2019

# Irrigation Crop Diversification Corporation

# Research and Demonstration Report






ICDC

Irrigation Crop Diversification Corporation

Through innovation, the Irrigation Crop Diversification Corporation stimulates and services the development and expansion of sustainable irrigation in Saskatchewan.

# Research and Demonstration Program Report 2019

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ICDC Research and Demonstration Report 2019



This report is published annually. Copies of this report can be found on our website. If you would like to be added to our mailing list, please contact us:

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# VISION

To be the leading research and development organization for maximizing the value of irrigation.

# OBJECTIVES AND PURPOSES OF ICDC

a) to research and demonstrate to producers and irrigation districts profitable agronomic practices for irrigated crops;

b) to develop or assist in developing varieties of crops suitable for irrigated conditions;

c) to provide land, facilities and technical support to researchers to conduct research into irrigation technology, cropping systems and soil and water conservation measures under irrigation and to provide information respecting that research to district consumers, irrigation districts and the public;

d) to co-operate with the Ministry in promoting and developing sustainable irrigation in Saskatchewan.

# CONTACT

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# BOARD OF DIRECTORS

| Director | Position | Irrigation District | Development Area Represented | Term Expiry (current term) |
|---|---|---|---|---|
| Anthony Eliason | Chairman | Individual Irrigator | Non-District | 2021 (2nd) |
| Nigel Oram | Vice Chairman | Grainland | NDA | 2019 (1st) |
| Murray Purcell | Director | Moonlake | NDA | 2020 (1st) |
| David Bagshaw | Director | Riverhurst | SEDA | 2019[1] |
| Paul Heglund | Director | Consul-Nashlyn | SWDA | 2020 (2nd) |
| Kaitlyn Gifford | Director | LDDA | SSRID | 2020 (1st) |
| Greg Oldhaver | Director | Miry Creek | SWDA | 2019[2] |
| Larry Lee | Director | SSRID | SIPA representative | Appointed |
| Aaron Gray | Director | Miry Creek | SIPA representative | Appointed |
| Kelly Farden | Director | N/A | SA representative | Appointed |
| Penny McCall | Director | N/A | SA representative | Appointed |

[1] Pursuant to Bylaw 7, David Bagshaw was appointed to a one year term
[2] Pursuant to Bylaw 7, Greg Oldhaver was appointed to a one year term

The four Development Areas (DA), as defined in ICDC's bylaws, are:

Northern (NDA),
South Western (SWDA),
South Eastern (SEDA), and
Lake Diefenbaker (LDDA).

ICDC Directors are elected by District Delegates who attend the annual meeting. Each Irrigation District is entitled to send one Delegate per 5,000 irrigated acres or part thereof to the annual meeting. Two Directors are elected from LDDA, two from SWDA and one each from NDA and SEDA. Non-district irrigators elect one representative.

The Saskatchewan Irrigation Projects Association (SIPA) and the Saskatchewan Ministry of Agriculture (SA) appoint two directors each to the ICDC board.

In accordance with the *Irrigation Act, 1996*, the majority of the ICDC board must be comprised of irrigators.

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# FIELD CROP VARIETY TRIALS 2019

## Irrigated Field Pea Regional Variety Trial


### Funding
This project was funded by the Irrigation Crop Diversification Corporation and the Saskatchewan Variety Performance Group.



### Principal Investigator
- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)

### Organizations
- Irrigation Crop Diversification Corporation (ICDC)
- Saskatchewan Variety Performance Group
- Saskatchewan Advisory Council on Grain Crops


### Objectives
The objectives of this study were to:

(1) Evaluate experimental pea lines pursuant to registration requirements;
(2) Assess entries for suitability to irrigated production; and
(3) Update ICDC's annual *Crop Varieties for Irrigation* guide.

### Research Plan
The Pea Regional Variety Trial (PRVT) was conducted at Broderick, SK in the South Saskatchewan Regional Irrigation District. Site and soil type are as follows:

ICDC Rudy Agro Site (SW27-30-07-W3): Bradwell fine sandy loam to loam (NW quadrant)

Pea varieties were tested for their agronomic performance under irrigation. The Rudy Agro Off-station site was seeded on May 17. The trial was arranged in a randomized complete block design with three replicates. Plot size was 1.5 m x 4 m. All plots received 35 kg $P_2O_5$/ha as 12-51-0 as a side banded application and Cell Tech granular inoculant at a rate of 5.2 kg/ha as a seed place application during the seeding operation. Weed control consisted of a spring pre-plant soil incorporated application of granular Edge (ethalfluralin) and a post-emergence application tank mix of Viper ADV (imazamox + bentazon) at 0.4 L/ac with 0.81 L UAN/ac (28-0-0). Supplemental hand weeding was conducted as required. The trial received a fungicidal application of Priaxor (fluxapyroxad & pyraclostrobin) for control/suppression of powdery mildew, mycosphaerella, downy mildew and white mold at flowering. The trial was desiccated with 0.81 L/ac of Reglone Ion (diquat) on September 3, 2019. The trial was direct harvested with a small plot combine September 20, 2019.

Thirty-six pea varieties representing five market classes were evaluated in 2019. Fourteen registered varieties and five experimental entries were Yellow pea market class, eight registered varieties and two unregistered were Green market class, two registered Maple varieties, two registered varieties in the Maple market class, one registered Dun market class variety, three registered varieties and one unregistered entry in the Forage market class.

## Results

Varieties included in the trial were as followes;

Yellow Market Class – CDC Amarillo, Agaaaiz, AAC Aberdeen, AAC Ardill, AAC Carver, AAC Chrome, AAC Delhi, AAC Lacombe, CDC Canary, CDC Inca, CDC Lewochko, CDC Meadow, CDC Saffron, CDC Spectrum, CDC 4900-13, CDC4947-2, CDC 4999-5, CDC 5141-7 and CDC 5286-2.

Green Market Class – AAC Comfort, Blueman, CDC Forrest, CDC Greenwater, CDC Limerick, CDC Raezer, CDC Striker, CDC Spruce, CDC 4506-4 and CDC 4639-8.

Maple Market Class – AAC Liscard, CDC Blazer

Dun Market Class – CDC Dakota

Forage Market Class – CDC Jasper, DL Delicious, DL Goldeye and DL 15.50013

Results of the CSIDC pea trial is shown in Table 1. Varieties differed widely with respect to yield. AAC Aberdeen (Yellow) was the highest yielding registered pea variety, experimental CDC 4947-2 (Yellow) was the highest unregistered entry and the highest yielding overall, CDC Spruce the highest yielding registered Green class pea. CDC Jasper, a Forage class, was the lowest yielding. Forage class pea entries were among the lowest entries with respect to seed yield. Median yield of all varieties was 5997 kg/ha, average yield 5864 kg/ha. The Dun class varieties CDC Dakota and CDC Blazer were the highest registered entry with respect to protein. Pulse protein has become an area of increased interest with respect to human food products. Within the Yellow market class CDC Lewochko had the highest protein content, however it was the lowest yielding Yellow register variety, so higher protein concentration may have been a consequence of low yield. CDC Limerick had the highest protein in the Green market class registered varieties. On the basis of kg protein/ha production AAC Aberdeen (Yellow) produced the highest protein yields/ha of all registered varieties (1522 kg protein/ha), within the Green market class the highest protein yields/ha was with CDC Spruce (1349 kg protein/ha), data not shown. Median protein content was 22.7%. Median test weight was 80.3 kg/hl, seed weight was seed 217 mg. Entries ranged from 49 to 60 days to flower. The Forage variety CDC Jasper was the longest to mature, the Yellow pea varieties CDC Meadow and Agassiz the earliest to mature. Median days to flower and mature were 55 and 102 days, respectively. The environmental conditions of the 2019 growing season resulted in delayed maturity of most crop species, field pea included. Plant heights ranged from 76 to 119 cm. The Yellow class variety, Agassiz, and the Forage calls variety, DL Goldeye, exhibited the highest degree of lodging. The entry with the lowest lodging was the Yellow registered variety AAC Lacombe. In general any lodging rating of 7 or higher would provide harvest challenges, the median lodging rating of all entries was 6.0.

Table 1. Irrigated Pea Regional Variety Trial, CSIDC Off-Station Site, 2019.

| Variety | Yield (kg/ha) | Protein (%) | Test weight (kg/hl) | 1 K Seed weight (gm) | 10% Flower (days) | Maturity (days) | Height (cm) | Lodge rating (1=erect; 10=flat) |
|---|---|---|---|---|---|---|---|---|
| **Yellow** | | | | | | | | |
| ***CDC Amarillo*** | ***6446*** | ***21.7*** | ***80.5*** | ***224*** | ***55*** | ***96*** | ***102*** | ***4*** |
| Agassiz | 5955 | 22.8 | 79.0 | 222 | 49 | 94 | 99 | 8 |
| AAC Aberdeen | 6865 | 22.2 | 80.0 | 259 | 56 | 105 | 108 | 5 |
| AAC Ardill | 5792 | 21.5 | 79.9 | 235 | 57 | 99 | 99 | 5 |
| AAC Carver | 6139 | 20.2 | 79.6 | 239 | 53 | 95 | 106 | 5 |
| AAC Chrome | 6297 | 21.2 | 79.4 | 239 | 54 | 100 | 96 | 7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| AAC Delhi | 5930 | 22.6 | 78.9 | 278 | 54 | 95 | 101 | 6 |
| AAC Lacombe | 6111 | 21.6 | 80.5 | 264 | 55 | 100 | 108 | 4 |
| CDC Canary | 6186 | 21.8 | 81.2 | 228 | 49 | 95 | 103 | 6 |
| CDC Inca | 6144 | 22.9 | 79.8 | 213 | 56 | 98 | 107 | 4 |
| CDC Lewochko | 5291 | 24.7 | 80.1 | 215 | 57 | 104 | 111 | 6 |
| CDC Meadow | 6097 | 21.9 | 80.8 | 214 | 50 | 94 | 103 | 6 |
| CDC Saffron | 5837 | 23.0 | 80.1 | 234 | 54 | 97 | 93 | 6 |
| CDC Spectrum | 5829 | 23.2 | 80.3 | 233 | 55 | 102 | 87 | 4 |
| CDC 4900-13 | 6694 | 23.3 | 80.7 | 228 | 56 | 101 | 109 | 4 |
| CDC 4947-2 | 7116 | 21.5 | 80.7 | 222 | 57 | 103 | 104 | 4 |
| CDC 4999-5 | 6475 | 22.5 | 80.7 | 210 | 56 | 104 | 105 | 5 |
| CDC 5141-7 | 6249 | 22.9 | 80.3 | 201 | 49 | 100 | 106 | 6 |
| CDC 5286-2 | 5246 | 22.0 | 80.2 | 210 | 54 | 99 | 119 | 5 |
| **Green** | | | | | | | | |
| AAC Comfort | 5426 | 22.9 | 78.1 | 233 | 58 | 102 | 106 | 7 |
| Blueman | 5661 | 24.2 | 79.9 | 213 | 56 | 104 | 98 | 6 |
| CDC Forrest | 5813 | 23.2 | 79.9 | 220 | 56 | 104 | 104 | 5 |
| CDC Greenwater | 5835 | 21.5 | 80.0 | 228 | 56 | 101 | 104 | 5 |
| CDC Limerick | 6005 | 24.6 | 80.9 | 212 | 49 | 102 | 105 | 5 |
| CDC Raezer | 6127 | 22.0 | 80.1 | 217 | 54 | 96 | 110 | 5 |
| CDC Striker | 4980 | 24.2 | 80.3 | 226 | 54 | 97 | 87 | 7 |
| CDC Spruce | 6237 | 21.6 | 79.8 | 244 | 56 | 102 | 108 | 6 |
| CDC 4506-4 | 6564 | 21.3 | 80.6 | 221 | 57 | 102 | 101 | 4 |
| CDC 4639-8 | 6573 | 22.5 | 80.4 | 231 | 57 | 104 | 102 | 5 |
| **Maple** | | | | | | | | |
| AAC Liscard | 6444 | 22.1 | 83.5 | 191 | 58 | 96 | 104 | 5 |
| CDC Blazer | 5748 | 25.5 | 80.7 | 170 | 53 | 102 | 98 | 7 |
| **Dun** | | | | | | | | |
| CDC Dakota | 5809 | 25.5 | 80.6 | 177 | 58 | 104 | 101 | 6 |
| **Forage** | | | | | | | | |
| CDC Jasper | 3644 | 24.7 | 80.4 | 134 | 53 | 105 | 83 | 5 |
| DL Delicious | 4313 | 25.1 | 80.1 | 193 | 60 | 105 | 117 | 6 |
| DL Goldeye | 4107 | 24.7 | 80.1 | 136 | 52 | 104 | 76 | 8 |
| DL 15.50013 | 5113 | 23.2 | 79.4 | 159 | 50 | 98 | 113 | 7 |
| LSD (0.05) | 924 | 1.0 | 0.9 | 22.1 | 3.5 | 2.5 | 9.6 | 2.0 |
| CV (%) | 9.7 | 2.8 | 0.7 | 6.3 | 3.9 | 1.5 | 5.8 | 22.5 |

The results from this trial is used to update the irrigation variety database ICDC and provide recommendations to irrigators on the best field pea varieties suited to irrigation conditions. Results of the 2019 Irrigated Field Pea Regional Variety Trial will be used in the development of the annual publications *"Crop Varieties For Irrigation"* and the Saskatchewan Ministry of Agricultures *"Varieties of Grain Crops 2020."*

# Irrigated Canola Performance Trial – Conventional Swath

## Funding

This project was funded by the Canola Council of Canada.

## Principal Investigator


- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)


## Organizations


- Irrigation Crop Diversification Corporation (ICDC)
- Canola Council of Canada


## Objectives

The objectives of this study were to:

(1) Evaluate experimental lines and registered canola hybrids for regional performance;

(2) Assess entries for suitability to irrigated production; and

(3) Update ICDC's annual *Crop Varieties for Irrigation* guide.

## Research Plan

The irrigated canola performance trial was conducted on rented land owned by the Walker family (Rudy Agro) north of Broderick, SK. Canola varieties were tested for their agronomic performance under irrigation. Two Clearfield, four Liberty and fifteen Roundup tolerant canola hybrids where established in 2019. The trial was seeded on May 17. Plot size was 1.5 m x 6.0 m, varieties were blocked into their respective herbicide tolerance grouping for purpose of comparison and appropriate post emergent herbicide applications. The seed was treated with Helix XTra (thiamethoxam, difenoconazole, metalaxyl & fludioxonil) for seed borne disease and early season flea beetle control. The trial was established on potato stubble and soil testing indicated available residual N levels of 150 kg N in the top 60 cm. Supplemental nitrogen fertilizer was applied at 20 kg N/ha as 46-0-0 and phosphorus at 20 kg $P_2O_5$/ha as 12-51-0 side-banded at the time of seeding.

