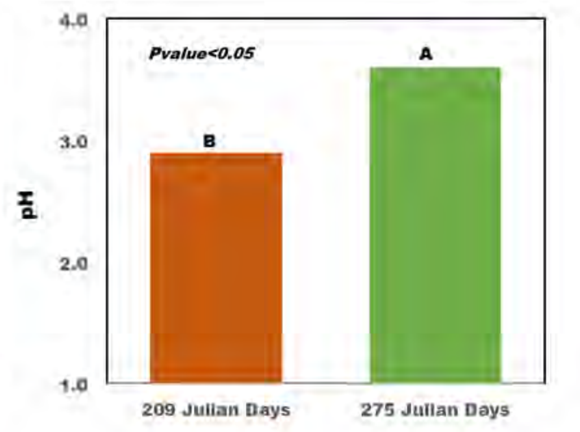



Figure 8. pH value in different Julian days.

**Yield:** There was an interaction effect between environment and cultivars for marketable total fruit number per plant (Figure 9) and marketable total yield per plant( Figure 10). The hail damage of strawberry plants in open field and low tunnel may be the reason for an interaction effect. The variety Portola produced highest marketable total fruit number (94) and marketable yield per plant (1200 g), whereas Fort Laramie produced lowest marketable fruit number (14) and marketable yield per plant (192 g). Overall, we harvested around 68 lbs of marketable fruit that is 65 percent of the total yield.

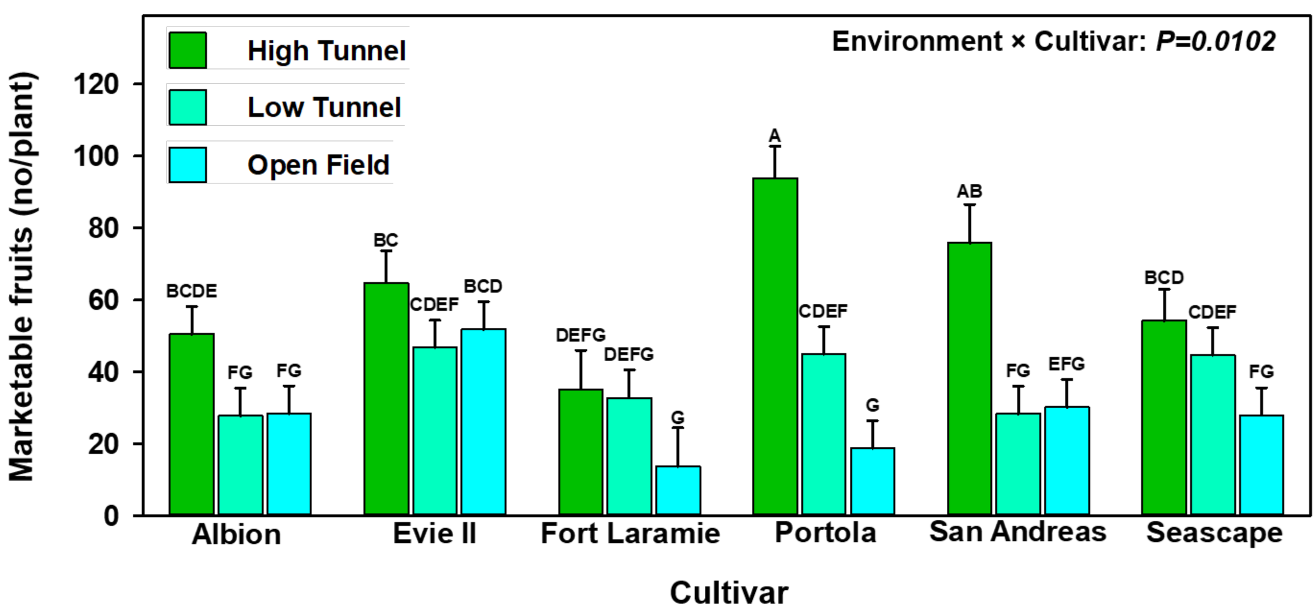



**Figure 9. Number of marketable fruits in different environments.**

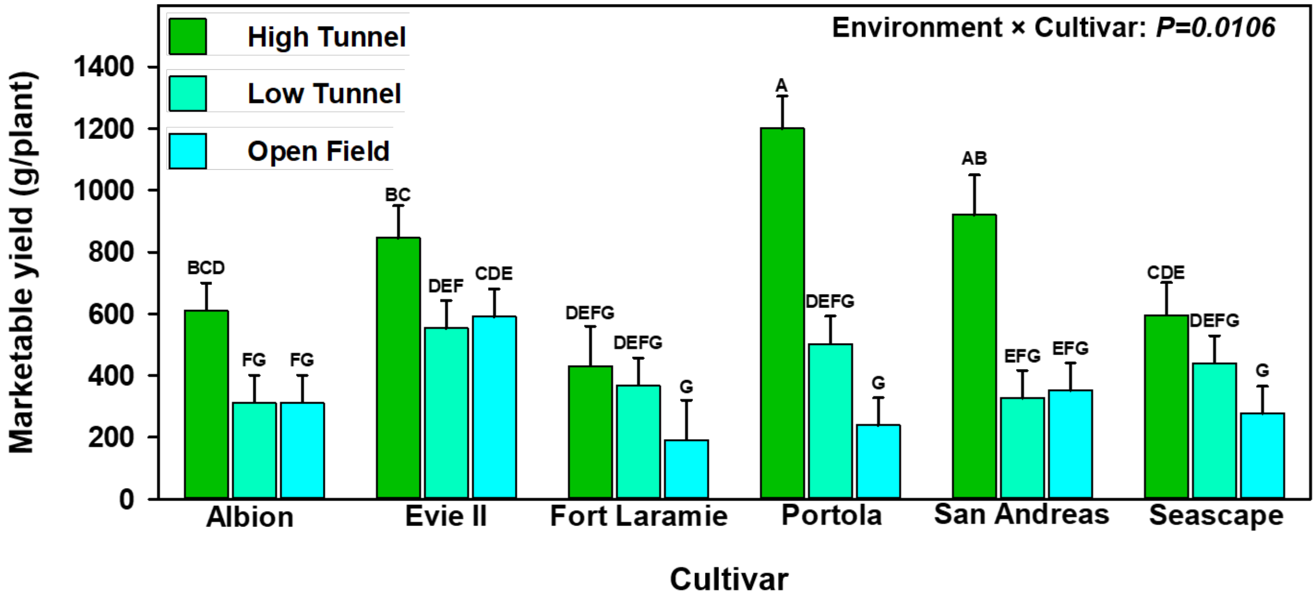



**Figure10. Marketable yield of strawberry cultivars in different environments.**

## Summary:

The outcomes showed that the high tunnel extends growing period of strawberries plants and results into higher berry yield compared to open field and low tunnel. Some of the variety did not survive during transplanting and over wintering. In our western region, high tunnel may be used to successfully grow some of the strawberry (specialty crop) variety. However, high tunnel needs to be monitored closely for the temperature fluctuation. The data loggers observed more than 90 °F one time in the month of March and from 90 to 115 °F for 11days in the April.


Photo 16. Day neutral Strawberry cultivars. Photo by Rojee.

# Growing Guar Beans under no-till semiarid conditions of Northern Great Plains

Gautam P. Pradhan, Saurabha Koirala, Md Mukhlesur Rahman
(Funding Agency: USDA-AMS/ND DoA)

**Background:**
North Dakota has been experiencing huge fluctuations in pea (*Pisum sativum* L.), and lentil (*Lens culinaris* Medik) acreage (Fig. 1). The change can be partially attributed to diseases, extreme weather events, and shifts in global legumes supply and demand. To address the challenges in farming, it is essential to introduce new legume crops that seamlessly integrate into existing cropping patterns, contribute to soil health, and are economically viable.

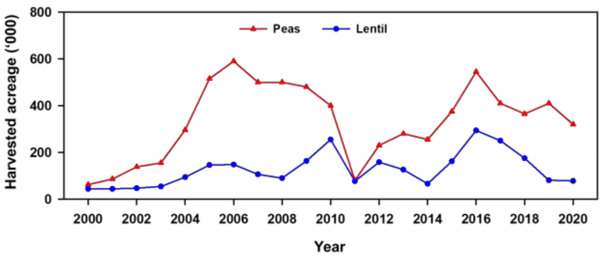



Figure 1. North Dakota Peas and Lentil Acres. Source: USDA-NASS, 2020.

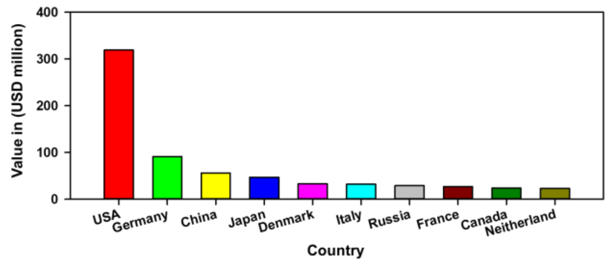



Figure 2. Top Ten Major Guam Importing Countries and Imported Values in 2019

Pic. 1.Guar plant with flowers.

Pic. 2. Guar plant with pods.

Pic. 3. Guar grains.

Guar (*Cyamopsis tetragonoloba* L.) is a drought tolerant annual legume that thrives best under arid to semiarid climate and the source of guar gum. It is a specialty crop that has high nutritional, agricultural, and economic values (Table 1).

Table 1. Nutritional, agricultural, and economic benefits of guar.

| **Benefits** | **Guar (*Cyamopsis tetragonoloba* L.)** |
|---|---|
| Human health | 1. Improves Digestion. 2. Lower Cholesterol Levels. 3. Reduce Blood Pressure. 4. Makes Bones and Teeth Stronger. |

| | |
|---|---|
| Agricultural | 1. Fixes nitrogen from air into the soil. 2. Thrives best under arid to semiarid climate. 3. Has a deeper root structure and greater foliage than peas and lentils, which successfully reduces soil erosion and effectively suppresses weeds. 4. Tolerant to soil salinity and alkalinity. |
| Economic | 1. USA is the top importer of guar gum ($300 million in 2019) in the world (Fig. 2). 2. Global market may increase from USD 787.6 million in 2019 to 1111.8 million by the end of 2028. |

## Objectives

- To evaluate the feasibility of growing and cultivating guar under no-till dryland conditions of Northern Great Plains of the USA.
- To identify guar genotypes best adapted to the dryland conditions.

## Materials and Methods

Eighteen guar accessions were seeded at the NDSU Williston Research Extension Center dryland research site (Latitude 48.12632; Longitude -103.738798) on June $9^{th}$, 2022. The experimental design was alpha lattice with two replications. The experimental field was kept weed free by spraying Spartan Charge Herbicide @ 3.5 fl. oz/ac on 5/6/2022 and hand weeding whenever needed. During crop growth, drones equipped with multispectral, thermal, or RGB cameras were flown over the experimental field to estimate Canopy Temperature (CT), Normalized Difference Vegetation Index (NDVI), and Normalized Difference Red Edge (NDRE). At maturity, we measured plant height, collected biomass, and hand harvested the crops. The harvested crops were air dried and processed using a laboratory thrasher. The data were analyzed using PROC GLIMMIX in SAS 9.4. The accessions were tested as fixed effects and replication, block (replication) were treated as random effects. The LSMeans were separated at LSD 0.5% level.

## Results

The guar accessions showed significant differences for cluster number, grain number, thousand grain weight, and grain yield but not for plant height. The average plant height of guar was 17.4 inches. PI 254367 exhibited the highest number of clusters per plant, with PI 288443 following closely, whereas PI 271546-1 demonstrated the lowest count (Fig. 3). In terms of grains per pod, PI 255928 led the way, trailed by PI 116034-1 and PI 288443, while PI 263900 displayed the fewest grains (Fig. 4). Grains from PI 263900 and PI 271546 were the heaviest, with PI 271546-2 ranking next, whereas PI 116034-1 and PI 288742 produced the lightest grains (Fig. 5). The top grain yields were from PI 428572-2, PI 428572-1, and PI 116034-1, with PI 288443 close behind, while PI 288347 yielded the lowest (Fig. 6).

## Summary

The findings demonstrated that there is a large genotypic variability for yield components and grain yield among guar accessions. The findings indicated that the guar may be grown in the Northern Great Plains of the United States under no-till, semiarid conditions.

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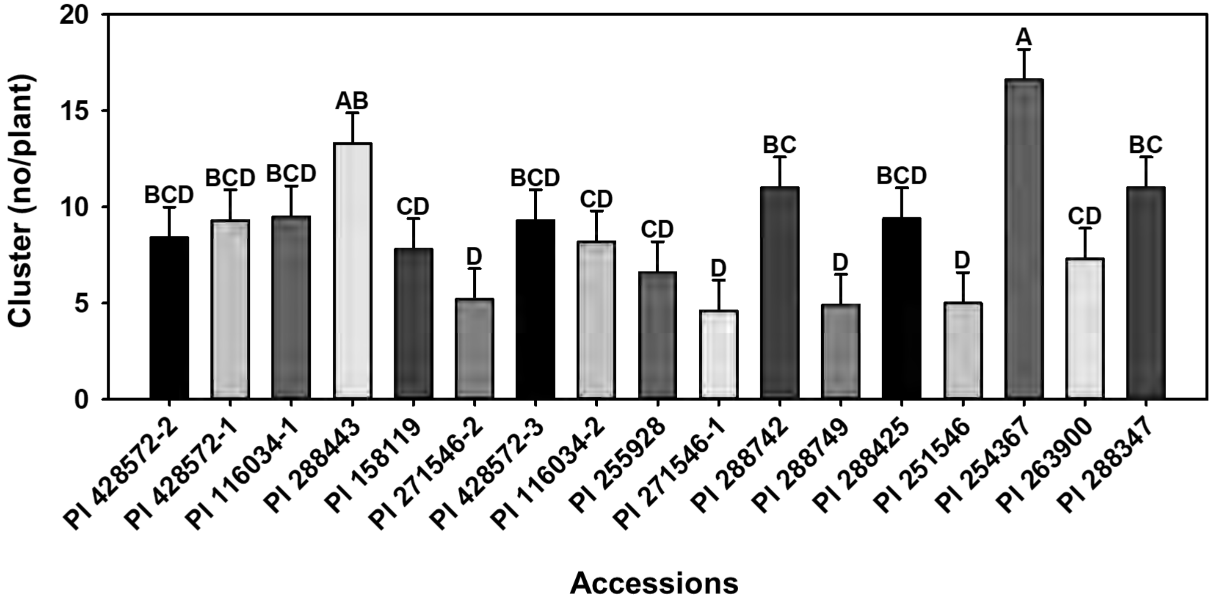


Figure 3. Cluster number of guar accessions under no-till semiarid conditions.