## Results

The trial was situated on, by visual appearances, flat level ground. However, during the 7 day period of June 15 – 22 site received in excess of 65 mm (2.6") and immediately prior to June 15 an irrigation application of 25 mm (1") had been applied. Unfortunately, the rainfall received collected within the trial area and the canola plots sustained plant mortality. Consequently, this trial was abandoned and will be repeated in 2020.

# Irrigated Canola Performance Trial – Straight Cut

## Funding

This project was funded by the Canola Council of Canada.

## Principal Investigator

- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Canola Council of Canada

## Objectives

The objectives of this study were to:

(1) Evaluate experimental lines and registered canola hybrids for regional performance in a straight cut combine production system;
(2) Assess entries for suitability to irrigated production; and
(3) Update ICDC's annual *Crop Varieties for Irrigation* guide.

## Research Plan

The irrigated canola performance trial was conducted on rented land owned by the Walker family (Rudy Agro) north of Broderick, SK. Canola varieties were tested for their agronomic performance under irrigation. One Clearfield, three Liberty and four Roundup tolerant canola hybrids where established in 2019. The trial was seeded on May 17. Plot size was 1.5 m x 6.0 m, varieties were blocked into their respective herbicide tolerance grouping for purpose of comparison and appropriate post emergent herbicide applications. The seed was treated with Helix XTra (thiamethoxam, difenoconazole, metalaxyl & fludioxonil) for seed borne disease and early season flea beetle control. The trial was established on potato stubble and soil testing indicated available residual N levels of 150 kg N in the top 60 cm. Supplemental nitrogen fertilizer was applied at 20 kg N/ha as 46-0-0 and phosphorus at 20 kg $P_2O_5$/ha as 12-51-0 side-banded at the time of seeding.

## Results

The trial was situated on, by visual appearances, flat level ground. However, during the 7 day period of June 15 – 22 site received in excess of 65 mm (2.6") and immediately prior to June 15 an irrigation application of 25 mm (1") had been applied. Unfortunately, the rainfall received collected within the trial area and the canola plots sustained plant mortality. Consequently, this trial was abandoned and will be repeated in 2020.

# ICDC Irrigated Canola Variety Trial

## Funding
This project was funded by the Irrigation Crop Diversification Corporation.

## Principal Investigator

- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)


## Organizations

- Irrigation Crop Diversification Corporation (ICDC)


## Objectives
The objectives of this study were to:

(1) Evaluate registered canola hybrids for which ICDC has limited data;
(2) Assess entries for suitability to irrigated production; and
(3) Update ICDC's annual *Crop Varieties for Irrigation* guide.

Every year ICDC conducts the Irrigated Canola Variety Trial. Historically selection of canola varieties was based upon results obtained in prior seasons through canola coop trials conducted by ICDC for the Canola Council of Canada. Once varieties are commercially available companies were then invited to provide seed of those varieties that prior observations have shown to be agronomically suitable for irrigation production. Companies approached for seed are also invited to provide an additional variety (registered or experimental) of their choosing for inclusion. However, in 2017 these registration trials were converted to "blind" trials where entries experimental/registered names were not divulged. Consequently, ICDC lost the ability to screen and assess varieties prior to registration and identify those best suited to irrigation production. Therefore, ICDC no longer participates in these trials.

As of 2018 ICDC invites seed companies to participate by submitting varieties to ICDC for assessment under irrigated production. These trials are offered by ICDC to the seed companies free of charge. Irrigation producers throughout the province pay for these trials directly from their irrigation levies. Some companies fully participate, others have declined to provide canola varieties. Results from these trials are used to update the irrigation variety database at CSIDC and provide recommendations to irrigators on the best canola varieties suited to irrigation conditions and will be used in the development of the annual publications "*Crop Varieties for Irrigation.*"

## Research Plan
Two irrigated canola variety trials were conducted at two locations in the Outlook irrigation area. Each site and soil type are as follows:

ICDC Knapik Site (NW12-29-08-W3): Asquith sandy loam (SW quadrant)
ICDC Rudy Agro Site (SW27-30-07-W3): Bradwell fine sandy loam to loam (NW quadrant)

A total of twenty-two canola varieties were tested for their agronomic performance under irrigation. Varietal selection was based upon solicitation of seed companies for entries they deemed suitable to intensive irrigation production practices. Seeding dates for the sites were: ICDC Knapik May 16, ICDC Rudy Agro May 17. Plot size was 1.5 m x 4.0 m, all plots were seeded on 25 cm row spacings, and replicated four times in a RBDC experimental design. All seed was treated by the seed suppliers for seed borne disease and early season flea beetle control. At Knapik supplemental fertilizer was applied at an application rate of 110 kg N/ha as 46-0-0 and supplemental phosphorus at 35 kg $P_2O_5$/ha as 12-51-0, all fertilizer was side banded. At Rudy Agro supplemental fertilizer was applied at a starter N application rate of 20 kg N/ha as 46-0-0 and supplemental phosphorus at 20 kg $P_2O_5$/ha as 12-51-0, all fertilizer was side banded. Higher rates of N fertilizer were not applied at Rudy Agro as the trial was established on potato stubble that contained residual soil test N levels of 150 kg N/ha. Weed control consisted of a pre-plant soil incorporated application of granular Edge (ethalfluralin) and a post-emergent tank-mix application of Muster Toss-N-Go (ethametsulfuron-methyl) and Poast Ultra (sethoxydim) and supplemented by periodic hand weeding. Both trials received a foliar application of Priaxor (fluxapyroxad & pyraclostrobin) fungicide at 50% bloom. Both trials were separated and swathed, after proper dry down Knapik was harvested September 18, the Rudy Agro on September 19. Total in-season rainfall at CSIDC (closest weather station) from May through mid-September was 204.4 mm (8.0”). Total in-season irrigation at Knapik was 100 mm (4”), at Rudy Agro 274 mm (10.8”).

## Results

Results obtained at the Knapik location are shown in Table 1, those of the Rudy Agro site in Table 2, and combined site analyses in Table 3.

One hybrid entry 45CS40 was eliminated from the trial, plant establishment of this hybrid was poor at both test locations. All varieties were seeded in the same manner at each location so the poor establishment is unexplainable. Regardless it was decided to remove the hybrid from statistical analyses and summaries of results.

Canola varieties in the Knapik trial (Table 1) were not statistically significantly different from each other. Median yield of varieties was 4303 kg/ha (76.8 bu/ac). Disease and insects were not an issue in 2019.

Percent oil content ranged from 46.4% (5545 CL) to 49.2% (L255PC). Median oil content of all varieties was 46.9%. Median test weight was 66.6 kg/hl and thousand seed weight 3.9 gm. Hybrids differed by as much as 6 days from one another, the experimental entry 92SC was the earliest to flower, 4187 RR and L252 the latest. The earliest hybrid to mature was L230, the latest 5545 CL. Median days to mature for canola hybrids was 109 days, which is later maturing than most irrigated seasons and likely a reflection of the cool start and wet finish to the season. Plant heights varied from the shortest with plant height of 88 cm (experimental 92SC) to the tallest height of 112 cm (CS2300), plants did not achieve the height normally expected for irrigated canola and where in-fact, exceptionally short. Lodging ratings, at this location, was not obtained because of the lateness of the season the decision was made to separate the plots while summer staff was still available. This is achieved mechanically but does disallow for realistic lodging evaluations.

At the Rudy Agro location (Table 2) varieties did differ statistically from one another, however, the trial did have a higher CV than typically is obtained. The Liberty herbicide tolerant L255PC obtained the highest yield, CS2500CL the lowest. However, only CS2500 CL, 92SC and 5545 CL were statistically lower yielding compared to the assigned check variety, L252. Conversely, only L233P was statistically higher yielding than the check variety. Median yield of varieties was 4593 kg/ha (81.9 bu/ac).

Percent oil content ranged from 44.1% (92SC) to 48.8% (L252). Median oil content of all varieties was 46.8%. Median test weight was 62.4 kg/hl. Thousand seed weight at this site was very low and statistics indicated a high amount of variation. Data for TKW at this site will not be used in ICDC’s historic data base nor be further discussed. Median days to 10% flower was 47 days. L230, 45M35 and 92SC were the earliest to flower, 4187 RR the latest. Any hybrids that flowered prior to 49 days were statistically different than the check L252. Median days to maturity was very late at 109 days (average of entries was 108 days), hybrid L233P was the earliest to mature, CS2300, 46H75 and 5545 CL the latest. The four earliest hybrids (L233P, L230, 45M35 and PV 200 CL) the latest maturing hybrid, CS2300 (days to maturity are round to the closest whole day in Tables) were the only hybrids differing in maturity from the check variety. Only the tallest hybrid 4187 RR and the shortest hybrids 92SC and CS2600 CR-T differed statistically from the control in plant height. Any hybrids with a lodging rating of 2.0, or higher, differed statistically from the control. The degree of lodging evident at Rudy Agro would not be deemed problematic to harvest.

Comparison between the two site location trials in Table 3 will not be discussed.

Results from these trials are used to update the irrigation variety database at ICDC and provide recommendations to irrigators on the best canola varieties suited to irrigation conditions and will be used in the development of the annual publications "*Crop Varieties for Irrigation.*"

Table 1. Yield and agronomic data for the 2019 ICDC Knapik Irrigated Canola Variety Trial.

| **Entry** | **Yield (kg/ha)** | **Oil (%)** | **Test Weight (kg/hl)** | **TKW (gm/1000 seed)** | **Height (cm)** | **First Flower (days)** | **Maturity (days)** | **Lodge rating (1=erect; 5=flat)** |
|---|---|---|---|---|---|---|---|---|
| ***L252*** | ***4730*** | ***48.0*** | ***67.8*** | ***3.4*** | ***105*** | ***51*** | ***112*** | ***NC*** |
| L230 | 4380 | 47.3 | 66.6 | 4.1 | 105 | 47 | 106 | NC |
| L233P | 4539 | 45.9 | 65.7 | 3.8 | 103 | 48 | 108 | NC |
| L241C | 4222 | 45.2 | 66.1 | 4.1 | 104 | 50 | 108 | NC |
| L255PC | 4982 | 49.2 | 67.1 | 3.4 | 100 | 48 | 107 | NC |
| 45CS40 | Variety eliminated from test | | | | | | | |
| 45H33 | 3650 | 47.1 | 64.4 | 3.7 | 101 | 50 | 109 | NC |
| 45M35 | 4281 | 49.1 | 66.9 | 4.0 | 101 | 49 | 109 | NC |
| 46H75 | 3901 | 46.0 | 66.0 | 3.7 | 107 | 50 | 115 | NC |
| CS2300 | 4406 | 46.7 | 66.6 | 4.1 | 112 | 48 | 113 | NC |
| CS2500 CL | 4089 | 46.1 | 67.2 | 4.6 | 98 | 47 | 112 | NC |
| CS2600 CR-T | 3988 | 48.5 | 67.3 | 4.0 | 100 | 47 | 107 | NC |
| 4187 RR | 4763 | 47.6 | 66.9 | 3.7 | 111 | 51 | 114 | NC |
| 5545 CL | 4531 | 44.6 | 68.4 | 4.0 | 110 | 49 | 117 | NC |
| 6076 CR | 4423 | 45.6 | 66.3 | 3.8 | 109 | 48 | 111 | NC |
| 6090 RR | 4374 | 45.3 | 66.9 | 3.8 | 104 | 50 | 112 | NC |
| PV 200 CL | 4039 | 46.0 | 67.0 | 3.8 | 107 | 50 | 113 | NC |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PV 540 G | 4838 | 45.4 | 66.1 | 3.7 | 111 | 50 | 115 | NC |
| PV 581 GC | 4366 | 47.7 | 64.3 | 3.9 | 101 | 49 | 109 | NC |
| PV 680 LC | 4025 | 46.8 | 64.3 | 3.9 | 105 | 50 | 109 | NC |
| 92SC | 3951 | 44.8 | 66.4 | 3.9 | 88 | 45 | 107 | NC |
| 94CR | 3848 | 47.5 | 66.7 | 4.0 | 91 | 48 | 107 | NC |
| LSD (0.05) | NS | 1.3 | 1.1 | 0.3 | 11.3 | 1.6 | 3.7 | |
| CV (%) | 13.9 | 1.9 | 1.2 | 4.6 | 7.7 | 2.3 | 2.3 | |

NS = Not Significant
NC = Observation not captured

Table 2. Yield and agronomic data for the 2019 ICDC Rudy Agro Irrigated Canola Variety Trial.

| **Entry** | **Yield (kg/ha)** | **Oil (%)** | **Test Weight (kg/hl)** | **TKW (gm/1000 seed)** | **Height (cm)** | **First Flower (days)** | **Maturity (days)** | **Lodge rating (1=erect; 5=flat)** |
|---|---|---|---|---|---|---|---|---|
| ***L252*** | ***4949*** | ***48.8*** | ***64.2*** | ***2.3*** | ***123*** | ***50*** | ***108*** | ***1.3*** |
| L230 | 4181 | 47.5 | 63.5 | 2.5 | 118 | 48 | 105 | 1.8 |
| L233P | 5729 | 45.8 | 61.3 | 2.5 | 122 | 48 | 104 | 1.3 |
| L241C | 4932 | 45.2 | 62.1 | 3.0 | 124 | 50 | 109 | 1.3 |
| L255PC | 6085 | 48.1 | 64.0 | 2.1 | 120 | 48 | 109 | 1.0 |
| 45CS40 | Variety eliminated from test | | | | | | | |
| 45H33 | 4669 | 47.9 | 59.7 | 2.2 | 118 | 49 | 106 | 2.0 |
| 45M35 | 5335 | 48.8 | 63.5 | 3.2 | 123 | 47 | 105 | 1.8 |
| 46H75 | 5172 | 47.0 | 60.9 | 2.6 | 124 | 50 | 111 | 1.0 |
| CS2300 | 4079 | 46.4 | 62.8 | 2.7 | 124 | 48 | 111 | 1.0 |
| CS2500 CL | 3012 | 45.7 | 63.9 | 3.9 | 116 | 48 | 109 | 2.0 |
| CS2600 CR-T | 4670 | 48.4 | 63.2 | 3.5 | 112 | 48 | 110 | 2.0 |
| 4187 RR | 4196 | 48.3 | 62.1 | 2.5 | 132 | 51 | 109 | 1.8 |
| 5545 CL | 3669 | 44.9 | 64.2 | 3.2 | 120 | 48 | 111 | 1.8 |
| 6076 CR | 4292 | 46.2 | 60.9 | 2.5 | 130 | 49 | 109 | 1.0 |
| 6090 RR | 4573 | 46.2 | 61.2 | 2.8 | 127 | 49 | 108 | 1.5 |
| PV 200 CL | 4667 | 47.0 | 61.9 | 2.8 | 121 | 49 | 105 | 1.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PV 540 G | 4793 | 46.5 | 61.0 | 2.2 | 123 | 49 | 109 | 1.0 |
| PV 581 GC | 4912 | 47.4 | 60.5 | 3.1 | 122 | 49 | 110 | 1.3 |
| PV 680 LC | 4575 | 46.6 | 60.3 | 2.5 | 129 | 49 | 108 | 1.5 |
| 92SC | 3580 | 44.1 | 60.9 | 2.4 | 112 | 47 | 108 | 2.3 |
| 94CR | 4710 | 47.2 | 63.1 | 2.7 | 121 | 49 | 107 | 1.3 |
| LSD (0.05) | 938 | 1.3 | 1.6 | NS | 7.6 | 1.2 | 2.9 | 0.5 |
| CV (%) | 14.4 | 1.9 | 1.8 | 17.2 | 4.4 | 1.8 | 1.9 | 25.3 |

NS = Not Significant

Table 3. Yield and agronomic data for the 2019 ICDC Irrigated Canola Variety Trial, Combined Site Analysis, 2019.

| Location / Entry | Yield (kg/ha) | Oil (%) | Test Weight (kg/hl) | TKW (gm/1000 seed) | Height (cm) | First Flower (days) | Maturity (days) | Lodge rating (1=erect; 5=flat) |
|---|---|---|---|---|---|---|---|---|
| **Trial Site** | | | | | | | | |
| Knapik | 4301 | 46.7 | 66.4 | 3.9 | 103 | 49 | 110 | N/A |
| Rudy Agro | 4608 | 46.9 | 62.1 | 2.7 | 122 | 49 | 108 | N/A |
| LSD (0.05) | NS | NS | 0.7 | 0.03 | 8.8 | NS | 2.0 | |
| CV (%) | 14.2 | 1.9 | 1.5 | 10.7 | 6.0 | 2.0 | 2.2 | |
| **Variety** | | | | | | | | |
| ***L252*** | ***4840*** | ***48.4*** | ***66.0*** | ***2.8*** | ***114*** | ***50*** | ***110*** | N/A |
| L230 | 4281 | 47.4 | 65.0 | 3.3 | 111 | 47 | 105 | N/A |
| L233P | 5114 | 45.8 | 63.5 | 3.2 | 112 | 48 | 106 | N/A |
| L241C | 4577 | 45.2 | 64.1 | 3.5 | 114 | 50 | 109 | N/A |
| L255PC | 5533 | 48.6 | 65.5 | 2.7 | 110 | 48 | 108 | N/A |
| 45CS40 | Variety not included in combined site assessment | | | | | | | |
| 45H33 | 4160 | 47.5 | 62.1 | 2.9 | 109 | 49 | 108 | N/A |
| 45M35 | 4808 | 48.9 | 65.2 | 3.6 | 112 | 48 | 107 | N/A |
| 46H75 | 4537 | 46.5 | 63.4 | 3.2 | 115 | 50 | 113 | N/A |
| CS2300 | 4242 | 46.6 | 64.7 | 3.4 | 118 | 48 | 112 | N/A |
| CS2500 CL | 3550 | 45.9 | 65.5 | 4.3 | 107 | 48 | 110 | N/A |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CS2600 CR-T | 4329 | 48.5 | 65.2 | 3.8 | 106 | 47 | 108 | N/A |
| 4187 RR | 4479 | 47.9 | 64.5 | 3.1 | 121 | 51 | 112 | N/A |
| 5545 CL | 4100 | 44.8 | 66.3 | 3.6 | 115 | 49 | 114 | N/A |
| 6076 CR | 4357 | 45.9 | 63.6 | 3.1 | 119 | 48 | 110 | N/A |
| 6090 RR | 4473 | 45.7 | 64.0 | 3.3 | 115 | 49 | 110 | N/A |
| PV 200 CL | 4353 | 46.5 | 64.5 | 3.3 | 114 | 50 | 109 | N/A |
| PV 540 G | 4815 | 46.0 | 63.6 | 2.9 | 117 | 50 | 112 | N/A |
| PV 581 GC | 4639 | 47.5 | 62.4 | 3.5 | 112 | 49 | 110 | N/A |
| PV 680 LC | 4300 | 46.7 | 62.3 | 3.2 | 117 | 50 | 108 | N/A |
| 92SC | 3766 | 44.5 | 63.6 | 3.1 | 100 | 46 | 108 | N/A |
| 94CR | 4279 | 47.4 | 64.9 | 3.4 | 106 | 49 | 107 | N/A |
| LSD (0.05) | 625 | 0.9 | 0.9 | 0.35 | 6.7 | 0.98 | 2.3 | |
| Location x Variety Interaction | | | | | | | | |
| LSD (0.05) | S | NS | NS | NS | NS | S | S | |

S = Significant
NS = Not Significant
NA = Not Applicable (observations not collected at Knapik trial location)

# Irrigated Flax Variety Trial

## Funding

Funded by the Irrigation Crop Diversification Corporation and the Saskatchewan Variety Performance Group

## Principal Investigator

- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Saskatchewan Variety Performance Group
- Saskatchewan Advisory Council on Grain Crops

## Objectives

The objectives of this study were to:

(1) Evaluate registered and experimental flax varieties
(2) Assess entries for suitability to irrigated production; and
(3) Update ICDC's annual *Crop Varieties for Irrigation* guide.

## Research Plan

The irrigated flax trials were conducted at two locations, ICDC On-station (Field 11) and at the ICDC Rudy Agro Off-station location.

Twenty flax varieties, ten registered and ten experimental entries, were tested for their agronomic performance under irrigation. The ICDC site was seeded May 14 and the Rudy Agro site on May 18. Plot size was 1.5 m x 4.0 m, treatments were replicated three times and the trials were established in an experimental lattice design. The ICDC On-station trial received supplemental fertilizer applied application rates of 100 kg N/ha, as 46-0-0, and 20 kg $P_2O_5$/ha as 12-51-0, all fertilizer was side-banded at the time of seeding. The Rudy Agro trial received additional supplemental N fertilizer at a rate of 20 kg N/ha (the trial was established on potato stubble that soil testing procedures indicated had a soil N reserve of 150 kg N/ha) and 20 kg $P_2O_5$/ha as 12-51-0, all fertilizer was side-banded at the time of seeding. Weed control consisted of a post-emergence applications of Badge II (bromoxynil +MCPA ester) + Centurion (clethodim), supplemented by some hand weeding at the Rudy Agro location. The Rudy Agro sites also received a fungicidal application of Priaxor (fluxapyroxad & pyraclostrobin) fungicide at 50% bloom. Neither trial location was combined.

## Results

Neither site was combined. The ICDC On-station trial was seeded into dry soil conditions that resulted in uneven germination. Typically, post-seed irrigation can often encourage even emergence. Unfortunately, the irrigation system experienced an underground rupture and was not operational until into June. Therefore, this trial was abandoned. The Rudy Agro trial is presently unharvested as varieties did not mature prior to killing frost and snow.

These trials will be repeated in 2020.

# Irrigated Early Season Sunflower Hybrid Trial & Irrigated Sunflower Hybrid Trial

## Funding

Funded by the Irrigation Crop Diversification Corporation

## Principal Investigator

- Garry Hnatowich, PAg, Research Director, ICDC
- William May, AAFC, Indian Head

## Organizations

- Agriculture & Agri-Food Canada
- Irrigation Crop Diversification Corporation (ICDC)

## Objectives

The objectives of the Early Season Hybrid study were to:

(1) Evaluate sunflower varieties to irrigated production

(2) Demonstrate the new early season hybrid Honeycomb NS; and

(3) Determine the appropriate plant density for this new hybrid.

## Research Plan

Both trials were established at the ICDC Rudy Agro Off-station location. Methodology will not be outlined for reasons to be discussed.

## Results

Neither trial matured prior to harvest. Both trials were shrouded with bale wrap after flowering, as seed was maturing, to prevent bird depredation. Unfortunately, snowfall and storm events at the end of September resulted in both trials sustaining significant stock breakage. The shrouding likely exaggerated the damage by acting as a "blanket" that snow accumulated on increasing the stem breakage.

Little interest has been expressed by irrigators in sunflower production. It is unlikely these trials will be repeated in 2020.

# ICDC Irrigated Wheat Variety Trial

## Funding

Funded by the Irrigation Crop Diversification Corporation.

## Principal Investigator

- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)

## Objectives

The objectives of this study were to:

(1) Evaluate registered wheat varieties for which ICDC has limited data;
(2) Assess entries for suitability to irrigated production; and
(3) Update ICDC's annual *Crop Varieties for Irrigation* guide.

## Research Plan

The irrigated wheat variety trials were conducted at two locations in the Outlook area. Each site and soil type are as follows:

ICDC Knapik Site (NW12-29-08-W3): Asquith sandy loam (SW quadrant)
ICDC Rudy Agro Site (SW27-30-07-W3): Bradwell fine sandy loam to loam (NW quadrant)

Thirty spring wheat varieties of four different market classes (19 CWRS varieties, 5 CPSR varieties, 3 CWSP and 1 CWHWS, 2 unclassed experimental entries) and four durum varieties were tested for their agronomic performance under irrigation. The ICDC Knapik site was seeded on May 15, ICDC Rudy Agro site was seeded on May 18. Plot size was 1.5 m x 4.0 m (final harvest area), treatments were replicated four times in a RBDC experimental design. The seed was treated with Cruiser Maxx Cereals (thiamethoam + difenoconazole + metalaxyl-M) for seed and soil borne disease and wireworm control. Nitrogen fertilizer at Knapik was applied at a rate of 135 kg N/ha as 46-0-0 as a sideband application and 30 kg $P_2O_5$/ha as 12-51-0 seed placed. At the Rudy Agro location starter nitrogen fertilizer was applied at a rate of 20 kg N/ha as 46-0-0 and 20 kg $P_2O_5$/ha as 12-51-0 as a sideband application at seeding. Trials at Rudy Agro were established on potato stubble that soil testing indicated residual available soil N of 150 kg/ha. Weed control at both sites consisted of a post-emergence tank mix application Simplicity (pyroxsulam) and Buctril M (bromoxynil +MCPA ester). Both trial locations received an application of Caramba (metconaole) at 50% flower of wheat heads. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. The Knapik trial was harvested September 23, the Rudy Agro trial on October 4. Total in-season irrigation at Knapik was 150 mm (6.0”), at Rudy Agro 274 mm (10.8”).

## Results

Results obtained at the Knapik location are shown in Table 1, the Rudy Agro location in Table 2.

Results of the Knapik trial are provided in Table 1. The highest yield was obtained with the CWSP variety AAC Awesome VB, the highest CWRS variety was SY Slate. The lowest yield with the CWRS variety AAC Brandon. No CWRS variety was statistically differing in yield from the control, Carberry. Within the durum varieties CDC Dynamic was the lowest yielding, CDC Credence the highest. Median grain yield of the Knapik trial was 6336 kg/ha (94.2 bu/ac). Protein content generally followed the order of CWRS > CPSR > CWAD >CWSP. Median protein was 11.7%. As a general observation yields were high, consequently protein levels tended on the low side. AAC Starbuck VB had the highest test weight, Alderon the lowest. Varieties varied greatly with respect to seed size, CWRS tended to have the lowest seed weight. The CWSP and CWAD varieties were generally significantly later maturing than all other varieties. Median days to maturity of all entries was 107 days. All varieties were late maturing in 2019 compared to historic days to maturity of spring wheat. AAC Cameron VB was significantly taller than all other varieties, CDC Credence exhibited the greatest degree of lodging.

Results from the Rudy Agro trial are shown in Table 2. At the Rudy Agro trial varieties with a grain yield exceeding 7600 kg/ha, were statistically higher yielding than the check Carberry. Only SY Solvite and SY Slate were statistically lower yielding than the check variety. The highest yielding CWRS variety was AAC Viewfield. Median grain yield at the Rudy Agro location was 6441 kg/ha (95.7 bu/ac). Among market classes the CWRS varieties, in general, had higher protein contents as compared to other entries. Unlike the Knapik location protein contents at this location were high, this likely can be attributed to the high amount of available soil N at the location. Median protein content was 15.0. Only AAC Succeed VB, Alderon and AAC Enticehad test weights statistically lower than the check Carberry, none were statistically higher. Thousand seed weight tended to be highest for the durum entries. Days to heading and maturity, plant height and lodging varied within and between classes. Any variety with a lodging rating > 3.0 was significantly different from the check variety. AAC Congress had lodging at this location that resulted in harvest difficulties.

Results from these trials, when deemed valid, are used to update the irrigation variety database at ICDC and provide recommendations to irrigators on the best wheat varieties suited to irrigation conditions and will be used in the development of the annual publications "*Crop Varieties for Irrigation.*"

Table 1. Yield and Agronomic Data for the ICDC Irrigated Wheat Variety Trial, ICDC Knapik Site, 2019.