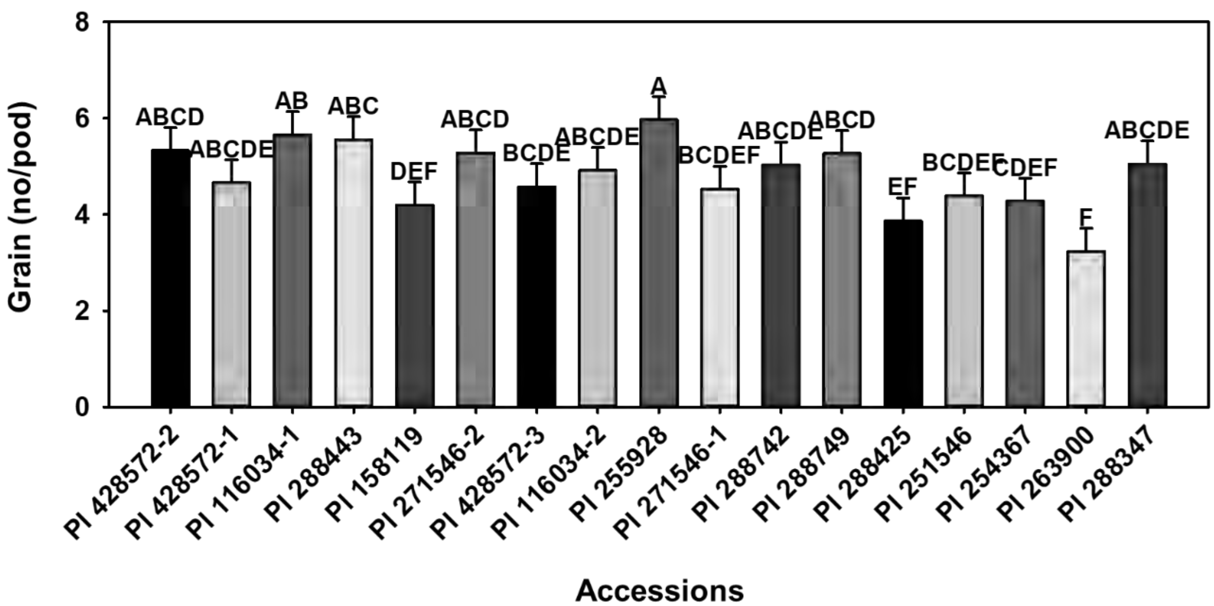


Figure 4. Grain number of guar accessions under no-till semiarid conditions.

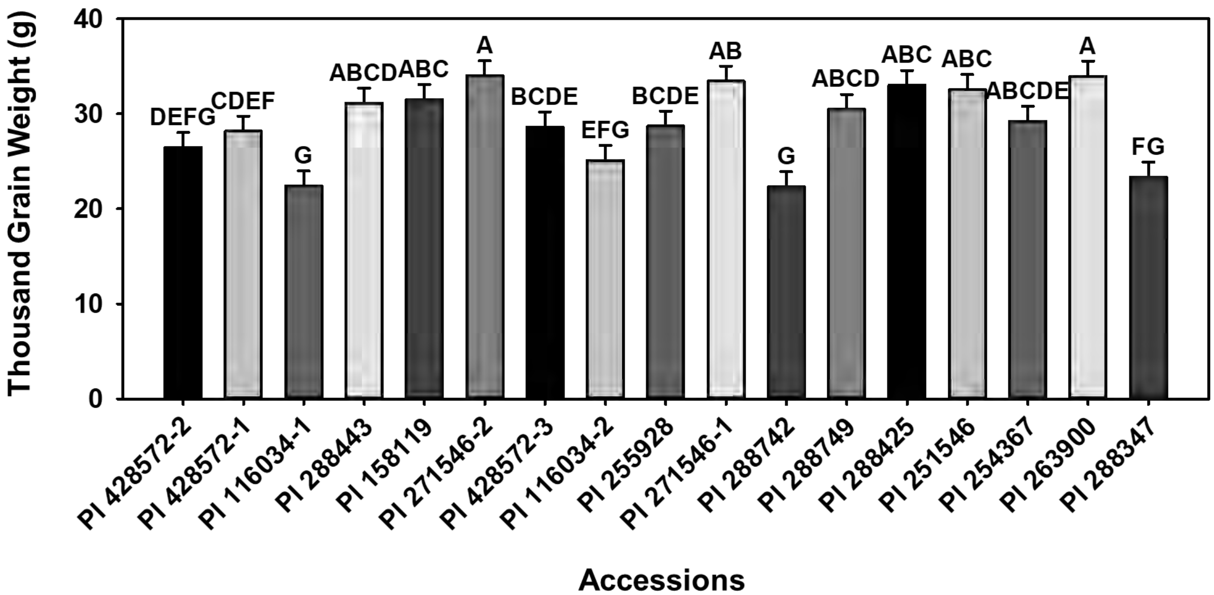


Figure 5. Thousand grain weights of guar under no-till semiarid conditions.

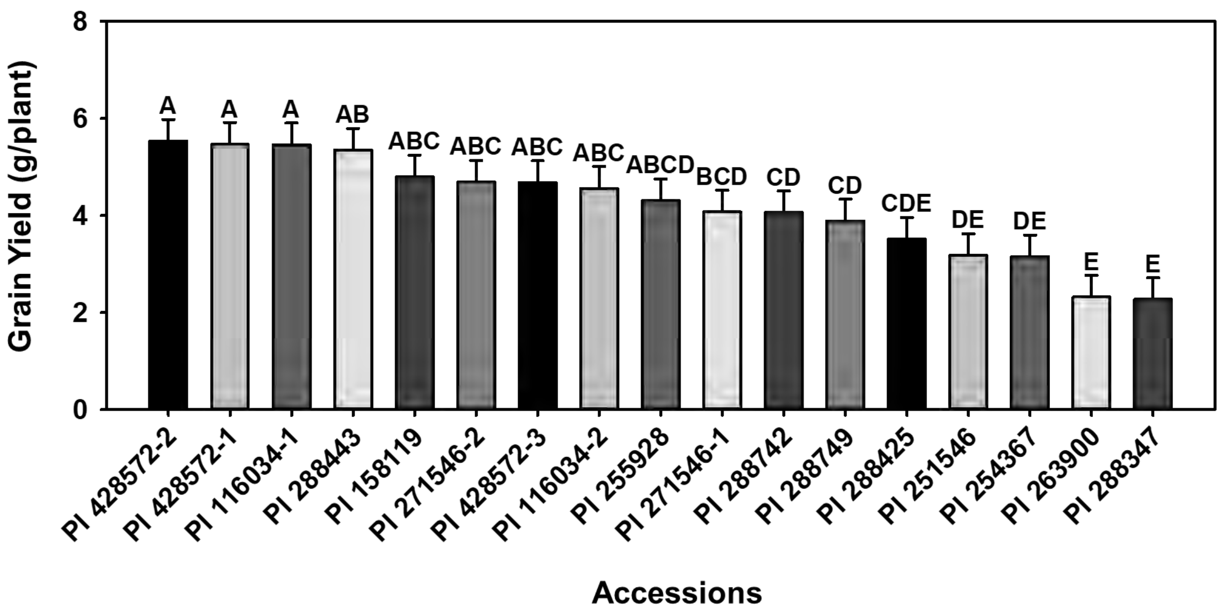


Figure 6. Grain yield of guar under no-till semiarid conditions.

**Sugar beet root yield and sucrose concentration response to foliar application of Mg, Zn, and Fe**

**Maral Etesami, Chengci Chen, Ronald Brown, William Franck, Sooyoung Franck, Calla Kowatch-Carlson, Thomas Gross, Amy Williams**

## Introduction

Sugar beet (*Beta vulgaris* L.) had been the major cash crop in the MonDak area of the Lower Yellowstone River valley for many decades. Sugar beet productivity largely depends on balancing N doses with other nutrient elements like Mg and Zn to maximize the utilization and efficiency of N and achieve the optimal root yield and sucrose concentration. Studies have shown that soil and foliar applications of Zn, B, Mo, Fe, and Mn in addition to the macronutrients improved sugar beet root yield and sugar quality. Masri and Hamza (2015) stated that foliar application of Zn+ Mn+ Fe+ B micronutrients increased beet yield, total soluble solids, sucrose content, purity value, and extractable sucrose. This research addressed the importance of micronutrient application in conjunction with nitrogen application effects on root yield and sucrose concentration. We hypothesized that macro- and micronutrient balance maximizes fertilizer use efficiency and enhance shoot and root growth, sugar quality, and sucrose translocation.

## Materials and methods

The experiment was conducted in a randomized complete block design at the Eastern Agricultural Research Center in Sidney, MT (47◦43′32″ N, 104◦9′5″ W) under sprinkler irrigation and conventional tillage systems to evaluate the effect of micro-nutrient effect on sugar beet productivity and sucrose content. We considered 4 nutrient sources including Zinc Sulfate Monohydrate 35.5% at a rate of 1.01 kg $ha^{-1}$ $Znso_4$, Ethylenediaminetetraacetic Acid Disodium Zinc Salt Hydrate >98% at a rate of 1.01 kg $ha^{-1}$ ZnChelate, Ethylenediaminetetraacetic Acid dipotassium magnesium salt dihydrate 97% at a rate of 1.12 kg $ha^{-1}$ MgChelate, and Ferrous Sulfate Heptahydrate 20% at a rate of 1.12 kg $ha^{-1}$. The products were foliar applied two times in June and July when the plants are at the 6 and 8 leaves stages. The soil was prepared by applying double disking, mulching, and leveling to provide the proper seedbed for sugar beet, and 168 kg $ha^{-1}$ N, 25 Kg $ha^{-1}$ $P_2O_5$, and 40 kg $ha^{-1}$ $K_2O$ were surface spread prior to tillage. Stand count was assessed from the middle row within each plot. At the harvesting time, plants were mechanically defoliated in early October. Roots were collected using a single-row harvester, and their fresh weight was recorded. Subsequently, random subsamples of 10 beets were chosen from each plot, washed, and the upper part was trimmed before being divided into two portions. One part was kept in the oven at 75°C to record the dry weight and the second portion of the subsamples was ground to measure the sucrose concentration using digital Saccharimeter Autopol 880. Gross sucrose yield was obtained by multiplying the root yield by sucrose concentration.

## Results and discussion

The timing of foliar application had an impact on the sugar beet plant population (Table 1), with a higher stand count observed in July applications. However, the combinations of fertilizers did not significantly affect plant establishment. On average, there were 10.97 plants.$m^{-2}$ (Figure 1).

Root fresh weight was affected by fertilizer treatment and application timing (Table 1). The July application had a higher root yield (Figure 2). Among the treatments, the highest root yield was observed in July MgChelate (88 t. $ha^{-1}$) followed by July $Znso_4$ (81 t. $ha^{-1}$) application and the lowest root yield was found in the treatment with N fertilizer only (73 t $ha^{-1}$) (Figure 3). The results support the hypothesis that properly supplying sugar beet with Mg and Zn in conjunction of N provides a faster leaf growth which results in a

larger assimilation of carbohydrates and further efficient utilization of water and nitrogen simultaneously. Results showed that micronutrients through foliar application enhanced the growth and yield of sugar beet (*Beta vulgaris* L.), however, application timing and fertilizer compounds and properties showed varying effects on beet performance. For MgChelate, July is the best time for the foliar application and displayed a 20% increase in root yield compared with the control (no foliar application). ZnChelate showed more effective when it was applied in June resulting in a 17 % increase in beet yield compared to the check plots with N application only. $Znso_4$ improved 12% sugar beet yield in the July application compared to check. For Fe treatments, there was no significant difference between the June and July applications, but foliar Fe applications resulted in about 9.5% yield increase compared to the control (Figure 3).
Significant variations in sucrose concentration were observed among the treatments (Table 1). The highest sucrose concentration was obtained from the control plots with application of nitrogen only (N). July-MgChelate and July- ZnChelate were associated with decreased sucrose levels in the roots (Figure 4). The inverse relationship between root yield and sucrose concentration is often attributed to the dilution effect. Gross sucrose yield was affected by fertilizers significantly and the variation in gross sucrose yield is due to the variations in root yield and sucrose concentration. The maximum gross sucrose yield was observed in July- MgChelate and the minimum was observed in the control plots with N application.