| Variety | Yield (kg/ha) | Yield % of Carberry | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Heading (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| ***Canada Western Red Spring (CWRS)*** | | | | | | | | | |
| ***Carberry*** | ***5895*** | ***100*** | ***12.4*** | ***79.5*** | ***41.2*** | ***62*** | ***107*** | ***86*** | ***1.0*** |
| AAC Alida VB | 5790 | 98 | 12.5 | 79.3 | 40.7 | 65 | 106 | 96 | 1.0 |
| AAC Brandon | 5552 | 94 | 12.1 | 80.2 | 40.8 | 65 | 108 | 85 | 1.0 |
| AAC Cameron VB | 5794 | 98 | 11.3 | 78.1 | 42.5 | 64 | 103 | 104 | 1.0 |
| AAC Leroy | 6603 | 112 | 12.0 | 79.6 | 39.6 | 64 | 103 | 95 | 1.3 |
| AAC Magnet | 5978 | 101 | 12.2 | 77.7 | 40.0 | 63 | 104 | 94 | 1.0 |
| AAC Redberry | 6686 | 113 | 12.2 | 80.4 | 37.7 | 61 | 102 | 90 | 1.3 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AAC Starbuck VB | 6678 | 113 | 12.2 | 80.6 | 40.8 | 66 | 110 | 89 | 1.0 |
| AAC Tisdale | 6047 | 103 | 12.3 | 79.6 | 39.1 | 66 | 105 | 94 | 1.0 |
| AAC Viewfield | 6129 | 104 | 12.0 | 80.5 | 37.9 | 68 | 111 | 84 | 1.0 |
| AAC Warman VB | 6344 | 108 | 11.8 | 79.8 | 38.0 | 66 | 105 | 98 | 1.0 |
| AAC Wheatland VB | 6078 | 103 | 11.9 | 79.6 | 40.7 | 68 | 110 | 86 | 1.0 |
| CS Tracker | 5914 | 100 | 11.7 | 77.9 | 34.9 | 68 | 104 | 90 | 1.0 |
| Ellerslie | 6238 | 106 | 11.9 | 76.2 | 35.5 | 65 | 105 | 92 | 1.0 |
| Parata | 5999 | 102 | 11.7 | 79.1 | 36.4 | 63 | 101 | 94 | 1.0 |
| SY Obsidian | 6300 | 107 | 11.7 | 78.2 | 39.4 | 65 | 105 | 91 | 1.0 |
| SY Slate | 6745 | 114 | 12.4 | 78.3 | 38.8 | 65 | 106 | 94 | 1.3 |
| SY Solvite | 6329 | 107 | 13.2 | 79.5 | 42.5 | 62 | 108 | 94 | 1.3 |
| SY Torach | 6290 | 107 | 12.2 | 80.2 | 32.6 | 65 | 110 | 85 | 1.0 |
| **Canada Western Amber Durum (CWAD)** | | | | | | | | | |
| AAC Congress | 6913 | 117 | 10.6 | 78.6 | 43.4 | 72 | 115 | 93 | 2.3 |
| CDC Credence | 6975 | 118 | 10.3 | 79.0 | 44.7 | 69 | 113 | 96 | 2.7 |
| CDC Dynamic | 6740 | 114 | 10.9 | 78.8 | 43.9 | 71 | 108 | 89 | 2.3 |
| AAC Succeed VB | 6804 | 115 | 11.1 | 79.0 | 46.4 | 68 | 107 | 94 | 2.3 |
| **Canada Prairie Spring Red (CPSR)** | | | | | | | | | |
| AAC Crossfield | 6554 | 111 | 11.8 | 80.5 | 48.3 | 67 | 109 | 86 | 1.3 |
| AAC Entice | 6550 | 111 | 10.9 | 76.6 | 40.2 | 64 | 104 | 89 | 1.3 |
| AAC Foray VB | 6616 | 112 | 11.0 | 78.0 | 47.2 | 71 | 108 | 96 | 1.0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AAC Goodwin | 6504 | 110 | 12.0 | 79.4 | 41.7 | 65 | 106 | 90 | 1.0 |
| AAC Penhold | 6691 | 114 | 10.9 | 79.0 | 42.9 | 63 | 104 | 77 | 1.0 |
| **Canada Western Special Purpose** | | | | | | | | | |
| AAC Awesome VB | 7659 | 130 | 9.7 | 78.4 | 44.3 | 70 | 110 | 88 | 1.0 |
| Alderon | 7548 | 128 | 9.7 | 73.2 | 43.3 | 73 | 117 | 81 | 1.0 |
| Sparrow VB | 6638 | 113 | 10.0 | 75.7 | 41.5 | 73 | 116 | 87 | 1.0 |
| **Canada Western Hard White Spring** | | | | | | | | | |
| AAC Cirrus | 6246 | 106 | 12.4 | 79.9 | 33.2 | 65 | 106 | 93 | 1.0 |
| **Experimental** | | | | | | | | | |
| LNR13-0601 | 6004 | 102 | 12.4 | 79.2 | 43.2 | 65 | 115 | 86 | 1.0 |
| LNR14-1299 | 6925 | 117 | 11.0 | 79.2 | 35.8 | 64 | 106 | 84 | 1.0 |
| LSD (0.05) | 976 | | 0.9 | 0.9 | 1.8 | 2.7 | 3.9 | 4.3 | 0.7 |
| CV (%) | 9.3 | | 4.5 | 0.7 | 2.7 | 2.5 | 2.2 | 2.9 | 35.6 |

Table 2. Yield and Agronomic Data for the ICDC Irrigated Wheat Variety trial, ICDC Rudy Agro Site, 2019.

| **Variety** | **Yield (kg/ha)** | **Yield % of Carberry** | **Protein (%)** | **Test weight (kg/hl)** | **1K Seed weight (gm)** | **Heading (days)** | **Maturity (days)** | **Height (cm)** | **Lodging 1=erect; 9=flat** |
|---|---|---|---|---|---|---|---|---|---|
| ***Canada Western Red Spring (CWRS)*** | | | | | | | | | |
| ***Carberry*** | ***6194*** | ***100*** | ***15.4*** | ***78.6*** | ***41.9*** | ***53*** | ***108*** | ***90*** | ***1.0*** |
| AAC Alida VB | 6377 | 103 | 14.9 | 77.6 | 43.2 | 54 | 102 | 96 | 1.0 |
| AAC Brandon | 6292 | 102 | 14.3 | 79.0 | 41.4 | 55 | 102 | 90 | 2.0 |
| AAC Cameron VB | 5772 | 93 | 14.9 | 77.7 | 45.2 | 56 | 100 | 109 | 5.5 |
| AAC Leroy | 5918 | 96 | 14.6 | 78.4 | 41.3 | 54 | 99 | 99 | 2.5 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AAC Magnet | 5913 | 95 | 15.6 | 77.6 | 41.8 | 52 | 105 | 95 | 1.8 |
| AAC Redberry | 5615 | 91 | 13.7 | 80.3 | 40.9 | 52 | 97 | 99 | 2.3 |
| AAC Starbuck VB | 6067 | 98 | 15.0 | 78.4 | 41.2 | 58 | 110 | 92 | 2.3 |
| AAC Tisdale | 5762 | 93 | 16.5 | 77.1 | 41.9 | 54 | 104 | 99 | 3.8 |
| AAC Viewfield | 7339 | 118 | 15.3 | 79.5 | 39.8 | 59 | 110 | 87 | 2.3 |
| AAC Warman VB | 5584 | 90 | 14.4 | 78.3 | 38.5 | 53 | 101 | 108 | 2.8 |
| AAC Wheatland VB | 7312 | 118 | 15.2 | 79.2 | 43.6 | 57 | 111 | 93 | 1.0 |
| CS Tracker | 5719 | 92 | 14.8 | 77.5 | 37.5 | 56 | 97 | 98 | 2.5 |
| Ellerslie | 6327 | 102 | 14.7 | 76.2 | 37.5 | 56 | 103 | 98 | 1.5 |
| Parata | 6495 | 105 | 15.3 | 79.5 | 40.3 | 51 | 100 | 99 | 2.0 |
| SY Obsidian | 5766 | 93 | 14.0 | 77.9 | 42.6 | 55 | 101 | 94 | 1.8 |
| SY Slate | 4768 | 77 | 15.1 | 77.0 | 40.5 | 54 | 100 | 98 | 3.5 |
| SY Solvite | 3679 | 59 | 14.3 | 77.3 | 43.6 | 53 | 102 | 101 | 1.5 |
| SY Torach | 6106 | 99 | 15.4 | 79.5 | 33.0 | 54 | 114 | 83 | 1.3 |
| **Canada Western Amber Durum (CWAD)** | | | | | | | | | |
| AAC Congress | 6845 | 111 | 14.3 | 78.8 | 46.7 | 62 | 113 | 97 | 7.5 |
| CDC Credence | 6098 | 98 | 14.0 | 76.1 | 44.6 | 62 | 109 | 100 | 5.8 |
| CDC Dynamic | 7241 | 117 | 15.2 | 79.1 | 47.2 | 61 | 107 | 100 | 5.8 |
| AAC Succeed VB | 7074 | 114 | 15.6 | 70.2 | 50.2 | 60 | 108 | 104 | 6.0 |
| **Canada Prairie Spring Red (CPSR)** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AAC Crossfield | 6519 | 105 | 13.4 | 79.2 | 49.6 | 60 | 111 | 90 | 3.5 |
| AAC Entice | 6371 | 103 | 14.2 | 75.3 | 39.7 | 58 | 110 | 93 | 5.0 |
| AAC Foray VB | 7814 | 126 | 12.9 | 77.4 | 51.0 | 62 | 109 | 95 | 3.0 |
| AAC Goodwin | 6662 | 108 | 14.1 | 78.7 | 42.4 | 57 | 105 | 90 | 2.5 |
| AAC Penhold | 7221 | 117 | 13.8 | 80.2 | 45.5 | 57 | 106 | 84 | 1.3 |
| **Canada Western Special Purpose** | | | | | | | | | |
| AAC Awesome VB | 7897 | 128 | 11.7 | 76.4 | 47.7 | 62 | 110 | 98 | 3.5 |
| Alderon | 9620 | 155 | 11.0 | 74.5 | 47.0 | 66 | 114 | 78 | 1.0 |
| Sparrow VB | 9020 | 146 | 11.4 | 76.8 | 43.8 | 66 | 113 | 83 | 1.0 |
| **Canada Western Hard White Spring** | | | | | | | | | |
| AAC Cirrus | 6666 | 108 | 14.8 | 80.2 | 35.9 | 58 | 104 | 96 | 1.0 |
| **Experimental** | | | | | | | | | |
| LNR13-0601 | 6482 | 105 | 15.2 | 79.3 | 46.0 | 57 | 112 | 97 | 3.5 |
| LNR14-1299 | 7443 | 120 | 13.5 | 78.7 | 37.7 | 53 | 103 | 88 | 2.3 |
| LSD (0.05) | 1263 | | 2.0 | 2.7 | 2.1 | 1.5 | 6.8 | 3.9 | 2.4 |
| CV (%) | 13.8 | | 6.9 | 2.5 | 3.4 | 1.9 | 4.6 | 2.9 | 62.3 |

# Saskatchewan Variety Performance Group
# Irrigated Wheat, Durum, Barley and Oat Regional Variety Trials

## Funding

Funded by the Irrigation Crop Diversification Corporation and the Saskatchewan Variety Performance Group

## Principal Investigator

- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Saskatchewan Variety Performance Group
- Saskatchewan Advisory Council on Grain Crops

## Objectives

The objectives of this study were to:

(1) Evaluate experimental cereal lines pursuant for registration requirements;
(2) Assess entries for suitability to irrigated production; and
(3) Update ICDC's annual *Crop Varieties for Irrigation* guide.

## Research Plan

The Saskatchewan Variety Performance Group (SVPG) wheat, durum, barley and oat regional trials were seeded between May 15 and 23. The spring wheat were divided into two separate trials, the Hex 1 was comprised of CWRS class varieties or experimental lines, total entries evaluated was 42. The Hex 2 was comprised of high yielding classes of spring wheat with 20 entries. The durum trial had 14 entries. The barley trial was exclusively 2-row barleys with 18 entries. The oat trial comprised a total of 13 entries. The trial was arranged in a randomized complete block design with three replicates. Plot size was 1.5 m x 4.0 m. The seed was treated with Cruiser Maxx Cereals (thiamethoam + difenoconazole + metalaxyl-M) for seed and soil borne disease and wireworm control. Nitrogen fertilizer at ICDC Knapik Off-station was applied at a rate of 110 kg N/ha as 46-0-0 as a sideband application and 30 kg $P_2O_5$/ha as 12-51-0 seed placed (second durum trial and the oat trial). At the ICDC Rudy Agro Off-station location nitrogen fertilizer was applied at a rate of 45 kg N/ha as 46-0-0 as a sideband application and 30 kg $P_2O_5$/ha as 12-51-0 seed placed (this trial was conducted on potato stubble that soil testing indicated available soil N of 122 kg/ha). The Rudy Agro location had the Hex1, Hex2, first Durum, Barley and Soft White Spring evaluations established. The soft white spring wheat (CWSWS Coop) is not part of the SVPG program but rather a separate evaluation but included here for an inclusive cereal report. The CWSWS trial was replicated four times. Weed control consisted of a post-emergence tank mix application Simplicity (pyroxsulam) and Buctril M (bromoxynil +MCPA ester) with wheat, Assert 300SC (imazamethabenz) and Buctril M (bromoxynil +MCPA ester) with barley and Buctril M (bromoxynil +MCPA ester) only was applied to the oat trial. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. In-season precipitation from mid-May through September was 218 mm, in-season irrigation at Rudy Agro 274 mm.

## Results

Hex 1, Hex 2 and CWSWS are shown in Tables 1, 2 and 3, respectively. Results of the ICDC Knapik and Rudy Agro and the Combined Site Analysis for the SVPG Durum trials are shown in Tables 4, 5 and 6 respectively. Results of the 2-row barley are shown in Table 7. No results were obtained for the oat evaluation as the trial was severely infested with weeds that chemical applications did not control.

Results of these trials are used for registration purposes. Further, results from these trials are used to update the irrigation variety database at ICDC and provide recommendations to irrigators on the best wheat and barley varieties suited to irrigation conditions and will be used in the development of the annual publications *"Crop Varieties for Irrigation"* and the Saskatchewan Ministry of Agriculture's *"Varieties of Grain Crops 2019."*

Table 1. Saskatchewan Variety Performance Group Irrigated Hex 1 Wheat Regional Variety Trial, ICDC Off-Station Rudy Agro Site, 2019.