## Conclusion

The present study concluded that July is the best time for foliar application of Zn and Mg to obtain the optimum root yield. Sugar beets achieved a higher yield when Mg intercorporate to N. Further tissue analysis will be conducted to determine the nutrient balance and distribution during critical growth stages.

**Table 1. Anova analysis of stand count, root yield, sucrose concentration, and gross sucrose yield affected by micro-nutrient foliar application**

| Source | Stand Count | Root Fresh Yield | Sucrose | Gross Sucrose Yield |
|---|---|---|---|---|
| **Timing** | ** | ** | ns | ns |
| **Fertilizers** | ns | *** | * | *** |
| **Timing × Fertilizers** | ns | ns | ns | ns |
| **CV** | 7.93 | 4.92 | 2.35 | 4.86 |
| **MEAN** | 10.94 | 80.13 | 18.33 | 14.65 |
| **LSD** | 0.89 | 4.04 | 0.44 | 0.73 |

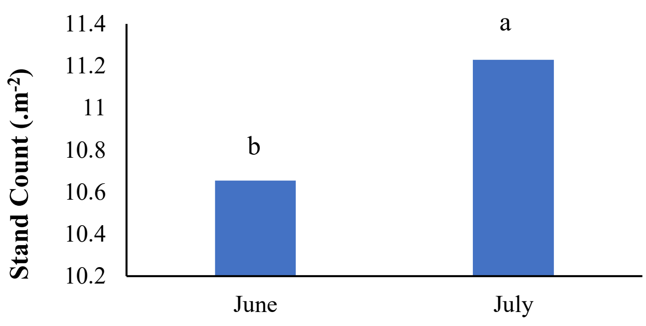


**Figure 1. Stand count affected by the timing of foliar application.**

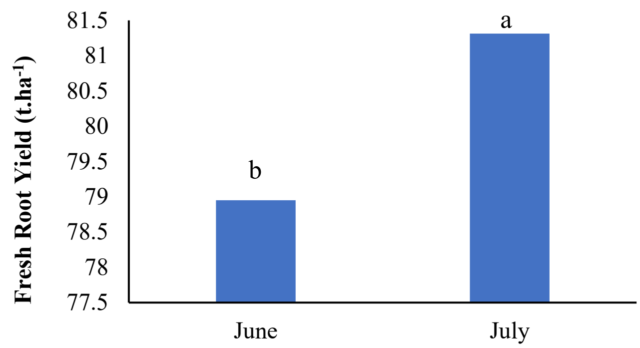


**Figure 2. Fresh root yield of sugar beet in response to June and July foliar application.**

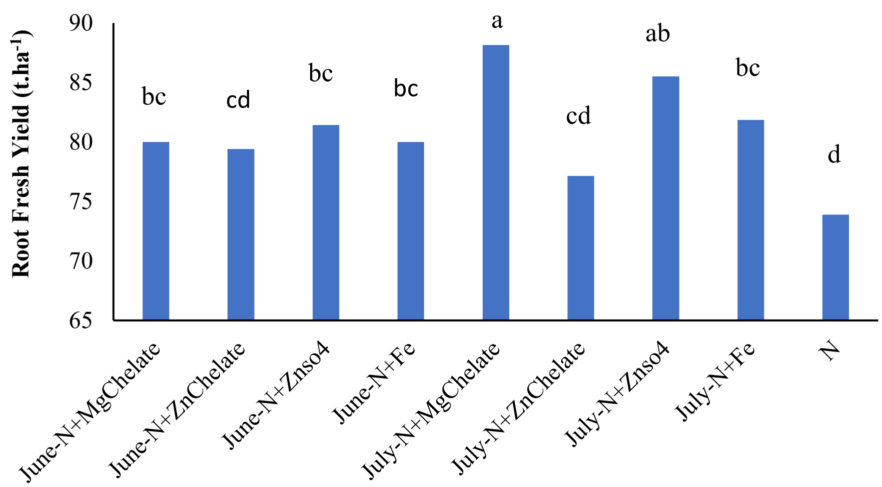


**Figure 3. Fresh root yield of sugar beet in response to the foliar application.**

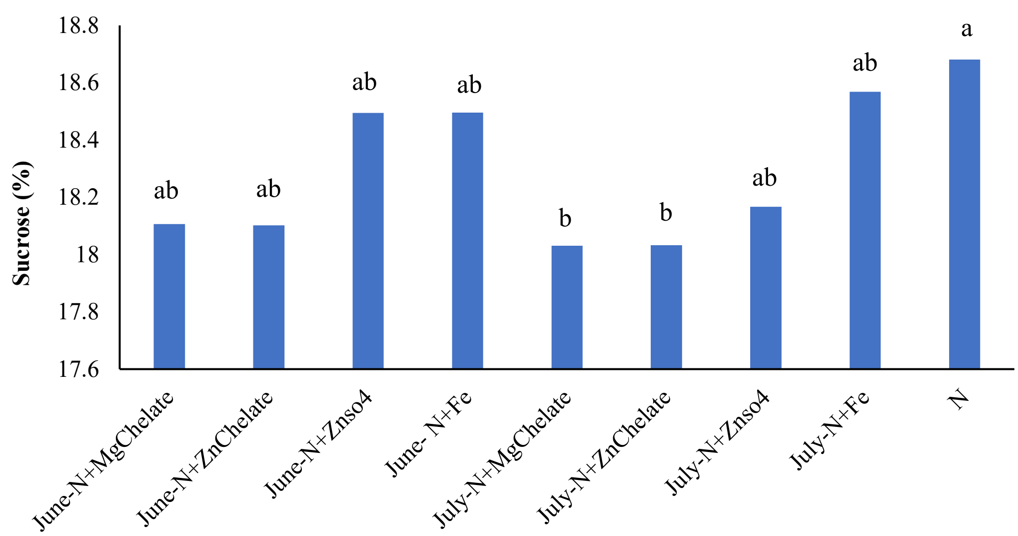


**Figure 4. Sucrose concentration varied in fertilizer treatments.**

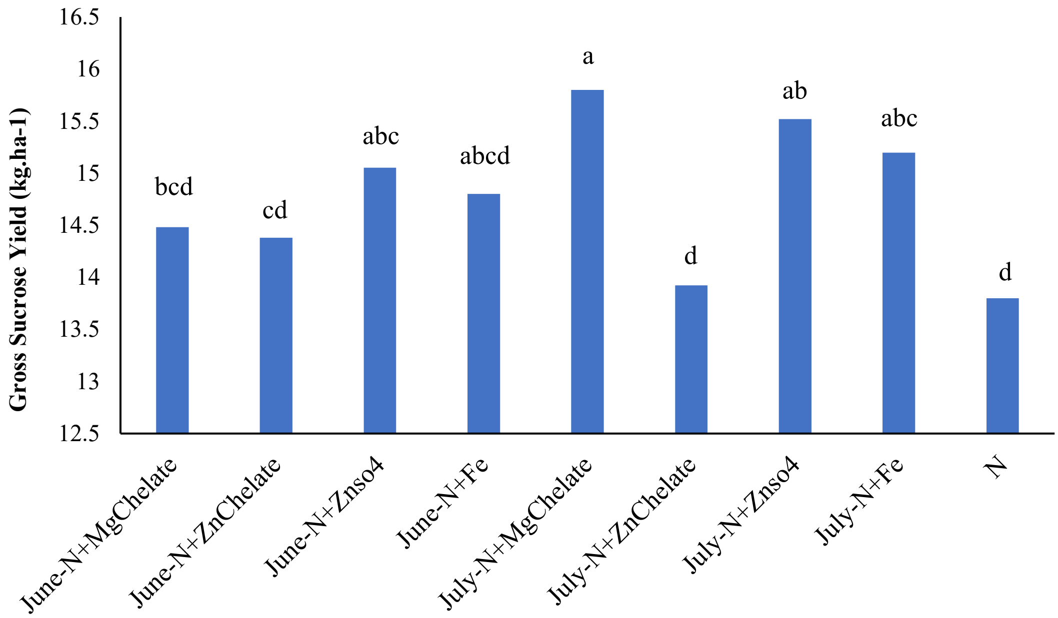


**Figure 5. Response of sugar beet gross sucrose yield to foliar application.**

## Efficient camelina varieties in yield, oil content, and NUE

**Maral Etesami, Chengci Chen, William Franck, Thomas Gross, Sooyoung Franck, and Calla Kowatch-Carlson**

### Introduction

Camelina has been identified as a promising alternative oilseed crop for biofuel with wide environmental adaptability to North American agroecology and multiple industrial and feed purposes. However, cultivar selection and fertility management information are needed to provide agronomic recommendations for growers in Eastern Montana. Nitrogen is the main input required in camelina production Sintim et al. 2015; Chen et al. 2015, Afshar et al. 2016; Mohammed et al. (2017) and N balance significantly enhanced camelina seed yield and oil quality in the semi-arid northern environments. Developing N-efficient and high-yielding genotypes along with agronomic strategies optimize crop yields while minimizing nitrogen inputs, thereby promoting sustainable and efficient agricultural practices.

The present study aimed to: a) assess yield and oil content of 23 camelina genotypes in low and nigh nitrogen environments; b) identify the efficient camelina genotypes in N uptake and nitrogen use efficiency (NUE).

### Materials and methods

This year's project extended the evaluation of camelina genotypes from previous years. The study was conducted in randomized complete block designs in low and high nitrogen rates (0 and 112 kg N ha$^{-1}$ from urea source) in the irrigated field of Eastern Agricultural Research Center Sidney, MT (47◦43′32″ N, 104◦9′5″ W). Twenty-three camelina genotypes were evaluated for yield, oil content, and NUE in 2023. Camelina was planted in early May using a 6-rowed plot drill, at a seeding rate of 5.6 kg ha$^{-1}$ at 1–2 cm soil depth. The plots were 1.50 m wide and 3 m long, in 0.25 m row spacing. Stand count, plant height, and biomass dry weight were recorded at physiological maturity. Plots were harvested when grains were completely matured (late July to early August) using a plot combine. After harvesting, sub-samples of seed were taken to measure the oil content using the Oxford Instruments MQC + benchtop NMR (Nuclear Magnetic Resonance) analyzer. Grain samples were ground to pass through a 1-mm mesh screen in a Wiley mill device for nitrogen concentration analysis using a Perkin Elmer CHNS/O Analyzer Model 2400. Nitrogen uptake and nitrogen use efficiency were calculated using the following formula:

N uptake = Grain N Content × Grain Yield

$$\text{NUE} = \frac{\text{Yield}}{\text{N supply ( N suply in soil+N provided by fertilizer)}}$$

### Results and discussion

G10 demonstrated the highest stand count, recording 175.5 plants m$^{-2}$ at low N rates and 181.5 plants m$^{-2}$ at high N rates while G2 exhibited the lowest stand count, with 64 plants m$^{-2}$ and 70.5 plants m$^{-2}$ at low and high N, respectively. Genotypes differed in plant height significantly and G9 achieved the tallest plant height at both N environments while the lowest plant height was observed for G17 (48.75 cm) in low N environment and G1 (54.8 cm) in high N environment.

G19 produced the highest biomass of 666.22 g m$^{-2}$ and 762.37 g m$^{-2}$ in low and high N environments, respectively. G8 and G17 had low biomass yields in low N environment and G1 produced the least biomass in the high N environment. The average biomass yield increased 25% in the high N environment compared to the low N environment.

A significant variation was observed in seed yield among the genotypes in both high and low N environments. Genotypes G17, G21, G8, G2, G1, and G16 had low seed yields in both low and high N environments, whereas genotypes G3, G4, G7, G9, and G20 had high seed yields in both low and high N rates (Table 2). On average, the seed yield of camelina increased by 17% from low to high N environment, except G1 showing a negative response. G5 and G14 showed the greatest responses as nitrogen rates increased (Figure 1).

Oil concentration varied significantly among genotypes ranging from 42.87% in G4 to 34.91% in G21 in low N environment and from 41.93% in G9 to 34.16% in G16 in high N environment. In both high and low N environments, some genotypes like G3, G7, and G20 showed not only high yields but also high oil concentrations, while some other genotypes like G1, G2, G8, G16, G17, and G21 produced low yield and oil concentration (Figure 1). The varied responses of assortments in yield and oil concentration resulted in significant variance in oil yield (Figure 1). Moreover, the results showed that there was no linear relationship between yield and oil content while the oil yield was affected more by yield rather than oil concentration. In the high N environment, oil yield varied from 961.03 kg $ha^{-1}$ in G9 to 335.99 kg $ha^{-1}$ in G1, and from 311.99 kg $ha^{-1}$ in G17 to 905.11 kg $ha^{-1}$ in G7, respectively (Figure 2). Averaged across the genotypes, oil yield increased by 15% from low N to high N environment.

Nitrogen uptake (kg N $ha^{-1}$) of each genotype was calculated from the seed yield and corresponding N concentration of the seeds. Across both low and high N environments, there was considerable variation among genotypes in nitrogen absorption, significantly impacting nitrogen use efficiency (NUE). At low N environment, G3 and G7 had the greatest N uptake and NUE while G17 showed the lowest N uptake and NUE. Under the high nitrogen environment, G3, G7, G14, and G20 demonstrated the highest nitrogen uptake and NUE. Average across the genotypes, nitrogen uptake increased by 22% from low to high N environment. The nitrogen uptake ranged from 37.98 to 107.43 kg $ha^{-1}$ in low N environment and from 43.44 to 120.55 kg $ha^{-1}$ in high N environment. NUE, however, ranged from 31.96 to 90.27 kg seed per kg N in low N environment and from 7.34 to 17.25 kg seed per kg N in high N environment, respectively (Table 2).

## Conclusion

The genetic and N environment affected camelina yield, oil concentration, and N uptake. Averaged across genotypes, 121 kg $ha^{-1}$ N fertilizer resulted in yield increase from 1600 kg $ha^{-1}$ to 1860 kg. $ha^{-1}$) but oil content decreased from 39.31% to 38.69%. Genotypes G3 and G7 were identified as the most efficient genotypes in terms of yield, N uptake, and NUE at both rates of nitrogen. High-yielding camelina genotypes in the present study generally have high NUE.

**Table 1. Anova for camelina varieties affected by low and high nitrogen rates**

| | Stand count | Height | Biomass | HI | Yield | Oil content | Oil Yield | N Uptake | NUE |
|---|---|---|---|---|---|---|---|---|---|
| **Low N-2023.** | | | | | | | | | |
| **Variety** | *** | *** | *** | ns | *** | *** | *** | *** | *** |
| **High N- 2023.** | | | | | | | | | |
| **Variety** | *** | *** | *** | ns | *** | *** | *** | *** | *** |

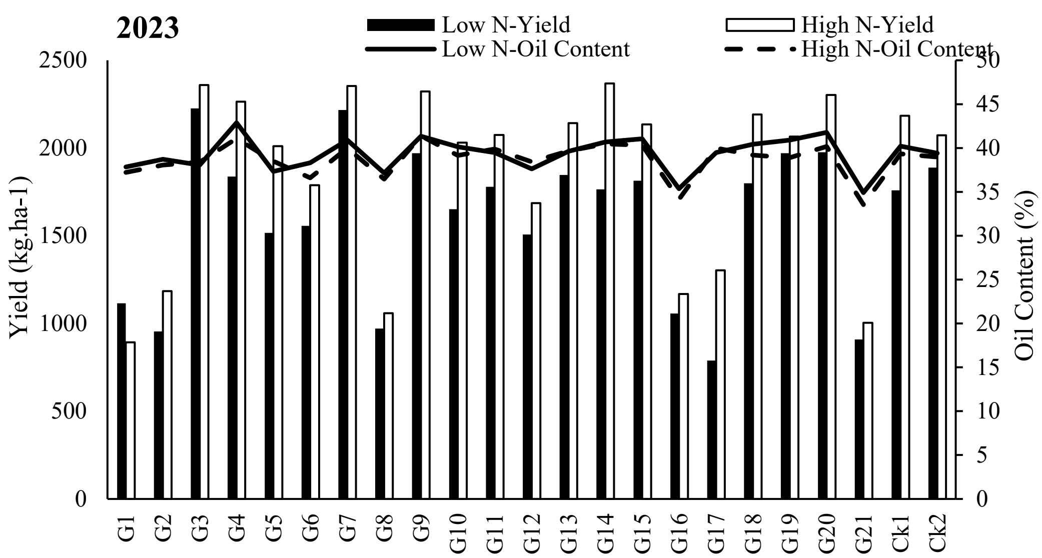


**Figure 1. Varied response of camelina accessions in terms of yield and oil concentration at low and high rates of N in 2023.**

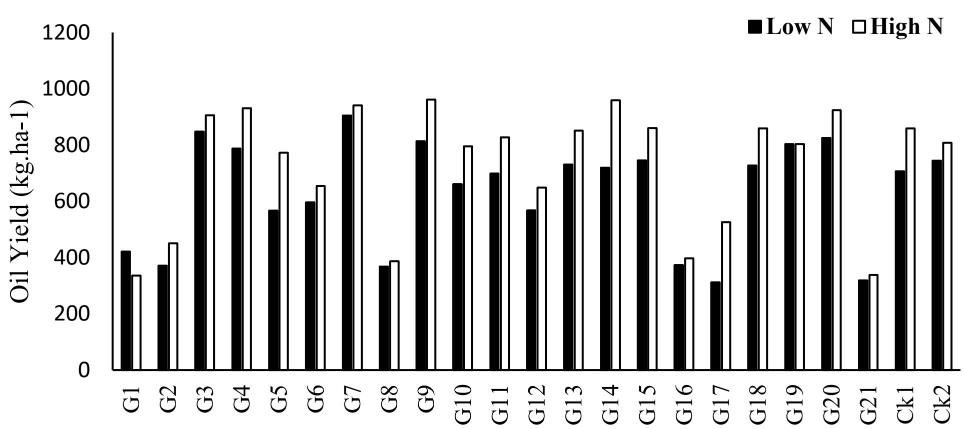


**Figure 2. Oil yield variation in camelina accessions which was affected by yield more than oil content, 2023.**

**Table 2. Mean ± standard deviation of measured parameters of camelina accessions, 2023.**

| | Low N | | | | | High N | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Accessions** | **Stand Count± SD** | **Height ± SD** | **Biomass± SD** | **N Uptake ± SD** | **NUE ± SD** | **Stand Count± SD** | **Height ± SD** | **Biomass± SD** | **N Uptake ± SD** | **NUE ± SD** |
| **G1** | 75.50±30.35 | 52.95±3.83 | 3482.57±268.77 | 51.86±14.59 | 45.22±13.07 | 79.00±18.51 | 54.80±4.57 | 3594.74±658.94 | 43.43±13.57 | 6.53±2.15 |
| **G2** | 64.00±14.51 | 54.05±2.83 | 3945.72±1152.91 | 45.39±7.02 | 38.73±6.89 | 70.50±17.54 | 56.95±5.87 | 4277.96±699.45 | 58.85±6.63 | 8.66±1.03 |
| **G3** | 139.50±48.59 | 69.30±4.41 | 6228.62±685.82 | 107.43±8.68 | 90.27±3.32 | 141.50±17.69 | 68.60±2.72 | 7551.97±838.87 | 120.55±11.64 | 17.25±1.29 |
| **G4** | 127.50±16.36 | 72.85±3.39 | 4881.25±434.67 | 82.80±13.04 | 74.51±9.30 | 124.50±13.70 | 74.70±5.27 | 6716.12±1375.68 | 107.02±4.12 | 16.56±0.81 |
| **G5** | 131.50±27.44 | 54.05±4.73 | 4349.01±488.23 | 73.10±11.45 | 61.52±9.36 | 145.00±32.60 | 58.00±3.93 | 6046.05±1535.81 | 99.63±19.38 | 14.71±2.46 |
| **G6** | 97.50±39.17 | 58.55±3.73 | 4681.25±532.76 | 72.75±10.33 | 63.11±9.00 | 101.50±22.71 | 62.30±2.13 | 6000.00±970.23 | 89.11±6.16 | 13.08±0.70 |
| **G7** | 133.50±43.74 | 63.70±1.35 | 6062.17±962.35 | 101.37±16.42 | 89.89±12.03 | 139.00±50.66 | 67.90±4.31 | 6720.07±596.74 | 115.40±3.21 | 17.21±0.42 |
| **G8** | 82.50±37.47 | 51.25±9.78 | 3201.32±428.04 | 47.47±30.02 | 39.40±25.38 | 101.00±38.42 | 56.15±6.01 | 4562.17±1902.64 | 53.93±22.50 | 7.74±3.33 |
| **G9** | 91.50±40.48 | 73.95±2.46 | 6325.33±379.60 | 87.35±7.98 | 79.92±7.77 | 124.00±22.92 | 78.25±1.89 | 7245.07±1171.46 | 104.74±11.40 | 16.98±1.29 |
| **G10** | 175.50±59.81 | 67.85±3.33 | 5211.18±953.69 | 73.83±15.52 | 66.93±11.53 | 181.50±38.03 | 73.55±4.29 | 6733.22±858.91 | 100.63±4.03 | 14.85±0.57 |
| **G11** | 121.50±36.01 | 70.10±4.31 | 5149.01±970.60 | 79.58±9.20 | 72.12±9.70 | 153.00±42.88 | 74.15±2.96 | 6759.21±627.23 | 99.10±10.11 | 15.16±1.34 |
| **G12** | 135.33±37.43 | 66.00±3.52 | 4860.09±847.60 | 73.38±12.95 | 61.11±9.74 | 90.00±2.00 | 63.40±1.06 | 5624.56±264.12 | 84.03±2.84 | 12.33±0.33 |
| **G13** | 152.50±27.15 | 65.25±3.93 | 5220.72±735.50 | 85.33±11.51 | 74.87±7.82 | 149.00±66.30 | 67.20±5.30 | 6621.05±643.57 | 103.15±6.50 | 15.67±0.84 |
| **G14** | 141.50±44.43 | 67.00±4.09 | 5428.95±818.82 | 79.51±26.99 | 71.53±22.84 | 108.00±37.91 | 67.60±4.52 | 7188.82±543.43 | 113.16±6.11 | 17.32±1.22 |
| **G15** | 137.00±39.24 | 59.80±3.59 | 4508.88±311.08 | 82.97±5.45 | 73.58±2.30 | 141.00±16.69 | 60.25±0.91 | 6358.55±296.17 | 102.89±3.93 | 15.61±0.93 |
| **G16** | 81.50±26.04 | 60.95±1.56 | 3541.12±1123.79 | 54.53±11.95 | 42.88±8.51 | 97.00±19.49 | 61.20±3.05 | 4692.76±873.88 | 59.13±10.97 | 8.54±1.16 |
| **G17** | 70.00±26.78 | 48.75±3.41 | 3211.18±1039.69 | 37.98±13.60 | 31.96±10.77 | 102.00±25.77 | 55.75±11.01 | 4545.72±2068.88 | 61.89±33.56 | 9.54±4.99 |
| **G18** | 126.00±24.11 | 62.75±3.83 | 5484.21±1115.56 | 83.35±13.80 | 72.93±10.44 | 139.00±16.37 | 69.50±4.72 | 7342.11±383.16 | 107.42±9.39 | 16.02±1.42 |
| **G19** | 138.00±29.35 | 67.10±5.89 | 6662.17±846.42 | 93.26±12.39 | 79.90±8.13 | 146.50±15.26 | 67.25±3.03 | 7623.68±409.66 | 103.84±8.46 | 15.10±1.60 |
| **G20** | 130.00±36.33 | 65.65±1.75 | 5583.22±436.85 | 91.59±10.94 | 80.12±7.99 | 128.50±15.61 | 65.75±1.75 | 6564.14±457.86 | 111.72±17.31 | 16.84±1.67 |
| **G21** | 82.50±5.97 | 55.65±2.22 | 3526.32±403.37 | 43.74±9.07 | 36.83±6.45 | 100.50±15.86 | 58.75±2.51 | 4338.16±455.89 | 50.69±12.02 | 7.34±1.67 |
| **Ck1** | 118.00±13.49 | 65.12±3.30 | 5282.63±996.10 | 81.16±10.24 | 71.34±7.16 | 144.80±41.54 | 67.36±2.16 | 6299.47±469.26 | 108.12±17.17 | 15.97±2.08 |
| **Ck2** | 118.50±19.28 | 67.45±1.36 | 4907.57±314.33 | 88.83±7.43 | 76.60±3.08 | 133.00±31.39 | 72.35±6.51 | 6450.00±1076.99 | 100.95±6.44 | 15.15±0.79 |

## 2023 Resistance of Spring Wheat Varieties to Fusarium Head Blight Sidney, MT

Frankie Crutcher, Jason Cook, Alma Chinchilla, Caitlin Gross, Debra Kunda

**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: May 4
Harvested: Aug 25
Plot Size: 2.5’ x 10’
Seeding Rate: 90 lbs/A
Soil Type: Savage silty clay loam
Previous Crops: Soybean

Residual Soil N to 3 ft: 1.1 ppm
Residual Soil P to 6 in: 16 ppm
Applied Fertilizer: 217 lb/A 70:26:0
Irrigated (sprinkler) on: May 20, Jun 5, Jun 9, Jun 16, Jul 6 (total: 3.7 in)
Herbicide Applications: Panoflex (0.6 oz/A); 2,4D (20.8 oz/A); Discover (12.8 oz/A); Wolverine (27.2 oz/A)
Precipitation April – September: 10.25 in
Disease assessment: Jul 26

**COMMENTS:**

Corn spawn inoculated with five isolates of *F. graminearum* was applied to the field May 24. Misting to increase humidity was applied from Jun 28 to Jul 27. Grasshoppers might have impacted the final yield.