| Variety | Yield (kg/ha) | Yield % of Carberry | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Heading (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| ***Carberry*** | ***6174*** | ***100*** | ***14.5*** | ***77.4*** | ***42.0*** | ***52*** | ***102*** | ***94*** | ***1.3*** |
| AAC Alida VB | 6185 | 100 | 13.9 | 76.9 | 43.2 | 53 | 95 | 95 | 1.0 |
| AAC Cirrus | 6228 | 101 | 14.0 | 79.5 | 36.9 | 57 | 100 | 96 | 1.0 |
| AAC Concord | 5759 | 93 | 14.9 | 75.5 | 44.6 | 57 | 102 | 100 | 7.3 |
| AAC Goodwin | 6621 | 107 | 13.5 | 77.3 | 42.7 | 56 | 99 | 94 | 1.0 |
| AAC Leroy VB | 6693 | 108 | 14.3 | 77.4 | 42.3 | 55 | 100 | 98 | 3.0 |
| AAC Magnet | 6752 | 109 | 14.3 | 77.5 | 43.0 | 51 | 97 | 97 | 1.0 |
| AAC Redberry | 6578 | 107 | 13.4 | 79.5 | 41.4 | 51 | 90 | 98 | 1.7 |
| AAC Starbuck VB | 6869 | 111 | 15.1 | 78.1 | 41.0 | 56 | 105 | 94 | 3.7 |
| AAC Tisdale | 6609 | 107 | 14.9 | 76.1 | 42.0 | 54 | 96 | 98 | 2.0 |
| AAC Viewfield | 7494 | 121 | 14.2 | 78.2 | 40.2 | 55 | 102 | 86 | 2.3 |
| AAC Warman VB | 6091 | 99 | 14.1 | 77.7 | 39.8 | 52 | 96 | 103 | 4.0 |
| AAC Wheatland VB | 7583 | 123 | 14.7 | 78.3 | 43.3 | 55 | 103 | 92 | 1.0 |
| Bolles | 6412 | 104 | 14.6 | 76.8 | 42.4 | 58 | 102 | 90 | 1.0 |
| CDC Adamant VB | 6577 | 107 | 15.1 | 78.7 | 37.6 | 55 | 101 | 98 | 4.0 |
| CDC Hughes VB | 6971 | 113 | 14.1 | 78.4 | 44.8 | 54 | 98 | 94 | 1.3 |
| CDC Kinley | 6144 | 100 | 14.4 | 77.3 | 39.5 | 55 | 96 | 95 | 2.0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CDC Landmark VB | 7298 | 118 | 13.5 | 79.1 | 43.1 | 54 | 96 | 95 | 1.0 |
| Ellerslie | 6912 | 112 | 13.6 | 75.2 | 38.9 | 55 | 96 | 94 | 1.0 |
| Jake | 6095 | 99 | 15.1 | 77.9 | 38.3 | 53 | 97 | 94 | 2.7 |
| Parata | 6519 | 106 | 15.2 | 78.5 | 39.9 | 51 | 98 | 100 | 3.7 |
| Rednet | 6322 | 102 | 14.8 | 77.8 | 40.7 | 57 | 103 | 103 | 4.3 |
| SY Chert VB | 4578 | 74 | 13.2 | 77.7 | 41.1 | 54 | 97 | 98 | 1.0 |
| SY Obsidian | 6217 | 101 | 13.8 | 77.1 | 42.4 | 54 | 100 | 95 | 1.3 |
| SY Slate | 5841 | 95 | 14.1 | 76.4 | 40.3 | 53 | 97 | 93 | 2.7 |
| SY Sovite | 4658 | 75 | 14.3 | 75.7 | 43.8 | 53 | 102 | 98 | 2.3 |
| SY Torach | 6236 | 101 | 14.4 | 77.6 | 36.7 | 53 | 100 | 95 | 1.0 |
| Tracker | 6206 | 101 | 13.5 | 77.9 | 39.2 | 55 | 94 | 97 | 2.3 |
| BW1041 | 6309 | 102 | 14.2 | 77.1 | 44.8 | 53 | 96 | 101 | 1.3 |
| BW1064 | 6376 | 103 | 13.2 | 77.4 | 38.0 | 53 | 98 | 101 | 2.3 |
| BW5028 | 6702 | 109 | 13.2 | 78.1 | 44.9 | 54 | 98 | 89 | 1.0 |
| BW5031 | 6521 | 106 | 13.8 | 75.9 | 44.3 | 56 | 98 | 93 | 1.0 |
| BW5056 | 6442 | 104 | 14.4 | 79.1 | 46.3 | 56 | 105 | 99 | 2.0 |
| CN010 | 7196 | 117 | 13.1 | 77.0 | 40.8 | 56 | 100 | 94 | 1.3 |
| CS11200104-11 | 6338 | 103 | 14.5 | 77.8 | 41.9 | 57 | 101 | 96 | 1.3 |
| CS11200214-17 | 7040 | 114 | 13.7 | 77.4 | 41.9 | 53 | 100 | 97 | 3.3 |
| PT252 | 6600 | 107 | 13.4 | 77.1 | 44.9 | 55 | 98 | 97 | 1.0 |
| PT488 | 5567 | 90 | 14.0 | 76.2 | 41.5 | 53 | 94 | 107 | 1.7 |
| PT596 | 6554 | 106 | 14.1 | 75.8 | 38.6 | 55 | 97 | 98 | 1.7 |
| PT598 | 7543 | 122 | 14.2 | 76.3 | 42.5 | 53 | 100 | 84 | 1.0 |
| PT599 | 6102 | 99 | 13.8 | 76.8 | 38.4 | 57 | 99 | 100 | 4.7 |
| PT652 | 6616 | 107 | 14.1 | 76.2 | 38.7 | 52 | 96 | 101 | 4.7 |
| LSD (0.05) | 810 | | NS | 1.3 | 2.2 | 1.5 | 6.0 | 7.5 | 2.3 |
| CV (%) | 7.7 | | 6.3 | 1.0 | 3.3 | 1.8 | 3.8 | 4.8 | 65.6 |

Table 2. Saskatchewan Variety Performance Group Irrigated Hex 2 Wheat Regional Variety Trial, ICDC Off-Station Rudy Agro Site, 2019.

| Variety | Yield (kg/ha) | Yield % of Carberry | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Heading (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| **Canada Western Red Spring (CWRS)** | | | | | | | | | |
| ***Carberry*** | ***5956*** | ***100*** | ***14.5*** | ***77.1*** | ***43.0*** | ***52*** | ***99*** | ***89*** | ***1.0*** |
| **Canada Northern Hard Red (CNHR)** | | | | | | | | | |
| CDC Cordon CLPlus VB | 7536 | 127 | 13.5 | 74.7 | 44.0 | 54 | 97 | 90 | 1.0 |
| Faller | 8287 | 139 | 13.1 | 76.1 | 48.3 | 57 | 101 | 92 | 2.7 |
| Prosper | 8048 | 135 | 13.2 | 75.0 | 49.1 | 56 | 102 | 94 | 1.3 |
| **Canada Prairie Spring – Red (CPSR)** | | | | | | | | | |
| AAC Castle VB | 7590 | 127 | 12.6 | 77.5 | 50.5 | 56 | 99 | 71 | 1.3 |
| AAC Crossfield | 8057 | 135 | 12.2 | 75.1 | 44.5 | 56 | 100 | 88 | 1.7 |
| AAC Entice | 6758 | 113 | 12.3 | 74.3 | 41.4 | 56 | 99 | 83 | 1.0 |
| CDC Terrain | 7182 | 121 | 13.4 | 76.6 | 49.4 | 57 | 100 | 95 | 1.7 |
| KWS Alderon | 8855 | 149 | 10.1 | 73.1 | 48.7 | 65 | 104 | 79 | 1.0 |
| Charing VB | 9430 | 158 | 10.7 | 74.3 | 45.1 | 59 | 107 | 83 | 1.0 |
| SY Rowyn | 5675 | 95 | 12.3 | 77.9 | 37.2 | 54 | 98 | 85 | 1.0 |
| **Canada Western Special Purpose (CWSP)** | | | | | | | | | |
| AAC Awesome VB | 8501 | 143 | 10.6 | 74.2 | 50.5 | 60 | 104 | 97 | 1.0 |
| **Canada Western Soft White Spring (CWSWS)** | | | | | | | | | |
| AAC Indus VB | 8553 | 144 | 10.2 | 72.2 | 44.3 | 60 | 107 | 93 | 1.0 |
| AAC Paramount VB | 8460 | 142 | 11.1 | 74.0 | 45.1 | 58 | 106 | 91 | 1.0 |
| **Canada Western General Purpose (CWGP)** | | | | | | | | | |
| CDC Throttle | 7929 | 133 | 12.1 | 76.7 | 50.5 | 57 | 106 | 91 | 4.1 |
| Elgin ND | 6569 | 110 | 13.8 | 77.2 | 41.4 | 53 | 96 | 101 | 1.0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| KWS Sparrow VB | 9104 | 153 | 11.1 | 75.2 | 45.4 | 64 | 107 | 84 | 1.0 |
| Experimental Entries | | | | | | | | | |
| HY2062 | 5909 | 99 | 13.2 | 77.2 | 42.8 | 59 | 106 | 88 | 1.0 |
| HY2068 | 6250 | 105 | 13.1 | 77.7 | 39.5 | 54 | 106 | 88 | 1.3 |
| HY2077 | 6947 | 117 | 12.8 | 77.0 | 38.6 | 53 | 95 | 84 | 1.0 |
| LSD (0.05) | 1162 | | 1.4 | 1.0 | 1.7 | 1.3 | 6.1 | 9.9 | 1.0 |
| CV (%) | 9.3 | | 6.8 | 0.8 | 2.3 | 1.4 | 3.6 | 6.8 | 52.7 |

Table 3. Soft White Spring Wheat Irrigated Coop Variety Trial, ICDC Off-Station Rudy Agro Site, 2019.

| Variety | Yield (kg/ha) | Yield % of AC Andrew | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Heading (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| Carberry | 6285 | 67 | 15.0 | 78.9 | 43.6 | 53 | 101 | 91 | 1 |
| ***AC Andrew (SWS 241)*** | ***9383*** | ***100*** | ***10.6*** | ***76.9*** | ***42.2*** | ***62*** | ***107*** | ***94*** | ***1*** |
| Sadash (SWS 349) | 8845 | 94 | 10.4 | 78.2 | 40.7 | 58 | 105 | 93 | 1 |
| AAC Indus (SWS 427) | 9090 | 97 | 10.6 | 76.6 | 44.5 | 64 | 107 | 99 | 1 |
| SWS 465 | 9566 | 102 | 10.3 | 79.2 | 44.1 | 64 | 106 | 96 | 1 |
| SWS 471 | 9457 | 101 | 10.9 | 78.1 | 41.6 | 59 | 106 | 95 | 1 |
| SWS 472 | 9584 | 102 | 10.1 | 78.4 | 40.7 | 58 | 104 | 87 | 1 |
| SWS 477 | 9509 | 101 | 10.2 | 78.5 | 39.0 | 62 | 105 | 85 | 1 |
| SWS 478 | 9275 | 99 | 9.9 | 78.5 | 40.0 | 62 | 105 | 87 | 1 |
| SWS 479 | 9614 | 102 | 10.6 | 77.8 | 44.0 | 60 | 106 | 93 | 1 |
| SWS 480 | 9122 | 97 | 10.6 | 79.3 | 36.0 | 64 | 106 | 87 | 1 |
| SWS 481 | 9235 | 98 | 10.6 | 79.1 | 35.5 | 65 | 106 | 89 | 1 |
| SWS 482 | 9167 | 98 | 11.9 | 79.2 | 35.8 | 64 | 108 | 89 | 1 |
| SWS 483 | 9134 | 97 | 10.6 | 79.8 | 34.7 | 64 | 105 | 86 | 1 |
| SWS 484 | 9748 | 104 | 10.3 | 78.4 | 42.7 | 61 | 108 | 92 | 1 |
| SWS 485 | 9524 | 102 | 10.4 | 78.6 | 43.2 | 59 | 106 | 94 | 1 |
| SWS 486 | 9442 | 101 | 10.5 | 78.4 | 42.6 | 58 | 105 | 94 | 1 |
| LSD (0.05) | 581 | | 0.8 | 0.7 | 1.8 | 1.7 | 2.8 | 2.9 | NS |
| CV (%) | 4.4 | | 5.0 | 0.6 | 3.0 | 2.0 | 1.8 | 2.2 | 0 |

NS = Not Significant

Table 4. Saskatchewan Variety Performance Group Irrigated CWAD Wheat Regional Variety Trial, Off-Station Knapik Site 2019.

| Variety | Yield (kg/ha) | Yield % of Strong field | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Heading (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| **Knapik Site** | | | | | | | | | |
| Carberry | 5712 | 78 | 13.3 | 80.4 | 42.4 | 63 | 112 | 83 | 1.0 |
| ***Strongfield*** | ***7359*** | ***100*** | ***13.2*** | ***78.2*** | ***44.5*** | ***68*** | ***113*** | ***90*** | ***4.0*** |
| AAC Congress | 7513 | 102 | 11.0 | 79.0 | 44.7 | 71 | 116 | 91 | 4.7 |
| AAC Grainland | 6816 | 93 | 11.8 | 77.6 | 44.7 | 69 | 111 | 92 | 3.0 |
| AAC Stronghold | 7288 | 99 | 12.1 | 77.9 | 50.3 | 69 | 116 | 90 | 1.7 |
| AAC Succeed VB | 7431 | 101 | 12.9 | 78.3 | 48.4 | 69 | 112 | 92 | 5.0 |
| CDC Alloy | 6954 | 94 | 11.9 | 78.8 | 44.0 | 70 | 113 | 96 | 4.3 |
| CDC Credence | 6897 | 94 | 11.0 | 78.6 | 46.2 | 70 | 113 | 98 | 4.7 |
| CDC Dynamic | 6950 | 94 | 12.8 | 78.8 | 44.4 | 70 | 111 | 94 | 5.7 |
| CDC Precision | 7043 | 96 | 11.4 | 79.8 | 46.6 | 67 | 114 | 91 | 3.7 |
| DT591 | 7947 | 108 | 11.5 | 78.0 | 46.9 | 66 | 110 | 92 | 1.3 |
| DT887 | 7497 | 102 | 10.7 | 79.1 | 46.5 | 67 | 109 | 97 | 2.3 |
| DT890 | 7487 | 102 | 10.9 | 79.5 | 45.2 | 68 | 114 | 89 | 3.3 |
| DT1003 | 6706 | 91 | 10.9 | 78.3 | 42.5 | 69 | 111 | 91 | 2.7 |
| DT1004 | 7677 | 104 | 10.5 | 80.2 | 46.4 | 68 | 112 | 96 | 2.7 |
| LSD (0.05) | 806 | | 1.5 | 1.0 | NS | 2.0 | NS | 5.2 | 2.7 |
| CV (%) | 6.7 | | 7.6 | 0.8 | 8.9 | 1.8 | 2.6 | 3.4 | 47.7 |

NS = Not Significant

Table 5. Saskatchewan Variety Performance Group Irrigated CWAD Wheat Regional Variety Trial, ICDC Off-Station Rudy Agro Site, 2019.

| Variety | Yield (kg/ha) | Yield % of Strong field | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Heading (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| **Rudy Agro Site** | | | | | | | | | |
| Carberry | 6424 | 88 | 14.7 | 79.3 | 44.2 | 53 | 98 | 94 | NC |
| ***Strongfield*** | ***7341*** | ***100*** | ***12.7*** | ***79.4*** | ***50.6*** | ***58*** | ***101*** | ***97*** | ***NC*** |
| AAC Congress | 7771 | 106 | 13.2 | 79.2 | 49.0 | 59 | 104 | 97 | NC |
| AAC Grainland | 7799 | 106 | 13.2 | 79.0 | 51.4 | 59 | 104 | 98 | NC |
| AAC Stronghold | 8405 | 114 | 12.9 | 79.8 | 53.7 | 59 | 106 | 98 | NC |
| AAC Succeed VB | 7756 | 106 | 13.1 | 78.4 | 53.0 | 59 | 102 | 101 | NC |
| CDC Alloy | 7460 | 102 | 13.7 | 79.2 | 50.8 | 58 | 105 | 99 | NC |
| CDC Credence | 7033 | 96 | 13.2 | 78.4 | 49.1 | 59 | 105 | 101 | NC |
| CDC Dynamic | 7697 | 105 | 13.8 | 80.4 | 50.8 | 59 | 104 | 99 | NC |
| CDC Precision | 7445 | 101 | 13.7 | 79.9 | 50.5 | 58 | 105 | 100 | NC |
| DT591 | 8674 | 118 | 13.8 | 77.3 | 52.8 | 55 | 106 | 100 | NC |
| DT887 | 8048 | 110 | 14.3 | 77.8 | 50.3 | 58 | 105 | 100 | NC |
| DT890 | 7832 | 107 | 13.8 | 79.8 | 49.2 | 59 | 105 | 101 | NC |
| DT1003 | 9005 | 123 | 12.2 | 80.4 | 49.8 | 59 | 106 | 101 | NC |
| DT1004 | 8546 | 116 | 12.4 | 79.8 | 48.7 | 55 | 104 | 104 | NC |
| LSD (0.05) | 813 | | NS | 0.8 | 1.9 | 1.1 | 3.5 | 4.1 | |
| CV (%) | 6.2 | | 7.1 | 0.6 | 2.3 | 1.1 | 2.0 | 2.5 | |