**RESULTS:**

**Table 1: Spring Wheat Variety Reponses to Fusarium Head Blight**

| Variety | Severity (%)[a] | Incidence (%)[b] | Index[c] | % FDK[d] | Yield (Bu/A)[e] | DON (ppm) |
|---|---|---|---|---|---|---|
| AAC CONCORD | 33.8 A-K | 81.1 AB | 27.6 A-I | 13.0 F-H | 49.6 A-G | 04.7 I-M |
| AP GUNSMOKE CL2 | 22.5 B-K | 74.4 AB | 17.6 B-I | 09.3 GH | 55.3 A-E | 06.0 G-M |
| AP SMITH | 20.1 C-K | 72.2 AB | 14.8 C-I | 16.7 D-H | 59.2 A | 06.6 F-M |
| CHOTEAU | 53.7 A-E | 91.1 AB | 49.1 A-F | 60.0 A | 39.6 A-I | 12.2 B-K |
| CORBIN | 36.6 A-K | 91.1 AB | 33.8 A-I | 36.7 A-H | 32.6 E-I | 11.1 B-L |
| DAGMAR | 43.9 A-J | 92.2 AB | 40.7 A-I | 35.0 A-H | 38.5 A-I | 12.0 B-K |
| DUCLAIR | 41.5 A-J | 84.4 AB | 35.1 A-I | 38.3 A-G | 36.8 A-I | 10.6 B-L |
| LANNING | 17.8 E-K | 64.4 A-C | 11.5 E-I | 25.0 B-H | 45.8 A-I | 08.3 E-M |
| LCS ASCENT | 22.4 B-K | 68.9 A-C | 16.2 C-I | 17.7 D-H | 53.5 A-F | 02.4 LM |
| LCS BOOM | 33.2 A-K | 76.7 AB | 28.9 A-I | 12.7 F-H | 58.6 AB | 03.4 K-M |
| LCS HammerAX | 24.8 A-K | 80.0 AB | 20.4 A-I | 41.7 A-F | 36.0 A-I | 11.4 B-L |
| McNEAL | 60.45 A | 98.9 A | 59.7 A | 36.7 A-H | 36.5 A-I | 19.4 AB |
| MS COBRA | 32.0 A-K | 84.4 AB | 26.8 A-I | 31.7 A-H | 50.3 A-G | 10.4 B-L |
| MS RANCHERO | 4.2 K | 26.7 C | 01.2 I | 05.3 H | 47.3 A-I | 01.0 M |
| MT 1809 | 23.4 B-K | 77.8 AB | 18.75 A-I | 18.3 D-H | 56.0 A-E | 04.4 I-M |
| MT 1939 | 58.1 AB | 95.6 AB | 55.9 A-C | 45.0 A-E | 31.0 F-I | 23.0 A |
| MT 2030 | 24.8 A-K | 81.1 AB | 20.9 A-I | 14.3 E-H | 52.9 A-F | 08.1 E-M |
| MT 2049 | 30.3 A-K | 68.9 A-C | 22.4 A-I | 30.0 A-H | 49.1 A-I | 09.0 D-M |
| MT 2050 | 43.7 A-J | 84.4 AB | 38.0 A-I | 33.3 A-H | 55.7 A-E | 10.9 B-L |
| MT 2063 | 41.9 A-J | 84.4 AB | 36.4 A-I | 41.7 A-F | 30.5 F-I | 12.8 B-J |
| MT 21016 | 51.2 A-F | 87.8 AB | 47.0 A-G | 60.0 A | 36.4 A-I | 17.9 A-D |
| MT 21031 | 35.0 A-K | 82.2 AB | 29.6 A-I | 26.7 B-H | 43.8 A-I | 08.9 D-M |
| MT 21037 | 55.7 A-D | 94.4 AB | 53.3 A-D | 38.3 A-G | 34.3 C-I | 13.0 B-J |
| MT 21074 | 50.0 A-G | 90.0 AB | 46.3 A-H | 41.7 A-F | 25.3 HI | 18.7 A-C |
| MT 21104 | 25.3 A-K | 66.7 A-C | 20.8 A-I | 20.0 C-H | 42.2 A-I | 07.9 E-M |
| MT 21214 | 41.2 A-J | 91.1 AB | 38.1 A-I | 40.0 A-G | 40.7 A-I | 10.8 B-L |
| MT 21220 | 34.8 A-K | 74.4 AB | 26.7 A-I | 35.0 A-H | 48.0 A-I | 10.1 C-M |
| MT 21224 | 36.7 A-K | 85.6 AB | 31.4 A-I | 23.3 B-H | 45.0 A-I | 08.7 E-M |
| MT 21230 | 27.5 A-K | 73.3 AB | 21.3 A-I | 33.3 A-H | 42.7 A-I | 12.8 B-J |

| | | | | | | |
|---|---|---|---|---|---|---|
| MT 21247 | 36.7 A-K | 78.9 AB | 30.3 A-I | 41.7 A-F | 46.7 A-I | 11.7 B-K |
| MT 21214 | 43.6 A-J | 93.3 AB | 41.4 A-I | 41.7 A-F | 43.1 A-I | 14.3 A-H |
| MT 21220 | 56.0 A-C | 87.8 AB | 49.1 A-F | 31.7 A-H | 42.1 A-I | 08.6 E-M |
| MT 21224 | 32.3 A-K | 88.9 AB | 28.9 A-I | 38.3 A-G | 39.4 A-I | 11.3 B-L |
| MT 21230 | 27.7 A-K | 83.3 AB | 24.6 A-I | 20.0 C-H | 57.1 A-D | 06.1 G-M |
| MT 21247 | 43.0 A-J | 85.6 AB | 37.8 A-I | 35.0 A-H | 52.5 A-F | 08.5 E-M |
| MT 21262 | 35.9 A-K | 87.8 AB | 32.1 A-I | 35.0 A-H | 45.7 A-I | 09.3 D-M |
| MT 21313 | 32.7 A-K | 86.7 AB | 29.0 A-I | 33.3 A-H | 50.7 A-G | 12.8 B-J |
| MT 21314 | 35.8 A-K | 81.1 AB | 29.1 A-I | 36.7 A-H | 43.4 A-I | 12.1 B-K |
| MT 21352 | 51.0 A-F | 92.2 AB | 47.4 A-F | 26.7 B-H | 44.7 A-I | 09.6 C-M |
| MT 21359 | 52.2 A-E | 93.3 AB | 49.1 A-F | 51.7 AB | 34.8 B-I | 15.1 A-G |
| MT 21384 | 47.4 A-H | 93.3 AB | 45.2 A-H | 41.7 A-F | 40.4 A-I | 14.3 A-H |
| MT 21473 | 34.9 A-K | 85.6 AB | 29.9 A-I | 25.0 B-H | 46.1 A-I | 08.4 E-M |
| MT 21484 | 44.8 A-J | 98.9 A | 44.2 A-H | 41.7 A-F | 37.9 A-I | 14.7 A-H |
| MT 21485 | 27.3 A-K | 74.4 AB | 21.5 A-I | 26.7 B-H | 47.5 A-I | 06.9 F-M |
| MT 21487 | 32.6 A-K | 83.3 AB | 27.1 A-I | 33.3 A-H | 52.6 A-F | 09.3 D-M |
| MT 22004 | 37.3 A-K | 90.0 AB | 33.5 A-I | 33.3 A-H | 50.1 A-G | 07.4 F-M |
| MT 22005 | 45.7 A-J | 93.3 AB | 42.5 A-I | 36.7 A-H | 45.1 A-I | 10.6 B-L |
| MT 22009 | 36.4 A-K | 95.6 AB | 35.1 A-I | 23.3 B-H | 49.8 A-G | 07.0 F-M |
| MT 22035 | 29.0 A-K | 84.4 AB | 25.3 A-I | 21.7 B-H | 47.7 A-I | 05.8 H-M |
| MT 22037 | 48.2 A-H | 93.3 AB | 45.1 A-H | 41.7 A-F | 32.8 E-I | 10.3 B-L |
| MT 22066 | 15.4 F-K | 53.3 BC | 08.4 F-I | 30.0 A-H | 46.3 A-I | 08.4 E-M |
| MT 22069 | 23.9 B-K | 70.0 A-C | 17.2 B-I | 40.0 A-G | 49.2 A-H | 11.5 B-L |
| MT 22071 | 35.0 A-K | 80.0 AB | 27.9 A-I | 23.3 B-H | 41.4 A-I | 09.2 D-M |
| MT 22108 | 60.44 A | 95.6 AB | 57.9 AB | 40.0 A-G | 27.5 G-I | 15.8 A-F |
| MT 22111 | 48.1 A-H | 96.7 AB | 46.6 A-G | 46.7 A-D | 39.9 A-I | 16.8 A-E |
| MT 22156 | 22.3 B-K | 70.0 A-C | 16.7 B-I | 13.3 F-H | 50.6 A-G | 04.3 I-M |
| MT 22159 | 30.4 A-K | 80.0 AB | 25.6 A-I | 15.0 E-H | 48.6 A-I | 05.7 H-M |
| MT 22165 | 35.3 A-K | 81.1 AB | 30.1 A-I | 41.7 A-F | 40.7 A-I | 09.7 C-M |
| MT 22167 | 29.8 A-K | 76.7 AB | 23.6 A-I | 30.0 A-H | 46.0 A-I | 08.5 E-M |
| MT 22311 | 34.4 A-K | 92.2 AB | 31.7 A-I | 23.3 B-H | 50.5 A-G | 08.0 E-M |
| MT 22345 | 46.1 A-I | 94.4 AB | 43.5 A-H | 26.7 B-H | 46.3 A-I | 06.1 G-M |
| MT 22361 | 40.6 A-K | 85.6 AB | 35.0 A-I | 30.0 A-H | 44.6 A-I | 13.2 B-J |
| MT 22372 | 39.3 A-K | 93.3 AB | 36.9 A-I | 35.0 A-H | 44.8 A-I | 10.7 B-L |
| MT SIDNEY | 24.7 A-K | 78.9 AB | 20.2 A-I | 26.7 B-H | 44.6 A-I | 13.4 B-I |
| NDHRS14-0134-C03 | 10.0 I-K | 56.7 A-C | 05.8 G-I | 50.0 A-C | 29.7 F-I | 11.3 B-L |
| NS PRESSER CLP | 19.3 D-K | 70 A-C | 15.1 C-I | 14.7 E-H | 58.4 A-C | 03.0 K-M |
| REEDER | 32.6 A-K | 76.7 AB | 24.8 A-I | 31.7 A-H | 55.7 A-E | 08.4 E-M |
| ROCKER | 28.7 A-K | 87.8 AB | 25.7 A-I | 30.0 A-H | 34.2 D-I | 09.1 D-M |
| SY 611 CL2 | 18.3 E-K | 64.4 A-C | 14.2 D-I | 31.7 A-H | 43.7 A-I | 08.3 E-M |
| SY INGMAR | 35.4 A-K | 93.3 AB | 34.0 A-I | 25.0 B-H | 33.9 D-I | 13.1 B-J |
| SY LONGMIRE | 13.3 H-K | 56.7 A-C | 08.8 F-I | 14.7 E-H | 58.6 AB | 05.5 H-M |
| SY ROCKFORD | 9.4 JK | 61.7 A-C | 06.1 F-I | 14.0 E-H | 52.3 A-G | 03.0 K-M |
| VIDA | 37.7 A-K | 75.6 AB | 31.4 A-I | 30.0 A-H | 45.2 A-I | 11.2 B-L |
| W-2 | 9.4 JK | 53.3 BC | 05.0 HI | 13.7 E-H | 53.3 A-F | 02.4 LM |
| WB 9879 CLP | 27.7 A-K | 84.4 AB | 23.5 A-I | 33.3 A-H | 35.7 A-I | 08.0 E-M |
| WB GUNNISON | 52.9 A-E | 98.9 A | 52.4 A-E | 50.0 A-C | 25.0 I | 16.8 A-E |
| Mean | 35 | 81.7 | 30.6 | 31.2 | 44.2 | 9.9 |
| % CV | 43.1 | 20.2 | 53.3 | 43.5 | 22.7 | 47.1 |
| HSD (0.05) | 36.3 | 45.3 | 41.3 | 31.6 | 24.2 | 9.22 |
| *P* -value | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 |

Letters in common did not differ significantly according to a Tukey's HSD test at a significance level of 5%.
[a]Pest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot.
[b]Pest Incidence: Percent of thirty plants per plot that had visible FHB symptoms.
[c]Index: Severity X Incidence / 100
[d]Fusarium diseased kernels.
[e]Grain yield adjusted to 12.0% moisture.

# Effect of Fertility and Crop Rotation on Durum Productivity and Soil Health

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## Introduction

The North Dakota Wheat Nitrogen Calculator (https://www.ndsu.edu/pubweb/soils/wheat/) recommends a total rate of 75 lb. /ac of nitrogen to wheat grown in "low productivity" areas of the state (Figure 1. Western North Dakota).

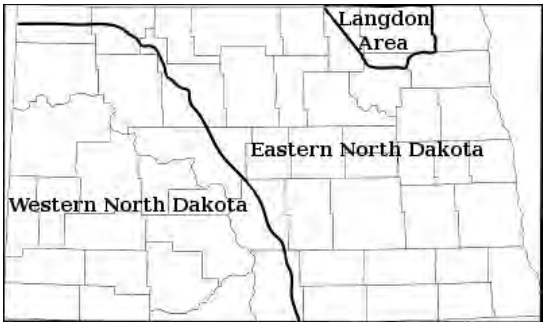


Figure 1. Wheat productivity map. North Dakota Wheat Nitrogen Calculator. Franzen, NDSU.

It is common practice to take a nitrogen credit in the wheat crop following a legume such as pea, chickpea, soybean or lentil. Research conducted by Dr. Dave Franzen (NDSU, Soil Extension Specialist) has found that growers can take a 40 lb. /ac nitrogen credit. In addition, he has found that growers may take a 50 lb. nitrogen credit when wheat is grown under mature no-till conditions (> 5 years in no-till). In practice, growers may be hesitant to take a 90 lb. nitrogen credit as the negative outcome resulting from low fertility (low yield, protein and test weight) outweighs the potential cost savings. To determine the impact of a nitrogen credit on durum productivity and quality, we evaluated durum yield, protein and test weight under two nitrogen credit regimes (below) under different crop rotations.

1) 20 lb. no-till credit when following barley or canola
2) 20 lb. no-till credit + 30 lb. credit when following lentil

## Methods

The crop rotation study was designed as a randomized complete block design with 30 x 40 ft. plots. Rotation treatments are listed below. Durum that received a 30 lb. nitrogen credit is in italics. Durum appeared more than once in some rotations, and only the durum crop following lentil within that rotation received the credit (treatments 4-9). The rotation treatments have been in place since 2018.