NS = Not Significant
NC = Observation not captured

Table 6. Saskatchewan Variety Performance Group Irrigated CWAD Wheat Regional Variety trial, Combined Site Analysis, 2019.

| **Location / Variety** | **Yield (kg/ha)** | **Yield % of Check** | **Protein (%)** | **Test weight (kg/hl)** | **1K Seed weight (gm)** | **Heading (days)** | **Maturity (days)** | **Height (cm)** | **Lodging 1=erect; 9=flat** |
|---|---|---|---|---|---|---|---|---|---|
| Knapik Site | 7152 | 100 | 11.7 | 78.8 | 45.0 | 68 | 112 | 92 | NC |
| Rudy Agro Site | 7816 | 109 | 13.4 | 79.2 | 50.2 | 58 | 104 | 99 | NC |
| LSD (0.05) | 475 | | 0.5 | 0.2 | 1.7 | 1.7 | 3.8 | 3.4 | |
| CV (%) | 6.5 | | 7.3 | 0.7 | 6.2 | 1.6 | 2.3 | 2.9 | |
| **Variety** | | | | | | | | | |
| Carberry | 6068 | 83 | 14.0 | 79.8 | 43.3 | 58 | 105 | 88 | NC |
| ***Strongfield*** | ***7350*** | ***100*** | ***13.0*** | ***78.8*** | ***43.6*** | ***63*** | ***107*** | ***93*** | NC |
| AAC Congress | 7642 | 104 | 12.1 | 79.1 | 46.8 | 65 | 110 | 94 | NC |
| AAC Grainland | 7308 | 99 | 12.5 | 78.3 | 48.0 | 64 | 108 | 95 | NC |
| AAC Stronghold | 7847 | 107 | 12.5 | 78.9 | 52.0 | 64 | 111 | 94 | NC |
| AAC Succeed VB | 7594 | 103 | 13.0 | 78.3 | 50.7 | 64 | 107 | 96 | NC |
| CDC Alloy | 7207 | 98 | 12.8 | 79.0 | 47.4 | 64 | 109 | 97 | NC |
| CDC Credence | 6965 | 95 | 12.1 | 78.5 | 47.6 | 64 | 109 | 99 | NC |
| CDC Dynamic | 7324 | 100 | 13.3 | 79.6 | 47.6 | 65 | 108 | 97 | NC |
| CDC Precision | 7244 | 99 | 12.6 | 79.9 | 48.6 | 63 | 110 | 95 | NC |
| DT591 | 8311 | 113 | 12.6 | 77.7 | 49.9 | 61 | 108 | 96 | NC |
| DT887 | 7772 | 106 | 12.5 | 78.4 | 48.4 | 62 | 107 | 98 | NC |
| DT890 | 7659 | 104 | 12.3 | 79.6 | 47.2 | 64 | 110 | 95 | NC |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DT1003 | 7856 | 107 | 11.5 | 79.4 | 46.2 | 64 | 109 | 96 | NC |
| DT1004 | 8111 | 110 | 11.5 | 80.0 | 47.6 | 62 | 108 | 100 | NC |
| LSD (0.05) | 560 | | 1.1 | 0.7 | 3.4 | 1.1 | 2.9 | 3.2 | |
| **Location x Variety Interaction** | | | | | | | | | |
| LSD (0.05) | S | | S | S | NS | S | S | NS | |

S = Significant
NS = Not Significant
NC = Observation not captured

Table 7. Saskatchewan Variety Performance Group Irrigated 2-Row Barley Regional Variety Trial, ICDC Off-Station Rudy Agro Site, 2019.

| Variety | Yield (kg/ha) | Yield % of AC Metcalfe | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Heading (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| **Malt** | | | | | | | | | |
| ***AC Metcalfe*** | ***7964*** | ***100*** | ***13.3*** | ***62.1*** | ***48.4*** | ***58*** | ***91*** | ***95*** | ***5.3*** |
| AAC Synergy | 9157 | 115 | 12.4 | 61.9 | 51.4 | 59 | 92 | 93 | 4.3 |
| CDC Copeland | 7075 | 89 | 12.2 | 62.4 | 58.5 | 59 | 95 | 99 | 7.0 |
| **Feed-Hulled** | | | | | | | | | |
| Altorado | 10139 | 127 | 13.3 | 64.5 | 54.1 | 59 | 93 | 91 | 1.7 |
| AB Advantage | 9822 | 123 | 13.3 | 60.0 | 53.0 | 57 | 102 | 112 | 5.3 |
| AB Cattlelac | 9627 | 121 | 13.3 | 62.5 | 45.1 | 57 | 92 | 108 | 2.3 |
| **Other (malting market may exist)** | | | | | | | | | |
| AAC Connect | 8750 | 110 | 12.6 | 61.5 | 52.9 | 59 | 89 | 92 | 2.7 |
| CDC Ascent | 7971 | 100 | 14.6 | 75.3 | 46.9 | 62 | 96 | 96 | 3.3 |
| CDC Copper | 9272 | 116 | 12.6 | 62.6 | 51.4 | 58 | 93 | 86 | 3.7 |
| CDC Fraser | 9112 | 114 | 12.2 | 60.5 | 51.9 | 59 | 92 | 93 | 4.3 |
| CDC Goldstar | 9279 | 117 | 12.4 | 62.4 | 49.9 | 59 | 91 | 96 | 4.0 |
| Lowe | 8892 | 112 | 12.7 | 63.5 | 56.7 | 59 | 95 | 96 | 6.7 |
| Sirish | 9001 | 113 | 12.0 | 62.6 | 50.6 | 60 | 93 | 77 | 1.0 |
| **Experimental Entries** | | | | | | | | | |
| TR15155 | 9674 | 121 | 12.8 | 62.7 | 48.1 | 60 | 93 | 88 | 4.0 |
| TR16629 | 8228 | 103 | 13.7 | 62.1 | 50.1 | 60 | 94 | 98 | 4.7 |
| TR16742 | 10109 | 127 | 12.0 | 63.6 | 49.0 | 57 | 90 | 90 | 1.3 |
| TR17163 | 9647 | 121 | 12.3 | 63.4 | 54.0 | 59 | 91 | 98 | 2.7 |
| TR17639 | 9279 | 117 | 12.9 | 64.1 | 50.7 | 59 | 90 | 96 | 3.0 |
| LSD (0.05) | 978 | | 0.5 | 1.0 | 6.6 | 1.3 | 2.4 | 4.5 | 2.5 |
| CV (%) | 6.5 | | 2.4 | 1.0 | 7.8 | 1.3 | 1.6 | 2.9 | 40.1 |

# Winter Wheat Variety Evaluation for Irrigation vs Dry Land Production

## Funding

Funded by Agricultural Demonstration of Practices and Technologies (ADOPT) Program and ICDC

## Principal Investigator


- Garry Hnatowich, PAg, Research Director, ICDC (Project Lead)
- Co-investigators: Dr. Robert Graf, AAFC Lethbridge Research Centre


## Organizations


- Irrigation Crop Diversification Corporation (ICDC)


## Objectives

This project's objective is to identify the top producing or best adapted varieties of winter wheat for irrigation production. Until recently, winter wheat varieties had not been evaluated for their irrigation production potential for approximately 25 years. No variety at that time suited intensive irrigation management. Genetic improvements to the latest winter wheat varieties warrant a renewed assessment for their potential under irrigation management. Results from these trials will also be used to develop a data base on winter wheat varieties for entry into the *"Crop Varieties for Irrigation"* publication.

## Research Plan

Seed of twelve winter wheat varieties were acquired from winter wheat breeder Dr. R. Graf, AAFC-Lethbridge. Varieties were direct seeded into canola stubble on September 11, 2018. Winter wheat varieties were established in a small plot replicated and randomized trial design, replicated 3 times. All varieties are being evaluated under both irrigated and dry land systems. At seeding each trial received 80 kg N/ha as urea (46-0-0) side banded, 25 kg $P_2O_5$/ha side banded and an additional 25 kg $P_2O_5$/ha seed placed monoammonium nitrate (11-52-0), in the spring upon regrowth an additional 50 kg N/ha was intended to broadcast on the irrigated trial. Weed control consisted of a pre-seed application of glyphosate and a post-emergence tank mix application of Simplicity (pyroxsulam) and Buctril M (bromoxynil +MCPA ester). No foliar fungicides were applied for either leaf disease or Fusarium Head Blight. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. Both trials were harvested August 15, 2019.

## Results

Results obtained for the Irrigated trial are shown in Table 1, the dry land trial in Table 2 and a comparison of irrigated vs dry land in Table 3.

Irrigated yields obtained were low, this can be attributed, in part, to a breakdown of the linear irrigation system providing water to this trial. The system had an underground rupture that required major excavation, and irrigation was not available through much of July. This was a critical period for winter wheat seed development and filling. Hence the low yields obtained.

Results obtained for the Irrigated trial are shown in Table 1. Statistical procedures indicated that AAC Icefield was the highest yielding variety and significantly higher yielding than all varieties yielding less than 6100 kg/ha. Conversely experimental entry W569 was significantly lower yielding than all other varieties excepting Emerson, AAC Gateway and AAC Goldrush. Median yield was 6040 kg/ha (89.8 bu/ac). Grain protein ranged from a low of 7.9% (Pintail) to a high of 9.6% (AC Emerson), this result mimics results obtained in two other prior years evaluations. Median test weight and seed weights for all evaluated varieties was 80.7 and 35.0, respectively. Heading of all varieties occurred within a period of 6 days from earliest to latest, maturity was also spread over a duration of 6 days. W522 experimental line was the earliest maturing variety, AAC Wildfire the latest. Entry W522 was the shortest variety, CDC Chase the tallest variety. Lodging did not occur in the trial in 2019.

Results obtained for the Dry Land trial are shown in Table 2. Statistical procedures concluded that W563 entry was the highest yielding variety and significantly higher yielding than all varieties yielding less than 5500 kg/ha. W569 was significantly lower yielding than all other varieties excepting entries yielding less than 5100 kg/ha. Median yield was 5380 kg/ha (80.0 bu/ac). Grain protein ranged from a low of 8.9% (Pintail) to a high of 11.3% (Emerson). Median test weight and seed weights for all evaluated varieties was 8.5 and 36.8, respectively. Heading of all varieties occurred within a period of 10 days from earliest to latest, maturity was spread over a duration of 7 days. AAC Goldrush and AAC Elevate were the earliest maturing varieties, AAC Wildfire the latest. Entry W569 was the shortest variety, Radiant the tallest variety. Lodging did not occur within the trial.

Although yields were believed to be significantly reduced by lack of available irrigation a comparison of the two production systems are shown in Table 3. The mean yield of all varieties produced under irrigation was statistically higher yielding than the mean yield of dry land production. Irrigation produced 751 kg/ha (11.2 bu/ac) more winter wheat grain yield than dry land, or 12% greater production. Although unknown, it is possible that this irrigation benefit to grain production is less than would be obtained with spring wheat or other conventional spring crops when compared to dry land production. This, if true, could be a result of earlier growth making better use of spring moisture and the crop maturing prior to the dry, hot conditions usually experienced in August. On average W563 was the highest yielding entry combining both systems, W569 the lowest yielding. No production system by variety interaction was detected for most agronomic observations indicating varieties responded to irrigation additions in a similar manner.

Grain protein was significantly higher under dry land production, as were test weights and seed weight. Plant heights were taller under irrigation.

This trial was continued with 12 winter wheat entries seeded September 17, 2019.

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. Funding is gratefully acknowledged.

Table 1. Winter Wheat Variety Evaluation, Irrigated 2019

| Variety | Yield (kg/ha) | Yield % of CDC Buteo | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Date of Heading | Date of Maturity | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| **CDC Buteo** | **6186** | **100** | **8.8** | **82.2** | **36.6** | **June 19** | **July 26** | **106** | **1** |
| AAC Elevate | 6015 | 97 | 8.8 | 79.4 | 38.3 | June 21 | July 26 | 93 | 1 |
| AAC Gateway | 5815 | 94 | 9.5 | 79.7 | 35.1 | June 21 | July 26 | 85 | 1 |
| AAC Goldrush | 5829 | 94 | 9.6 | 81.2 | 36.0 | June 23 | July 26 | 103 | 1 |
| AAC Icefield | 6478 | 105 | 8.3 | 80.4 | 33.9 | June 23 | July 30 | 89 | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| AAC Wildfire | 6256 | 101 | 8.5 | 81.8 | 38.7 | June 23 | July 31 | 95 | 1 |
| CDC Chase | 6153 | 99 | 8.6 | 80.9 | 34.1 | June 18 | July 26 | 108 | 1 |
| Emerson | 5712 | 92 | 9.6 | 81.0 | 32.7 | June 21 | July 29 | 100 | 1 |
| Pintail | 6356 | 103 | 7.9 | 78.5 | 32.7 | June 23 | July 30 | 102 | 1 |
| Radiant | 5894 | 95 | 8.7 | 80.8 | 36.5 | June 21 | July 27 | 104 | 1 |
| W520 | 6177 | 100 | 8.7 | 81.5 | 34.1 | June 21 | July 29 | 91 | 1 |
| W522 | 6382 | 103 | 8.6 | 80.1 | 36.4 | June 17 | July 25 | 81 | 1 |
| W563 | 6356 | 103 | 8.2 | 78.4 | 35.6 | June 22 | July 29 | 96 | 1 |
| W569 | 5431 | 88 | 8.9 | 81.1 | 33.8 | June 21 | July 29 | 82 | 1 |
| LSD (0.05) | 448 | | 0.4 | 1.3 | 1.2 | 2.5 days | 1.1 days | 6.5 | NS |
| CV (%) | 4.4 | | 2.7 | 0.9 | 2.0 | 0.9 | 0.3 | 4.1 | 0 |