1) *Durum*/Lentil
2) *Durum*/Lentil+Mustard
3) *Durum*/Barley/Lentil
4 & 5) *Durum*/Barley/Durum/Lentil
6 & 7) *Durum*/Canola/Durum/Lentil
8 & 9) *Durum*/Canola/Durum/Barley/Lentil

Soil samples were collected from each plot in the fall at a depth of 0-24" to determine residual soil nitrate. A base N fertility rate of 100 lb/N was used for urea fertilizer calculations and soil nitrate (0-24"), nitrogen fertilizer contained in the starter fertilizer, as well as nitrogen credits were subtracted from that. All plots received 50 lb/ac MicroEssentials S10 with the seed at planting. Durum plots received either 0, 20, 30, 40 or 60/lb. N/ac in the fall (2022) or spring (2023) as High NRG-N (AgroLiquid - 6.75% Nitrate, 6.75% Ammoniacal nitrogen and 13.50% urea) or in the spring (2021) as urea, depending on the residual soil N test results and nitrogen credits for each plot. These rates were generating by grouping the plots according to the calculated N rate required and the rate applied was generally within 5 - 10 lb. of the exact rate needed. Weed control consisted of a glyphosate burn down (1 qt. /ac) and bromoxynil-ester (24 oz. /ac) and fenoxaprop-P ethyl (8 oz. /ac) in crop. Durum (var. ND Riveland) was planted on May 19th, 2023 and harvested August 24th using a plot combine. Grain was cleaned and assessed for yield, test weight and protein. Yield and test weight were adjusted to 13.5% moisture. Post-harvest soil samples were collected from durum plots to submit to the Cornell Soil Health testing laboratory for the Comprehensive Assessment of Soil Health (CASH) test. Soil samples were collected at three locations per plot down to a depth of 6 inches, and pooled prior to analysis. We followed collection methods suggested by the Cornell lab.

## Results and Discussion

Overall yield and test weight were low in in the 2023 trial (Table 1), which was due to a combination of factors including hail, grasshopper damage and poor soil health (Table 3). Estimated loss due to hail was 45%. There was no difference in yield or quality (protein and test weight) between treatments where a 30-lb. nitrogen credit was taken following lentil (# 1, 2, 3, 4, 6, & 8) and where no credit was taken when durum was following canola or barley (# 5, 7 & 9) (Table 1). In 2021 and 2022, there was also no effect of the 30-lb./ac nitrogen credit in yield or protein. Yield in 2021 was low due to drought and yield in 2022 was likely affected by grasshopper damage. There did appear to be slightly higher protein in rotation 9, a five-year rotation where durum follows canola (Table 2). Due to the study design, we are unable to assess the yield or quality impact of the 20 lb. no-till credit which was applied to all plots.

Table 1. 2023 durum protein, yield and test weight. Means analyzed using ANOVA and Tukey's HSD ($\alpha < 0.05$). There were no treatment differences in any of these variables

| # | Treatment | Protein (%) | Yield (bu/ac) | Test Weight (lb/bu) |
|---|---|---|---|---|
| 1 | Durum/Lentil | 18.1 | 14.6 | 56.5 |
| 2 | Durum/Lentil+Mustard | 18.3 | 11.7 | 57.2 |
| 3 | Durum/Barley/Lentil | 18.3 | 14.5 | 56.4 |
| 4 | **Durum**/Barley/Durum/Lentil | 18.2 | 16.8 | 56.7 |
| 5 | Durum/Barley/**Durum**/Lentil | 18.7 | 12.5 | 56.1 |
| 6 | **Durum**/Canola/Durum/Lentil | 17.8 | 14.1 | 57.0 |
| 7 | Durum/Canola/**Durum**/Lentil | 18.1 | 14.5 | 56.6 |
| 8 | **Durum**/Canola/Durum/Barley/Lentil | 18.0 | 16.1 | 56.8 |
| 9 | Durum/Canola/**Durum**/Barley/Lentil | 18.4 | 13.8 | 56.6 |
| | p-value ($\alpha < 0.05$) | 0.93 | 0.57 | 0.94 |

Table 2. 2021 and 2022 yield and protein data. Means analyzed using ANOVA and Tukey's HSD ($\alpha < 0.05$). Treatments followed by non-overlapping letters (ex. a vs b) are significantly different.

| | | 2021 | | | 2022 | | |
|---|---|---|---|---|---|---|---|
| # | Rotation | Yield (bu/ac) | Protein (%) | | Yield (bu/ac) | Protein (%) | |
| 1 | Durum/Lentil | 12.8 | 18.0 | ab | 24.7 | 13.1 | ab |
| 2 | Durum/Lentil+Mustard | 9.7 | 17.2 | ab | 28.0 | 14.0 | ab |
| 3 | Durum/Barley /Lentil | 11.8 | 17.1 | ab | 22.3 | 12.8 | ab |
| 4 | Durum/Barley/**Durum**/Lentil | 13.4 | 16.4 | b | 22.0 | 13.1 | ab |
| 5 | **Durum**/Barley/Durum/Lentil | 11.6 | 16.9 | ab | 23.1 | 12.8 | ab |
| 6 | **Durum**/Canola/Durum/Lentil | 11.8 | 16.6 | ab | 23.1 | 12.6 | b |
| 7 | Durum/Canola/**Durum**/Lentil | 12.0 | 18.1 | ab | 25.2 | 13.9 | ab |
| 8 | **Durum**/Canola/Durum/Barley/Lentil | 15.5 | 16.7 | ab | 23.3 | 12.8 | ab |
| 9 | Durum/Canola/**Durum**/Barley/Lentil | 9.5 | 18.8 | a | 30.3 | 14.8 | a |
| | p-value ($\alpha < 0.05$) | 0.65 | 0.02 | | 0.18 | 0.03 | |

The Cornell Assessment of Soil Health (CASH) categorizes soil based on physical, biological and chemical characteristics. Physical characteristics include compaction, predicted water holding capacity and aggregate stability. Biological characteristics are those that facilitate and evaluate the living component of the soil and include organic matter, soil protein, soil respiration and active carbon. Chemical characteristics include pH, macronutrients and micronutrients. More information about this evaluation can be found on their website https://soilhealthlab.cals.cornell.edu/. We evaluated each rotation using the CASH assessment and surprisingly did not observe a rotation effect, despite being five years into the rotation treatments. Arguments have been made that frequent production of legumes in a rotation will harm soil health due to low carbon contribution, but we have found no evidence of this and overall soil health was very low across all of the treatments. Frequent production of lentils will, however, significantly increase root rot risk. Results of the soil health analysis for the field where this study was planted are presented in Table 3, along with the typical observable range of values and the rating for that category. Predicted water holding capacity was considered high, most likely due to the no-till production system. Phosphorous and zinc were low, while the other nutrient levels were sufficient. The soil pH was very low, below even the lowest level considered poor for normal crop production (pH of 5.5). A pH of 4.8 is considered low even for crops adapted to acid soils. Soil organic matter and all of the biological assessments of soil health were also all considered very low.

Table 3. Results (study average) from the Cornell Assessment of Soil Health and soil health category rating. Observable ranges for analysis categories are included (North Dakota Fertilizer Recommendation Tables. NDSU Extension Publication SF882). NA = no categories established.

| | Observable Range | | Study Average | Rating* |
|---|---|---|---|---|
| Analysis | Low | High | | |
| Predicted Water Holding Capacity (g water/g soil) | 0 | 0.4 | 0.2 | High |
| Aggregate Stability (%) | 0 | 100 | 8.9 | Very Low |
| Organic Matter (%) | 0 | 8 | 1.6 | Very Low |
| Soil Organic Carbon | 0 | 4 | 1.0 | Very Low |
| Total Soil Carbon (%) | 0 | 4 | 1.0 | Very Low |
| Total Soil N (%) | 0 | 0.4 | 0.1 | Very Low |
| Ace Soil Protein Index (mg/g soil) | 0 | 20 | 3.3 | Very Low |
| Respiration ( mg CO2/g soil) | 0 | 2 | 0.1 | Very Low |
| Active Carbon (ppm) | 0 | 1200 | 168.7 | Very Low |
| pH (0-6") | 3 | 10 | 4.8 | Very Low |
| P (ppm) | 0 | 16+ | 5.7 | Low |
| K (ppm) | 0 | 151+ | 282.6 | Very High |
| Mg (ppm) | - | - | 255.1 | NA |
| Fe (ppm) | - | - | 3.3 | NA |
| Mn (ppm) | - | - | 16.4 | NA |
| Zn (ppm) | 0 | 1+ | 0.3 | Low |

*Ratings indicate level of soil health and range from very low soil function to very high soil function.

**Conclusions**

Taking a 30 lb. nitrogen credit for a lentil crop did not appear to reduce durum yield or protein, and while protein has been high two out of three years overall yield in this study has typically been low. While there was yield loss due to hail or grasshopper damage, it is likely that very low soil pH and soil quality contributed to low yields as well. Management tactics to improve soil quality include liming, cover cropping with mycorrhizal/rhizobial hosts and high biomass crops, rotation with perennials and the addition of organic matter (ex. manure). Under these circumstances and given our results, additional nitrogen fertilizer may not make up crop loss due to low soil pH and soil quality. Liming in this case should be given high priority. Rotation with legumes and reducing fertilizer input did not increase soil pH over the 5 years of this study. In the future, the no-till nitrogen credit should be assessed under normal soil pH conditions.

## 2023 Resistance of Durum Varieties to Fusarium Head Blight — Sidney, MT

Frankie Crutcher, Michael Giroux, Alma Chinchilla, Caitlin Gross, Debra Kunda

**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: May 4
Harvested: Aug 25
Plot Size: 2.5' x 10'
Seeding Rate: 90 lbs/A
Soil Type: Savage silty clay loam
Previous Crops: Soybean

Residual Soil N to 3 ft: 1.1 ppm
Residual Soil P to 6 in: 16 ppm
Applied Fertilizer: 217 lb/A 70:26:0
Irrigated (sprinkler) on: May 20, Jun 5, Jun 9, Jun 16, Jul 6 (total: 3.7 in)
Herbicide Applications: Panoflex (0.6 oz/A); 2,4D (20.8 oz/A); Discover (12.8 oz/A); Wolverine (27.2 oz/A)
Precipitation April – September: 10.25 in
Disease assessment: Jul 26

**COMMENTS:**

Corn spawn inoculated with five isolates of *F. graminearum* was applied to the field May 24. Misting to increase humidity was applied from Jun 28 to Jul 27. Grasshoppers might have impacted the final yield.

**RESULTS:**

**Table 1: Durum Variety Reponses to Fusarium Head Blight**

| Variety | Severity (%)[a] | Incidence (%)[b] | Index[c] | % FDK[d] | Test Weight | Protein | Yield (Bu/A)[e] |
|---|---|---|---|---|---|---|---|
| Alzada | 71.3 AB | 97.9 A | 70.6 AB | 56.7 | 53.5 FG | 15.5 AB | 26.0 DE |
| Carpio | 18.1 H | 65.7 A-F | 12.1 G | 35.0 | 59.7 A-C | 13.4 AB | 69.7 A |
| Divide | 23.2 E-H | 53.4 EF | 13.9 FG | 22.7 | 60.3 A-C | 13.2 AB | 69.5 A |
| Joppa | 30.1 D-H | 81.2 A-E | 25.2 D-G | 48.3 | 59.8 A-C | 13.7 AB | 70.3 A |
| Lustre | 42.0 C-H | 73.4 A-F | 34.6 D-G | 24.3 | 60.6 AB | 12.7 B | 72.3 A |
| Mountrail | 35.4 D-H | 75.7 A-F | 27.3 D-G | 35.0 | 59.0 A-D | 13.1 AB | 60.6 A-C |
| MT Blackbeard | 22.4 F-H | 59.0 C-F | 13.5 F-G | 46.7 | 58.9 A-D | 13.1 AB | 60.3 A-C |
| MT Raska | 45.1 B-G | 93.4 A-C | 42.7 B-F | 48.3 | 57.6 B-E | 15.2 AB | 32.8 B-E |
| MTD18148 | 66.8 A-C | 99.0 A | 66.8 A-C | 56.7 | 54.4 E-G | 15.9 A | 31.6 C-E |
| MTD19011 | 34.4 D-H | 79.0 A-E | 27.5 D-G | 25.0 | 59.2 A-D | 13.3 AB | 70.6 A |
| MTD19077 | 21.4 F-H | 50.1 EF | 10.8 G | 36.7 | 59.9 A-C | 14.5 AB | 65.8 A |
| MTD19089 | 19.4 GH | 41.2 F | 10.1 G | 24.3 | 60.9 AB | 14.0 AB | 68.2 A |
| MTD19103 | 28.1 D-H | 77.9 A-F | 22.2 D-G | 31.7 | 59.2 A-D | 14.4 AB | 63.4 A |
| MTD19109 | 34.5 D-H | 92.3 A-D | 32.3 D-G | 41.7 | 57.9 B-D | 13.1 AB | 62.8 AB |
| MTD19115 | 47.1 B-F | 96.8 AB | 46.0 B-E | 48.3 | 58.3 A-D | 14.4 AB | 58.6 A-C |
| MTD19209 | 23.1 F-H | 55.7 D-F | 13.1 FG | 26.7 | 61.4 A | 12.9 AB | 73.4 A |
| MTD19241 | 27.1 D-H | 65.7 A-F | 17.7 E-G | 23.3 | 58.6 A-D | 12.6 B | 68.2 A |
| MTD19349 | 41.2 C-H | 85.7 A-E | 35.9 D-G | 28.3 | 58.9 A-D | 12.8 B | 71.4 A |
| MTD19499 | 28.3 D-H | 85.7 A-E | 25.3 D-G | 56.7 | 57.2 C-E | 14.6 AB | 59.0 A-C |
| MTD19507 | 51.4 B-D | 93.4 A-C | 48.7 B-D | 28.3 | 58.5 A-D | 13.6 AB | 60.7 A-C |
| MTD19511 | 51.2 B-D | 95.7 A-C | 49.8 B-D | 41.7 | 56.3 D-F | 14.4 AB | 54.9 A-D |
| MTD19529 | 49.8 B-E | 97.9 A | 49.4 B-D | 40.0 | 57.1 C-E | 13.2 AB | 54.4 A-D |
| MTD19611 | 42.6 C-H | 92.3 A-D | 39.7 C-G | 58.3 | 57.9 B-D | 14.4 AB | 49.5 A-D |
| MTD19617 | 25.4 D-H | 63.4 A-F | 16.3 E-G | 43.3 | 59.6 A-C | 14.2 AB | 63.3 A |
| MTD19623 | 35.8 D-H | 85.7 A-E | 32.1 D-G | 33.3 | 58.6 A-D | 13.4 AB | 63.4 A |
| MTD19653 | 31.8 D-H | 86.8 A-E | 28.7 D-G | 36.7 | 59.5 A-C | 14.0 AB | 60.9 A-C |
| MTD19703 | 23.1 F-H | 75.7 A-F | 18.2 E-G | 58.3 | 58.0 B-D | 13.8 AB | 53.5 A-D |
| ND Grano | 29.6 D-H | 80.1 A-E | 24.5 D-G | 33.33 | 60.60 AB | 13.73 AB | 66.79 A |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ND Riveland | 18.0 H | 60.1 B-F | 11.8 G | 23.33 | 61.20 A | 13.47 AB | 71.04 A |
| YUM-816-065 | 82.0 A | 99.0 A | 82.0 A | 56.67 | 50.3 G | 13.57 AB | 18.80 E |
| Mean | 36.7 | 78.6 | 31.6 | 39.0 | 58.7 | 13.8 | 59.1 |
| % CV | 47.1 | 24.2 | 63.4 | 41.1 | 3.6 | 8.3 | 27.1 |
| HSD (0.05) | 26.0 | 37.8 | 30.0 | N/S | 3.2 | 3.1 | 30.5 |
| *P* -value | <.0001 | <.0001 | <.0001 | <.0008 | <.0001 | <.0062 | <.0001 |

Letters in common did not differ significantly according to a Tukey's HSD test at a significance level of 5%.
[a]Pest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot.
[b]Pest Incidence: Percent of thirty plants per plot that had visible FHB symptoms.
[c]Index: Severity X Incidence / 100
[d]Fusarium diseased kernels.
[e]Grain yield adjusted to 14.0% moisture.

## 2023 Resistance of Barley Varieties to Fusarium Head Blight Sidney, MT

Frankie Crutcher, Jaime Sherman, Alma Chinchilla, Caitlin Gross, Debra Kunda

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

**MATERIALS AND METHODS**:

**Irrigated**
Variety: Misc.
Location: Sidney, MT
Planted: May 4
Harvested: Aug 10
Plot Size: 2.5' x 10'
Seeding Rate: 90 lbs/A
Soil Type: Savage silty clay loam
Previous Crops: Soybean

Residual Soil N to 3 ft: 1.1 ppm
Residual Soil P to 6 in: 16 ppm
Applied Fertilizer: 217 lb/A 70:26:0
Irrigated (sprinkler) on: May 20, Jun 5, Jun 9, Jun 16, Jul 6 (total: 3.7 in)
Herbicide Applications: Panoflex (0.6 oz/A); 2,4D (20.8 oz/A); Discover (12.8 oz/A); Wolverine (27.2 oz/A)
Precipitation April – September: 10.25 in
Disease assessment: Jul 26

**COMMENTS:**

Corn spawn inoculated with five isolates of *F. graminearum* was applied to the field May 24. Misting was applied from Jun 28 to Jul 27 to increase humidity. Grasshoppers might have impacted the final yield.

**RESULTS:**

**Table 1: Barley Variety Reponses to Fusarium Head Blight**

| Variety | Severity (%)[a] | Incidence (%)[b] | Index[c] | Test Weight | Protein | Yield (Bu/A)[d] |
|---|---|---|---|---|---|---|
| Bearpaw | 5.8 C-E | 68.9 A-K | 4.0 CD | 52.2 C-H | 11.5 C-N | 65.8 A-H |
| Buzz | 10.7 B-E | 75.6 A-J | 8.15 B-D | 51.3 D-H | 10.8 H-N | 57.4 A-H |
| Cowgirl | 12.6 B-E | 84.4 A-F | 10.9 B-D | 50.5 D-H | 12.3 B-L | 65.9 A-H |
| Havener | 7.2 C-E | 78.9 A-H | 5.8 CD | 60.3 A | 11.8 C-N | 67.4 A-H |
| Haxby | 5.5 C-E | 63.3 B-L | 3.5 CD | 51.4 D-H | 11.0 E-N | 68.4 A-H |
| Haymaker | 12.7 B-E | 92.2 A-C | 11.9 B-D | 53.5 C-F | 12.7 A-H | 54.9 A-H |
| Hockett | 5.6 C-E | 53.3 F-L | 2.5 CD | 52.9 C-F | 10.8 G-N | 72.9 A-G |
| Lavina | 19.4 B-D | 90.0 A-D | 17.5 A-C | 49.8 D-H | 11.8 C-N | 58.9 A-H |
| MT Boy Howdy | 10.4 B-E | 82.2 A-G | 8.5 B-D | 51.1 D-H | 10.5 J-N | 77.4 A-D |
| MT Endurance | 9.8 C-E | 68.9 A-K | 7.3 B-D | 52.8 C-G | 10.9 F-N | 73.6 A-G |
| MT16F01601 | 26.9AB | 82.2 A-G | 23.9 AB | 49.9 D-H | 13.2 A-D | 50.7 C-H |
| MT16M01801 | 6.4 C-E | 68.9 A-K | 4.5 CD | 53.5 C-G | 10.6 I-N | 83.1 AB |
| MT17F02410 | 16.9 B-E | 94.4 A-C | 16.1 A-D | 49.9 D-H | 11.5 C-N | 57.5 A-H |
| MT17M01908 | 10.6 B-E | 76.7 A-I | 8.63 B-D | 51.9 D-H | 10.8 G-N | 70.5 A-H |
| MT17M05808 | 5.0 C-E | 56.7 E-L | 2.9 CD | 51.9 D-H | 10.8 G-N | 58.6 A-H |
| MT18F00507 | 18.9 B-E | 87.8 A-E | 17.5 A-C | 52.8 C-G | 12.1 B-N | 50.6 C-H |
| MT18F00607 | 8.5 C-E | 80.0 A-H | 6.8 CD | 49.4 F-H | 12.5 B-K | 55.0 A-H |
| MT18F00803 | 13.1 B-E | 80.0 A-H | 10.3 B-D | 48.7 GH | 13.1 A-E | 59.2 A-H |
| MT18H02702 | 5.9 C-E | 61.1 C-L | 3.7 CD | 58.8 AB | 12.0 C-N | 63.7 A-H |
| MT18M06008 | 14.8 B-E | 88.9 A-E | 13.5 B-D | 50.8 D-H | 11.0 E-N | 57.6 A-H |
| MT18M06011 | 14.1 B-E | 87.8 A-E | 12.5 B-D | 51.5 D-H | 11.2 D-N | 62.2 A-H |
| MT18M10106 | 9.6 C-E | 77.8 A-H | 7.5 B-D | 52.5 C-G | 10.4 K-N | 74.9 A-F |
| MT18M11002 | 7.1 C-E | 76.7 A-J | 5.5 CD | 52.6 C-G | 11.3 D-N | 75.0 A-F |
| MT18M11004 | 10.2 B-E | 78.9 A-H | 8.4 B-D | 51.3 D-H | 11.3 D-N | 74.8 A-F |
| MT18M11103 | 5.6 C-E | 64.4 B-L | 3.7 CD | 50.9 D-H | 10.0 N | 83.1 AB |
| MT19_F04_02 | 21.1 A-C | 80.0 A-H | 17.4 A-D | 51.3 D-H | 13.5 A-C | 65.2 A-H |
| MT19_H09_09 | 3.7 DE | 57.8 D-L | 2.2 CD | 61.4 A | 14.2 AB | 42.6 GH |
| MT19_H11_03 | 7.9 C-E | 82.2 A-G | 6.6 CD | 59.8 A | 12.7 A-I | 44.0 F-H |

| | | | | | | |
|---|---|---|---|---|---|---|
| MT19_H11_04 | 4.8 C-E | 65.6 B-L | 3.4 CD | 57.0 AB | 13.1 A-E | 48.8 D-H |
| MT19_H11_05 | 9.4 C-E | 87.8 A-E | 8.4 B-D | 58.8 AB | 12.4 B-K | 38.6 H |
| MT19_H14_11 | 4.3 C-E | 61.7 B-L | 2.9 CD | 60.7 A | 12.6 B-K | 61.4 A-H |
| MT19_M034_16 | 5.3 C-E | 67.8 A-K | 3.7 CD | 51.9 D-H | 10.2 L-N | 81.6 A-C |
| MT19_M046_16 | 9.1 C-E | 85.6 A-F | 7.8 B-D | 50.2 D-H | 11.1 D-N | 48.4 D-H |
| MT19_M061_19 | 7.8 C-E | 73.3 A-K | 5.8 CD | 50.9 D-H | 10.6 I-N | 68.5 A-H |
| MT19_M064_05 | 7.2 C-E | 76.7 A-I | 5.6 CD | 52.0 D-H | 10.1 MN | 69.8 A-H |
| MT19_M065_05 | 8.9 C-E | 75.6 A-J | 6.8 CD | 51.7 D-H | 10.5 J-N | 76.8 A-E |
| MT19_M067_02 | 8.9 C-E | 77.8 A-H | 6.9 CD | 50.6 D-H | 10.8 G-N | 58.7 A-H |
| MT19_M075_23 | 6.0 C-E | 67.8 A-K | 4.1 CD | 47.5 H | 10.9 F-N | 64.0 A-H |
| MT19_M095_04 | 12.3 B-E | 85.5 A-F | 10.5 B-D | 51.2 D-H | 11.0 E-N | 68.6 A-H |
| ND24388 | 7.7 C-E | 71.1 A-K | 5.4 CD | 52.8 C-G | 11.7 C-N | 58.6 A-H |
| Odyssey | 15.7 B-E | 98.9 A | 15.6 A-D | 49.7 D-H | 11.1 D-N | 57.4 A-H |
| Pinnacle | 12.2 B-E | 74.4 A-J | 9.5 B-D | 52.0 D-H | 10.7 H-N | 60.3 A-H |
| Stander | 37.3 A | 81.1 A-G | 30.5 A | 50.3 D-H | 12.23 B-M | 67.8 A-H |
| 2017-41-6 | 5.7 C-E | 63.3 B-L | 3.7 CD | 54.3 B-E | 14.7 A | 53.0 B-H |
| 2017-42-18 | 5.2 C-E | 56.7 E-L | 3.2 CD | 52.9 C-G | 13.1 A-E | 64.5 A-H |
| 2017-42-3 | 2.3 E | 33.3 L | 0.8 D | 54.3 B-D | 12.1 B-N | 68.9 A-H |
| 2017-43-18 | 6.0 C-E | 66.7 A-K | 4.0 CD | 53.3 C-G | 12.9 A-F | 63.4 A-H |
| 2017-43-20 | 10.2 B-E | 68.9 A-K | 7.0 CD | 49.5 E-H | 13.4 A-C | 45.1 E-H |
| 2017-43-22 | 4.1 DE | 50.0 G-L | 2.2 CD | 51.2 D-H | 12.1 B-N | 56.6 A-H |
| 2017-46-10 | 4.1 DE | 47.8 H-L | 2.1 CD | 51.8 D-H | 12.6 B-J | 59.1 A-H |
| 2017-46-19 | 2.8 DE | 41.1 KL | 1.2 CD | 53.6 C-F | 13.2 A-D | 51.7 B-H |
| 2017-47-6 | 3.2 DE | 43.3 J-L | 1.4 CD | 53.5 C-G | 10.9 F-N | 85.6 A |
| 2019-23-22 | 9.9 B-E | 81.1 A-G | 8.4 B-D | 50.2 D-H | 11.4 C-N | 56.6 A-H |
| 2019-23-26 | 12.3 B-E | 87.8 A-E | 11.1 B-D | 49.7 D-H | 11.7 C-N | 62.9 A-H |
| 2019-25-55 | 9.4 C-E | 75.6 A-J | 7.7 B-D | 51.6 D-H | 11.4 C-N | 59.2 A-H |
| 2020-27-1 | 5.0 C-E | 60.0 C-L | 3.1 CD | 52.6 C-G | 11.9 C-N | 66.4 A-H |
| 2021-45-11 | 6.4 C-E | 73.3 A-K | 4.8 CD | 51.9 D-H | 11.5 C-N | 54.8 A-H |
| 2021-45-7 | 3.3 DE | 44.4 I-L | 1.5 CD | 54.3 B-E | 12.9 A-G | 62.3 A-H |
| Mean | 9.6 | 72.3 | 7.7 | 52.4 | 11.8 | 62.5 |
| % CV | 76.8 | 22.5 | 90.9 | 5.9 | 10.1 | 20.7 |
| HSD (0.05) | 17 | 32.8 | 16.7 | 4.8 | 2.1 | 32.2 |
| *P* -value | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 | <.0001 |

Letters in common did not differ significantly according to a Tukey's HSD test at a significance level of 5%.
[a]Pest Severity: Average percent area of head covered by disease. Thirty heads were evaluated for each plot.
[b]Pest Incidence: Percent of thirty plants per plot that had visible FHB symptoms.
[c]Index: Severity X Incidence / 100
[d]Grain yield adjusted to 12.0% moisture.