NS = not significant

Table 2. Winter Wheat Variety Evaluation, Dryland 2019

| Variety | Yield (kg/ha) | Yield % of CDC Buteo | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Date of Heading | Date of Maturity | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| **CDC Buteo** | **5210** | **100** | **10.4** | **83.1** | **37.8** | **June 17** | **July 27** | **90** | **1** |
| AAC Elevate | 5599 | 107 | 9.9 | 80.3 | 41.0 | June 20 | July 23 | 86 | 1 |
| AAC Gateway | 4987 | 96 | 10.9 | 79.3 | 36.9 | June 21 | July 25 | 76 | 1 |
| AAC Goldrush | 5127 | 98 | 10.7 | 81.7 | 38.0 | June 25 | July 23 | 89 | 1 |
| AAC Icefield | 5083 | 98 | 9.7 | 79.8 | 36.2 | June 25 | July 27 | 77 | 1 |
| AAC Wildfire | 5737 | 110 | 9.6 | 82.5 | 38.7 | June 27 | July 30 | 84 | 1 |
| CDC Chase | 5555 | 107 | 9.4 | 81.3 | 35.3 | June 18 | July 26 | 95 | 1 |
| Emerson | 4790 | 92 | 11.3 | 81.9 | 33.3 | June 21 | July 29 | 86 | 1 |
| Pintail | 5091 | 98 | 8.9 | 80.1 | 34.3 | June 24 | July 27 | 83 | 1 |
| Radiant | 5718 | 110 | 10.0 | 81.6 | 38.7 | June 22 | July 29 | 98 | 1 |
| W520 | 5675 | 109 | 9.6 | 82.0 | 34.8 | June 21 | July 26 | 82 | 1 |
| W522 | 5553 | 107 | 9.8 | 81.0 | 38.0 | June 17 | July 24 | 76 | 1 |
| W563 | 5967 | 115 | 9.2 | 79.7 | 36.3 | June 24 | July 29 | 88 | 1 |
| W569 | 4429 | 85 | 10.6 | 81.9 | 34.1 | June 24 | July 30 | 74 | 1 |
| LSD (0.05) | 680 | | 0.8 | 2.2 | 1.5 | 3.6 days | 1.3 days | 7.2 | NS |
| CV (%) | 7.6 | | 5.0 | 1.6 | 2.5 | 1.3 | 0.4 | 5.1 | 0 |

NS = not significant

Table 3. Winter Wheat Variety Evaluation, Irrigated vs Dryland 2019

| System / Variety | Yield (kg/ha) | Yield % of CDC Buteo | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Date of Heading | Date of Maturity | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|
| **Production System** | | | | | | | | | |
| Irrigated | 6074 | 100 | 8.8 | 80.5 | 35.3 | June 21 | July 28 | 95 | 1 |
| Dryland | 5323 | 88 | 10.0 | 81.2 | 36.7 | June 22 | July 27 | 84 | 1 |
| LSD (0.05) | 722 | | 0.9 | 0.3 | 0.8 | NS | 0.9 days | 1.4 | NS |
| CV (%) | 6.0 | | 4.2 | 1.3 | 2.3 | 1.1 | 0.4 | 4.5 | 0 |
| **Variety** | | | | | | | | | |
| **CDC Buteo** | **5698** | **100** | **9.6** | **82.7** | **37.2** | **June 18** | **July 26** | **98** | **1** |
| AAC Elevate | 5807 | 102 | 9.3 | 79.9 | 39.7 | June 21 | July 25 | 89 | 1 |
| AAC Gateway | 5401 | 95 | 10.2 | 79.5 | 36.0 | June 21 | July 26 | 80 | 1 |
| AAC Goldrush | 5478 | 96 | 10.2 | 81.5 | 37.0 | June 24 | July 25 | 96 | 1 |
| AAC Icefield | 5781 | 101 | 9.0 | 80.1 | 35.1 | June 24 | July 28 | 83 | 1 |
| AAC Wildfire | 5997 | 105 | 9.1 | 82.2 | 38.7 | June 25 | July 31 | 90 | 1 |
| CDC Chase | 5854 | 103 | 9.0 | 81.1 | 34.7 | June 18 | July 26 | 101 | 1 |
| Emerson | 5251 | 92 | 10.4 | 81.5 | 33.0 | June 21 | July 29 | 93 | 1 |
| Pintail | 5724 | 100 | 8.4 | 79.3 | 33.5 | June 24 | July 29 | 93 | 1 |
| Radiant | 5806 | 102 | 9.3 | 81.2 | 37.6 | June 22 | July 28 | 101 | 1 |
| W520 | 5926 | 104 | 9.2 | 81.8 | 34.4 | June 21 | July 27 | 86 | 1 |
| W522 | 5967 | 105 | 9.2 | 80.5 | 37.2 | June 17 | July 25 | 78 | 1 |
| W563 | 6162 | 108 | 8.7 | 79.0 | 35.9 | June 23 | July 28 | 92 | 1 |
| W569 | 4930 | 87 | 9.7 | 81.5 | 33.9 | June 23 | July 30 | 78 | 1 |
| LSD (0.05) | 397 | | 0.5 | 1.2 | 0.9 | 2.2 days | 0.8 days | 4.7 | NS |
| Production System x Variety Interaction | | | | | | | | | |
| LSD (0.05) | NS | | NS | NS | NS | NS | S | NS | NS |

S = significant

NS = not significant

# Fall Rye Variety Evaluation for Irrigation

## Funding

Funded by ICDC

## Principal Investigator


- Joel Peru, PAg, Irrigation Agrologist, SK Ministry of Agriculture
- Garry Hnatowich, PAg, Research Director, ICDC
- Co-investigator: Dr. Jamie Larsen, AAFC Lethbridge Research Centre


## Organizations


- Irrigation Crop Diversification Corporation (ICDC)


## Objectives

This demonstration provided local producers a yield and visual comparison of fall rye production under irrigated and dryland conditions in central Saskatchewan. Producers had the opportunity to compare how new hybrid varieties perform compared to conventional varieties.

## Research Plan

Seed of five fall rye (3 conventional and 2 hybrid) varieties were acquired from fall rye breeder Dr. J. Larsen, AAFC-Lethbridge. Varieties were direct seeded into canola stubble on September 11, 2018. Fall rye varieties were established in a small plot replicated and randomized trial design, replicated 3 times. All varieties are being evaluated under both irrigated and dry land systems. Seeded plot size was 6 m in length and 1.5 m wide. At seeding each trial received 80 kg N/ha as urea (46-0-0) side banded, 25 kg $P_2O_5$/ha side banded and an additional 25 kg $P_2O_5$/ha seed placed monoammonium nitrate (11-52-0). On April 17$^{th}$, 2019 upon regrowth an additional 50 kg N/ha was broadcast on the irrigated trial. Weed control consisted of a pre-seed application of glyphosate and a post-emergence tank mix application of Buctril M (bromoxynil +MCPA ester) and Bison (tralkoxydim). No foliar fungicides were applied for either leaf disease or Fusarium Head Blight. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. Harvest plot size was 4 m x 1.5 m. Both trials were harvested August 15, 2019. Harvested samples were cleaned into respective crops and yields adjusted to a moisture content of 14.5%. Total in-season precipitation was 186.4 mm. An additional 233.7 mm was applied by irrigation to the irrigated production system from May 29 through to August 12, 2019.

Seasonal precipitation, 30-year historic precipitation and growing degree days at CSIDC are outlined in Tables 1 & 2. Seasonal precipitation was significantly lower in May, higher in June, and lower throughout the growing period compared to 30 year averages, Seasonal precipitation on the trials by seasons end was significantly less than long term averages. Seasonal Cumulative Growing Degree Days were cooler through the growing period, particularly at the start in May and at the end of the season.

Table 1. 2019 Growing Season Precipitation vs Long-Term Average, CSIDC.

| | Year | | |
|---|---|---|---|
| **Month** | **2019 mm (inches)** | **30 Year Average mm (inches)** | **% of Long-Term** |
| May | 13.2 (0.5) | 46.0 (1.8) | 29 |
| June | 90.2 (3.6) | 67.0 (2.6) | 135 |
| July | 43.8 (1.7) | 57.0 (2.2) | 77 |
| August | 39.2 (1.5) | 46.0 (1.8) | 85 |
| **Total** | 186.4 (7.3) | 216.0 (8.4) | **86** |

Table 2. Cumulative Growing Degree Days (Base 0°C) vs Long-Term Average, CSIDC.

| | Year | | |
|---|---|---|---|
| **Month** | **2019** | **30 Year Average** | **% of Long-Term** |
| May | 211 | 224 | 94 |
| June | 691 | 708 | 98 |
| July | 1249 | 1290 | 97 |
| August | 1750 | 1844 | 94 |

## Results

Results obtained for the irrigated trial are shown in Table 3, the dryland trial in Table 4 and a comparison of irrigated vs dryland in Table 5.

*Irrigated Trial*

Irrigated yields obtained were lower than expected, this can be attributed, in part, to a breakdown of the linear irrigation system providing water to this trial. The system had an underground rupture that required major excavation, and irrigation was not available through much of June and early July. This was a critical period for fall rye seed development.

The hybrid variety Gatano yielded the highest under irrigation (Table 3), and the conventional variety Prima the lowest. Yields of the 5 varieties ranged from 5898 kg/ha to 8672 kg/ha (93.9-138.1 bu/ac) with the median being 6660 kg/ha (106 bu/ac). The two hybrid varieties (Gatano and Daniello) yielded higher than the conventional varieties under irrigation. Grain protein was lowest in the hybrids (Gatano and Daniello) and the highest being in the conventional variety, Danko, at 9.8%. Median seed weights for all evaluated varieties was 33.5 grams per TKW. Maturity was spread over a period of 6 days among the varieties with Prima being the earliest and the two hybrids being the latest. Lodging was not a major factor on this trial.

*Dry Land Trial*

The hybrid variety Gatano yielded the highest under dryland (Table 4), and the conventional variety Danko the lowest. Yields of the 5 varieties ranged from 5020 kg/ha to 7216 kg/ha (79.9-114.9 bu/ac) with the median being 5766 kg/ha (91.8 bu/ac). The hybrid varieties outperformed the conventional under dryland conditions. Grain protein was as low as 8.1% (Gatano) to a high of 10.5% (Danko). Median seed weights for all evaluated varieties was 33.2 grams per TKW. Maturity was spread over a period of 8 days among the varieties with Prima being the earliest and Hazlet being the latest. Lodging was not a factor on this trial.

*Irrigated VS Dry Land*

A comparison of the dryland trial and irrigated trial are displayed in table 5. The irrigated trial gave an observed average yield increase of 21.5 bu/acre (22%) compared to the dryland trial. Table 5 also compares conventional vs hybrid varieties from both trials as a whole. The hybrid varieties had a clear yield advantage, averaging 32.5 bu/ac over the conventional.

Table 3. Fall Rye Variety Evaluation, Irrigation Site, 2019.

| Variety | Yield (kg/ha) | Yield (bu/ac) | Protein (%) | Seed Weigh t (mg) | Days to Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat | Ergot (%) |
|---|---|---|---|---|---|---|---|---|
| **Open-Pollinated Conventional Varieties** | | | | | | | | |
| Hazlet | 6720 | 107.0 | 8.9 | 38.4 | July 28 | 122 | 1 | 1.7 |
| Danko | 6406 | 102.1 | 9.8 | 38.0 | July 27 | 125 | 1 | 1.7 |
| Prima | 5898 | 93.9 | 8.6 | 32.9 | July 24 | 141 | 1 | 3.3 |
| **Hybrid Varieties** | | | | | | | | |
| Daniello | 8580 | 136.7 | 7.8 | 33.2 | July 29 | 112 | 1 | 1.7 |
| Gatano | 8672 | 138.1 | 7.5 | 31.4 | July 29 | 108 | 1 | 0 |
| LSD (0.05) | 452 | 7.2 | 0.5 | 2.0 | 2.1 days | 8.2 | NS | NS |
| CV (%) | 3.3 | 3.3 | 3.3 | 3.0 | 0.5 | 3.6 | 0 | 140 |

NS= not significant

Table 4. Fall Rye Variety Evaluation, Dryland Site, 2019.

| Variety | Yield (kg/ha) | Yield (bu/ac) | Protein (%) | Seed Weight (mg) | Days to Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat | Ergot (%) |
|---|---|---|---|---|---|---|---|---|
| **Open-Pollinated Conventional Varieties** | | | | | | | | |
| Hazlet | 5405 | 86.1 | 9.3 | 37.4 | July 28 | 101 | 1 | 1.7 |
| Danko | 5020 | 79.9 | 10.5 | 37.1 | July 24 | 100 | 1 | 1.7 |
| Prima | 5139 | 81.9 | 9.2 | 32.9 | July 20 | 119 | 1 | 1.7 |
| **Hybrid Varieties** | | | | | | | | |
| Daniello | 6754 | 107.6 | 8.2 | 32.1 | July 23 | 89 | 1 | 0 |
| Gatano | 7216 | 114.9 | 8.1 | 31.4 | July 26 | 85 | 1 | 0 |
| LSD (0.05) | 597 | 9.5 | 0.2 | 1.5 | 3.1 days | 6.4 | NS | NS |
| CV (%) | 5.4 | 5.4 | 1.1 | 2.4 | 0.8 | 3.4 | 0 | 224 |

Table 5. Fall Rye Variety Evaluation, Irrigation versus Dryland, 2019.

| System / Variety | Yield (kg/ha) | Yield (bu/ac) | Protein (%) | Seed Weight (mg) | Days to Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat | Ergot (%) |
|---|---|---|---|---|---|---|---|---|
| **Production System** | | | | | | | | |
| Irrigated | 7255 | 115.6 | 8.5 | 34.8 | July 27 | 122 | 1 | 1.7 |
| Dryland | 5907 | 94.1 | 9.0 | 34.2 | July 24 | 99 | 1 | 1.0 |
| LSD (0.06) | 1416 | 5.2 | 0.5 | NS | NS | 19 | NS | NS |
| CV (%) | 4.3 | 4.3 | 2.4 | 2.7 | 0.7 | 3.5 | 0 | 171 |
| **Varieties** | | | | | | | | |
| Open-Pollinated Conventional Varieties | | | | | | | | |
| Hazlet | 6063 | 96.6 | 9.1 | 37.9 | July 28 | 111 | 1 | 1.7 |
| Danko | 5714 | 91.0 | 10.1 | 37.5 | July 26 | 113 | 1 | 1.7 |
| Prima | 5519 | 87.9 | 8.9 | 32.9 | July 22 | 130 | 1 | 2.5 |
| Hybrid Varieties | | | | | | | | |
| Daniello | 7667 | 122.1 | 8.0 | 32.7 | July 26 | 100 | 1 | 0.8 |
| Gatano | 7944 | 126.5 | 7.8 | 31.4 | July 28 | 97 | 1 | 0 |
| LSD (0.05) | 344 | 2.6 | 0.3 | 1.1 | 1.7 days | 4.8 | NS | NS |
| **Production System x Variety Interaction** | | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | S | NS | NS | NS |

## Discussion

The combination of seasonal precipitation being significantly lower in May and break down of the linear pivot, likely effected yield for the irrigation trial. Seasonal Cumulative Growing Degree Days were cooler through the growing period, particularly at the start in May and at the end of the season which delayed harvest.

This project showed irrigators in Saskatchewan that fall rye benefits greatly from irrigation and the newer hybrid varieties have a yield advantage. Despite hybrid fall rye seed costing $69.60 per acre (2020 Crop Planning Guide), it's yield advantage has the potential to generate higher net profit compared to conventional fall rye. Further demonstration of this crop under irrigation and extension of this year's results will help provide awareness to Saskatchewan irrigators of both its risk and potential as an irrigated crop.