# Effect of seed treatments on nodulation, root rot and yield in chickpea

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## Introduction

Chickpea is highly susceptible to soil-borne seed rotting and seedling blight pathogens including the oomycetes in the *Pythium* genus as well as fungal pathogens *Rhizoctonia solani* and species of *Fusarium*. These pathogens reduce stand counts and can cause plant death shortly after emergence. *Fusarium* and *Rhizoctonia* can also cause root rot. Seed treatments that include the active ingredient metalaxyl, mefenoxam or ethaboxam are effective for management of *Pythium* and are the primary means by which this disease is controlled. Studies have linked some seed treatment products to reduced nodulation under laboratory or greenhouse conditions. This study was conducted to evaluate the effect of seed treatments on nodulation and soil-borne disease under field conditions.

## Methods

The trial was set up in a randomized complete block design, with 5 x 25 ft. plots and five replicates. The field sites selected had no history of chickpea production. The chickpea variety was CDC Frontier. Seed was treated with the selected products and allowed to dry (Table 1). All treatments except the non-inoculated, non-fungicide treated plots received rhizobial inoculum. A liquid inoculum was used in 2021 (Primo, Verdesian) and 2023 (LaFix, Lallemand), which was applied directly to the seed immediately prior to planting. In 2022, granular inoculum (Primo GX2, Verdesian) was applied at planting with the seed in-furrow. In 2021, the trial was planted April 22nd when soil temperature was 48°F. In 2022, the trial was plated on May 5th when the soil temperature was 57°F. In 2023, the trial was planted April 26th when the soil temperature was 45°F. Plant population was assessed at the V1-V5 growth stage by counting all plants along a 10-ft length in two rows per plot. Nodulation and root rot were assessed on 15 plants per plot at the late vegetative to early flowering growth stage. Root rot was rated on a 0 to 5 severity scale where 0 = no disease/white root and 5 = completely black root/dead plant. The trials were desiccated pre-harvest and harvested on August 17th in 2021, August 19th in 2022 and August 8th in 2023.

Table 1. Fungicides used in seed treatment study. North Dakota Field Crop Plant Disease Management Guide.

| Fungicide name | Application Rate | Active ingredient |
|---|---|---|
| Mertect 340F | 2.04 fl. oz./cwt | Thiabendazole (42.3%) |
| Intego Solo | 0.6 fl. oz. /cwt | Ethaboxam (34.2%) |
| Obvius | 4.6 fl. oz. /cwt | Metalaxyl (1.26%), Pyraclostrobin (1.58%), Fluxapyroxad (1.58%) |
| Rancona CTS | 1.53 fl. oz. /cwt | Metalaxyl (1.94%), Ipconazole (2.42%) |
| Apron Maxx RTA | 5 fl. oz. /cwt | Mefenoxam (1.1%), Fludioxonil (0.73%) |
| Cruiser Maxx Vibrance Pulses | 5.0 fl. oz /cwt | Mefenoxam (1.06%), Sedaxane (1.41%), Fludioxonil (0.71%), Thiabendazole (4.24%), Thiamethoxam (8.48%) |
| Allegiance | 0.75 fl. oz /cwt | Metalaxyl (28.35%) |
| Vibrance Maxx | 1.54 fl. oz./cwt | Mefenoxam (3.52%), Sedaxane (4.69%), Fludioxonil (2.35%) |
| Vibrance Maxx Pulses | 5 fl. oz. /cwt | Mefenoxam (1.07%), Sedaxane (1.43%), Fludioxonil (0.71%), Thiabendazole (4.3%) |

## Results and Discussion

### Crop Establishment

In all three study years, stand counts were lowest in the no fungicide and Mertect 340F treatments (Table 2). Mertect does not include an active ingredient for control of Pythium seed rot so this suggests that *Pythium* was causing disease in these trials. In 2021 and 2022 stand counts were lower in the Intego Solo treatment compared to the other products tested but this was not observed in 2023. While in 2021, Obvius and Allegiance also had somewhat lower stand counts, in 2022 and 2023 all fungicides except Mertect 340F and Intego Solo performed equally well in terms of crop establishment.

Table 2. Crop establishment in 2021, 2022 and 2023 as measured by plants per square foot. Inoculation refers to rhizobial inoculation. Means followed by different letters within years are significantly different as determined by Tukey's HSD (α<0.05).

| Treatment | Stand Count (Plants/$ft^2$) | | | | | |
|---|---|---|---|---|---|---|
| | 2021 | | 2022 | | 2023 | |
| No fungicides, non-inoculated | 0.2 | e | 3.0 | d | 2.9 | c |
| No fungicides, inoculated | 0.3 | e | 3.4 | d | 2.6 | c |
| Mertect 340F | 1.0 | de | 3.6 | cd | 3.2 | bc |
| Intego Solo | 1.9 | cd | 3.8 | bcd | 4.7 | a |
| Rancona CTS | 3.0 | abc | 4.8 | a | 5.3 | a |
| Obvius | 1.8 | cd | 4.8 | ab | 4.3 | ab |
| Allegiance | 2.3 | bcd | 4.6 | abc | 4.6 | ab |
| Cruiser Maxx Vibrance Pulses | 3.3 | ab | 4.5 | abc | 4.6 | a |
| Vibrance Maxx | 3.6 | ab | 5.1 | a | 4.9 | a |
| Vibrance Maxx Pulses | 3.7 | a | 4.8 | ab | 5.0 | a |
| Apron Maxx RTA | 2.6 | abc | 5.0 | a | 4.5 | ab |
| ANOVA (α < 0.05) | < 0.0001 | | < 0.0001 | | < 0.0001 | |

Root Rot

In 2021 and 2022, there was no effect of seed applied fungicides on root rot (Table 3). In 2023, root rot was highest in the non-fungicide treated check and lowest in the Cruiser Maxx Vibrance Pulses and Obvius treatments.

Table 3. Root rot in 2021, 2022 and 2023. Root rot was evaluated at early flowering. Means followed by different letters within years are significantly different as determined by Tukey's HSD (α<0.05).

| Treatment | Root Rot Ratings (0-5) | | | |
|---|---|---|---|---|
| | 2021 | 2022 | 2023 | |
| No fungicides, non-inoculated | 2.36 | 2.0 | 1.1 | a |
| No fungicides, inoculated | 2.48 | 1.8 | 0.9 | ab |
| Mertect 340F | 1.90 | 1.5 | 0.5 | abc |
| Intego Solo | 1.72 | 1.6 | 0.4 | abc |
| Rancona CTS | 1.78 | 1.6 | 0.5 | abc |
| Obvius | 1.86 | 1.7 | 0.2 | bc |
| Allegiance | 2.32 | 1.7 | 0.4 | bc |
| Cruiser Maxx Vibrance Pulses | 2.28 | 1.8 | 0.2 | c |
| Vibrance Maxx | 1.96 | 1.7 | 0.4 | abc |
| Vibrance Maxx Pulses | 2.06 | 1.5 | 0.4 | abc |
| Apron Maxx RTA | 1.94 | 1.8 | 0.4 | abc |
| ANOVA (α < 0.05) | NS | NS | 0.003 | |

Nodulation and Yield

There was no effect of seed treatment on nodulation in 2021 and 2022 (Table 4). In 2021, nodulation was very low and it is likely that this was due to drought conditions. The seed was planted into dry soil, and a significant rainfall event did not occur until 16 days after planting. Inoculant rhizobial survival under these conditions were likely impacted, resulting in reduced nodulation. Despite a lack of field history of chickpea, the non-inoculated plots had an average of 50 nodules/plant in 2022. Precautions were taken to avoid cross contamination by seeding the un-inoculated plots first, so either those precautions were insufficient or the study area had populations of rhizobia already present that were capable of nodulating chickpeas. In 2023, nodule number was lowest in the non-inoculated, Mertect 340F, Allegiance and Apron Maxx RTA treatments. The remaining treatments, both non-fungicide treated and several fungicide treatments, were not significantly different and nodulation ranged from 4-13 nodules/plant (Table 4).

In 2021, yield was greatly reduced where no seed treatment was used, but not significantly different among the different seed treatment products (Table 4). Yield data in 2022 showed a similar numerical trend, but in this case there was no significant difference among any of the treatments. In 2023, yield was lowest in the non-fungicide treated, Mertect 340F, Allegiance and Apron Maxx RTA treatments by 100-300 lb/ac. This largely corresponded with treatments with the lowest nodulation, with the exception of the non-fungicide treated, inoculated treatment, and nodule number was correlated with yield ($p = 0.0078$). Stand counts were significantly correlated with yield in all three study years ($p < 0.002$) and overall stand counts were higher in 2022 and 2023. *Pythium* is generally less problematic in warmer soils, thus the difference in soil temperatures at seeding may explain the lack of statistical separation among the treatments in 2022. Rainfall was also higher in 2022 and 2023, increasing overall crop productivity although there was likely some yield loss due to a hail event in 2023.

Table 4. Nodulation and yield data from 2021-2023 field trials. Statistical significance determined by ANOVA ($\alpha < 0.05$). Means followed by a common letter are not significantly different as determined by Tukey's HSD or Students t-test ($\alpha < 0.05$).

| Treatment | Nodule # | | | | Yield (lb/ac) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | | 2021 | | 2022 | 2023 | |
| No fungicides, non-inoculated | 0.96 | 50.3 | 0.8 | b | 157 | b | 1822 | 993 | cd |
| No fungicides, inoculated | 0.10 | 64.7 | 4.8 | ab | 270 | b | 1788 | 1015 | cd |
| Mertect 340F | 0.68 | 67.2 | 1.5 | b | 849 | a | 2023 | 900 | d |
| Intego Solo | 2.02 | 70.2 | 4.6 | ab | 867 | a | 2019 | 1191 | abc |
| Rancona CTS | 2.64 | 65.8 | 4.1 | b | 944 | a | 2152 | 1125 | abc |
| Obvius | 2.10 | 74.0 | 13.7 | a | 964 | a | 2342 | 1273 | ab |
| Allegiance | 0.14 | 69.9 | 1.5 | b | 989 | a | 2007 | 1015 | cd |
| Cruiser Maxx Vibrance Pulses | 0.74 | 63.1 | 4.3 | ab | 1079 | a | 2111 | 1233 | ab |
| Vibrance Maxx | 0.74 | 73.8 | 6.6 | ab | 1099 | a | 2074 | 1164 | abc |
| Vibrance Maxx Pulses | 1.08 | 75.2 | 4.6 | ab | 1113 | a | 2225 | 1204 | abc |
| Apron Maxx RTA | 1.06 | 67.5 | 1.8 | b | 1152 | a | 2063 | 1024 | bcd |
| ANOVA ($\alpha <$ 0.05) | NS | NS | 0.0003 | | < 0.0001 | | 0.0597 | 0.0148 | |

Conclusions

Rhizobial inoculation was important to maintaining chickpea yield across different years/environments. Seed treatment with fungicides consistently improved crop establishment (stand counts) which was associated with higher yield in all three study years. We observed a negative impact of seed applied fungicide for some products on nodulation in one out of three study years, however, we also observed significant yield loss in 2021 in the no-fungicide treatments. Both rhizobial inoculation and fungicide seed treatment are needed to consistently maximize yield in chickpea, and growers should select fungicide seed treatment products which do not have the potential to inhibit nodulation.

# 2024 WREC Seed Availability

## Spring Wheat

ND Heron= new NDSU release, early maturity, excellent quality, high protein.

MT Dagmar= new solid stem, high protein, excellent standability.

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## Winter Wheat

ND Allison= new variety with good yield, protein, and test weight. Good winter hardiness and more tolerant to acidic soils.

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AAC Stronghold=Solid stem for sawfly tolerance. Excellent choice for irrigated acres with its strong straw strengths.

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CDC Haymaker=forage oat, high tonnage potential, very large flag leaf and plump seed size.

AAC Douglas=white hulled, high yield and test weight.

## Peas

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ND Victory=New NDSU green pea. High protein, good yield, and small seed size.

## Chickpeas

ND Crown=NDSU new release. ND Crown is Kabuli type chickpea that has high yield potential in ND.

## Lentils

Avondale's=medium green lentil with good resistance to lodging.

## Flax

CDC Rowland=brown seeded flax with higher yields, larger seed, and strong straw.

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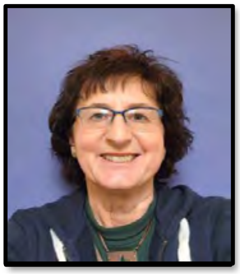

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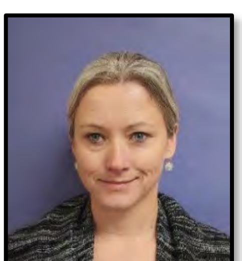

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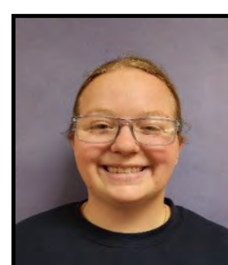

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