## Acknowledgements

- CSIDC staff
- Jamie Larson AAFC Lethbridge Research Centre, who organized and sourced seed fort this project

# Corn Varieties for Silage Demonstration

## Funding

Funded by Agricultural Demonstration of Practices and Technologies (ADOPT) Program and ICDC

## Principal Investigator


- Travis Peardon, Livestock S SK Ministry of Agriculture
- Garry Hnatowich, PAg, Research Director, ICDC
- Co-investigator: Dr. Jamie Larsen, AAFC Lethbridge Research Centre


## Organizations


- Saskatchewan Ministry of Agriculture
- Irrigation Crop Diversification Corporation (ICDC)


## Objectives

Growing corn for silage or winter grazing is a potential alternate winter feeding strategy for Saskatchewan beef producers. Variety selection is an integral component of ensuring success when growing corn, and producers must know which varieties are available locally and how those varieties perform under local growing conditions.

The objective of this project was to evaluate corn varieties suitable to growing conditions in the Lake Diefenbaker Area for silage quality and yield potential under irrigation and dryland management. Results of the irrigated portion of this trial will be added to a variety performance data base and is included in the Crop Varieties for Irrigation publication.

## Research Plan

The trial was established at Broderick, SK. on medium to moderately coarse-textured lacustrine soil, classified as a Bradwell loam to silty loam. Twelve corn varieties were planted on 75cm (30 inch) row spacing. Each plot consisted of two corn rows. A seeding rate of 79,071 plants/ha (32,000 plants/ac) was targeted for irrigated production. A seeding rate of 69,187 plants/ha (28,000 plants/ac) was targeted for dry land production. Seed for each individual plot was packaged according to individual seed weights and adjusted for estimated per cent germination. All seed received from suppliers was treated. Nitrogen fertilizer was side banded at a rate of 70 kg N/ha as urea (46-0-0) and phosphorus fertilizer was side banded at a rate of 20 kg P¬2O5/ha as 12-51-0 during the seeding operation. Trials were established on potato stubble that had residual soil nitrogen levels of 150 kg N/ha. Weed control consisted of spring pre-plant and a post emergence application of glyphosate, the dry land trial also received an in-season application of Buctril M (bromoxynil/MCPA ester) at the 5-6 leaf stage. All silage plots were harvested on October 11th with a Hegi forage harvest combine. Combine fresh weights were recorded and subsamples taken for moisture and feed value determinations. Unfortunately, after subsamples were dried and dry weights determined samples were inadvertantly deposed therefore feed quality determinations could not be conducted.

## Results

The corn heat unit (CHU) rating of varieties in the trial ranged from 2150 to 2450. (Table 1) The Outlook area received 2336 CHU during the 2019 growing season. Precipitation during the growing season was below normal. (Table 2).

Based on 2019 yield data, the varieties that performed the best were PS 2210VT2P RIB (irrigated) and P7958AM (Dryland).

This project will be highlighted at extension meeting in winter and spring of 2020. The irrigated portion of this trial will become part of the *Crop Varieties for Irrigation* Publication.

Table 1. Corn Varieties Included in Silage Corn Variety Demonstration

| Variety | Company | Corn Heat Unit Rating | Germination % | Kernel Weight (gm/1000) |
|---|---|---|---|---|
| DKC29-89 RIB | Dekalb | 2275 | 94 | 295 |
| DKC32-12 RIB | Dekalb | 2450 | 94 | 288 |
| DKC34-57 RIB | Dekalb | 2575 | 94 | 300 |
| PS 2210VT2P RIB | DLF Pickseed | 2225 | 100 | 332 |
| PS 2320 RR | DLF Pickseed | 2300 | 100 | 360 |
| LR 9474 VT2PRIB | Legend | 2225 | 95 | 330 |
| LR 9573 VT2PRIB | Legend | 2200 | 95 | 240 |
| LR 9579 RR | Legend | 2350 | 95 | 242 |
| LR 9676 VT2PRIB | Legend | 2275 | 95 | 252 |
| LR 99S77 RR | Legend | 2300 | 95 | 288 |
| P7527AM | Corteva/Pioneer | 2150 | 95 | 209 |
| P7958AM | Corteva/Pioneer | 2275 | 95 | 231 |

**Table 2. Seasonal vs Long-Term Precipitation & Cumulative Corn Heat Units (CHU)**

**CSIDC Outlook Weather Station**

| Month | 2019 mm (inches) | 30 Year Average mm (inches) | % of Long-Term | Cumulative CHU |
|---|---|---|---|---|
| May | 13.2 (0.5) | 46.0 (1.8) | 29 | 195 |
| June | 90.2 (3.6) | 67.0 (2.6) | 135 | 730 |
| July | 43.8 (1.7) | 57.0 (2.2) | 77 | 1378 |
| August | 39.2 (1.5) | 46.0 (1.8) | 85 | 1940 |
| September | 38.2 (1.5) | 33.0 (1.3) | 116 | 2336 |
| **Total** | **224.6 (8.8)** | **249.0 (9.8)** | **90** | |

Table 4. Agronomic Data of Irrigated Silage Corn, 2019

| Hybrid | Dry Yield (T/ha) | Dry Yield (T/ac) | Plant Stand (plants/ac) | Harvest Whole Plant Moisture (%) | 10% Anthesis (days) | 50% Silking (days) |
|---|---|---|---|---|---|---|
| DKC29-89 RIB | 16.06 bcd | 6.50 | 28666 b | 65.0 | 80 | 81 |
| DKC32-12 RIB | 17.85 ab | 7.22 | 29677 b | 63.2 | 80 | 83 |
| DKC34-57 RIB | 16.55 bc | 6.70 | 29453 b | 67.1 | 82 | 84 |
| PS 2210VT2P RIB | 18.69 a | 7.56 | 34736 a | 63.5 | 80 | 84 |
| PS 2320 RR | 14.82 cde | 6.00 | 27429 bc | 64.0 | 79 | 81 |
| LR 9474 VT2PRIB | 17.94 ab | 7.26 | 27429 bc | 60.4 | 79 | 83 |
| LR 9573 VT2PRIB | 13.35 e | 5.41 | 22033 d | 60.9 | 76 | 78 |
| LR 9579 RR | 14.18 de | 5.74 | 23832 cd | 66.6 | 81 | 85 |
| LR 9676 VT2PRIB | 14.18 de | 5.74 | 27430 bc | 62.3 | 76 | 77 |
| LR 99S77 RR | 14.72 cde | 5.96 | 26980 bc | 64.3 | 75 | 78 |
| P7527AM | 17.06 ab | 6.91 | 29116 b | 61.9 | 80 | 83 |
| P7958AM | 17.04 ab | 6.90 | 28104 b | 61.7 | 78 | 80 |
| LSD (0.05) | 1.92 | 0.78 | 3683 | 1.9 | 1.95 | 2.3 |
| CV (%) | 8.3 | 8.3 | 9.2 | 2.1 | 1.7 | 2.0 |

Table 5. Agronomic Data of Dry Land Silage Corn, 2019

| Hybrid | Dry Yield (T/ha) | Dry Yield (T/ac) | Plant Stand (plants/ac) | Harvest Whole Plant Moisture (%) | 10% Anthesis (days) | 50% Silking (days) |
|---|---|---|---|---|---|---|
| DKC29-89 RIB | 7.90 a | 3.20 | 27654 ab | 66.3 | 92 | 93 |
| DKC32-12 RIB | 7.63 ab | 3.09 | 26193 ab | 65.7 | 88 | 89 |
| DKC34-57 RIB | 7.71 a | 3.12 | 24057 bcd | 68.3 | 93 | 94 |
| PS 2210VT2P RIB | 7.94 a | 3.21 | 30577 a | 67.0 | 93 | 94 |
| PS 2320 RR | 7.43 abc | 3.01 | 21359 cde | 63.5 | 87 | 89 |
| LR 9474 VT2PRIB | 6.81 cd | 2.76 | 23944 bcd | 63.4 | 92 | 93 |
| LR 9573 VT2PRIB | 6.40 d | 2.59 | 20347 de | 62.2 | 87 | 90 |
| LR 9579 RR | 6.39 d | 2.59 | 18211 e | 66.5 | 95 | 97 |
| LR 9676 VT2PRIB | 6.83 bdc | 2.76 | 23944 bcd | 61.5 | 85 | 89 |
| LR 99S77 RR | 7.53 abc | 3.05 | 25069 bc | 67.9 | 86 | 89 |
| P7527AM | 6.57 d | 2.66 | 26418 ab | 62.6 | 91 | 93 |
| P7958AM | 8.03 a | 3.25 | 25630 bc | 64.4 | 88 | 90 |
| LSD (0.05) | 0.82 | 0.33 | 4433 | 1.9 | 5.5 | 4.6 |
| CV (%) | 7.8 | 7.8 | 12.6 | 2.0 | 4.3 | 3.5 |

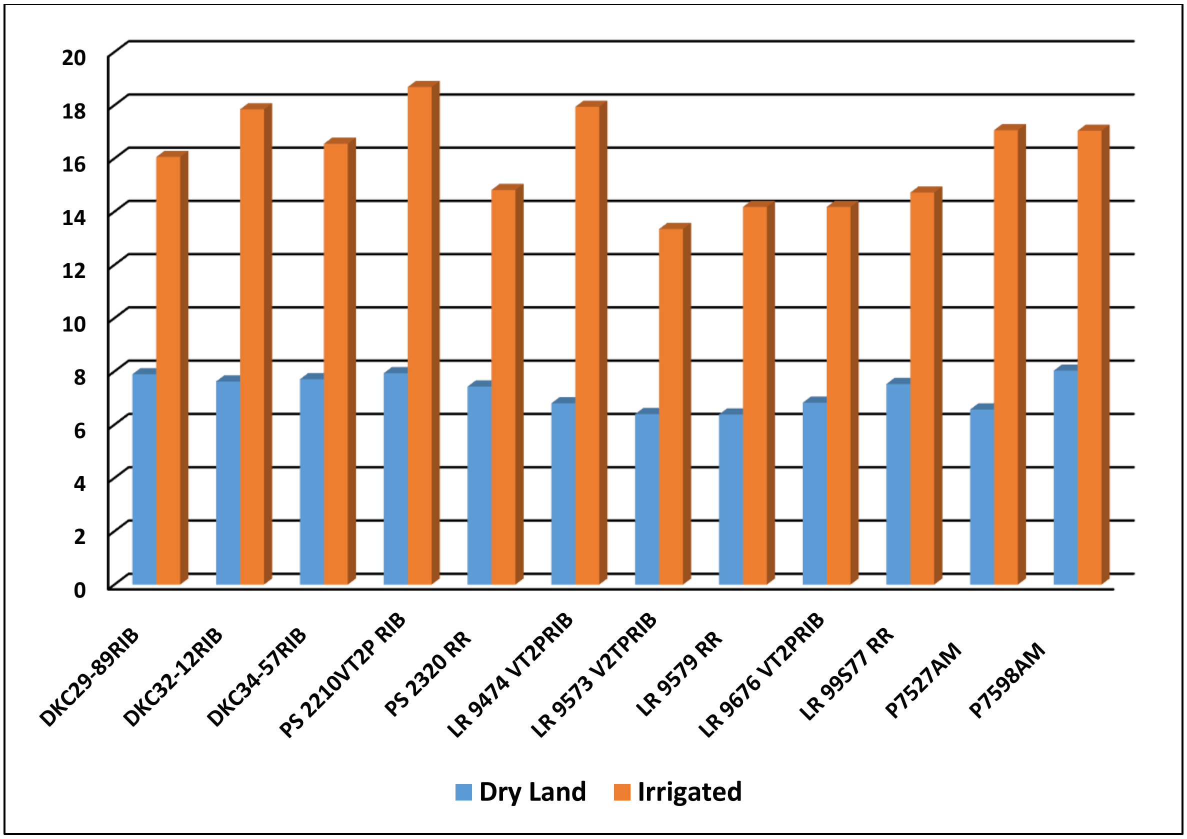
Table 6. Irrigated vs Dry Land Silage Corn, 2019

| Production System or Hybrid | Dry Yield (T/ha) | Dry Yield (T/ac) | % Yield Increase of Irrigated vs Dry Land | Plant Stand (pl/ac) | Harvest Whole Plant Moisture (%) | 10% Anthesis (days) | 50% Silking (days) |
|---|---|---|---|---|---|---|---|
| **Production System** | | | | | | | |
| Irrigated | 16.04 | 6.49 | 121 | 27907 | 63.4 | 78 | 81 |
| Dry Land | 7.26 | 2.94 | | 24450 | 65.0 | 90 | 92 |
| LSD (0.05) | 1.52 | 0.61 | | 2219 | 1.6 | 3.3 | 2.6 |
| CV (%) | 8.8 | 8.8 | | 10.8 | 2.1 | 3.4 | 2.9 |
| **Hybrid** | | | | | | | |
| DKC29-89 RIB | 11.98 bc | 4.85 | 103 | 28160 | 65.6 | 86 | 87 |
| DKC32-12 RIB | 12.74 ab | 5.15 | 134 | 27935 | 64.5 | 84 | 86 |
| DKC34-57 RIB | 12.13 bc | 4.91 | 115 | 26755 | 67.7 | 87 | 89 |
| PS 2210VT2P RIB | 13.31 a | 5.39 | 135 | 32657 | 65.3 | 86 | 89 |
| PS 2320 RR | 11.13 cd | 4.50 | 99 | 24394 | 63.8 | 83 | 85 |
| LR 9474 VT2PRIB | 12.37 ab | 5.01 | 164 | 25687 | 61.9 | 85 | 88 |
| LR 9573 VT2PRIB | 9.88 e | 4.00 | 109 | 21190 | 61.5 | 81 | 84 |
| LR 9579 RR | 10.28 de | 4.16 | 122 | 21022 | 66.6 | 88 | 91 |
| LR 9676 VT2PRIB | 10.50 de | 4.25 | 108 | 25687 | 61.9 | 80 | 83 |
| LR 99S77 RR | 11.13 cd | 4.51 | 95 | 26024 | 66.1 | 81 | 83 |
| P7527AM | 11.82 bc | 4.78 | 160 | 27767 | 62.3 | 85 | 88 |
| P7958AM | 12.54 ab | 5.07 | 112 | 26867 | 63.1 | 83 | 85 |
| LSD (0.05) | 1.02 | | | 2828 | 1.3 | 2.9 | 2.5 |
| **Production System x Hybrid Interaction** | | | | | | | |
| LSD (0.05) | S | S | | NS | S | NS | NS |

S = significant

NS = not significant

Figure 1. Irrigated vs Dry Land Dry Yield, 2019




## Summary

Growing corn for silage or winter grazing is a potential alternative winter feeding method for Saskatchewan beef producers. Variety selection is an integral piece of ensuring success when growing corn. Producers need to know which corn varieties are available locally and how these varieties perform under local growing conditions. Data collection included plant population, corn heat units (CHU) accumulated and dry matter (DM) yield.   Based on dry matter yield, *PS 2210VT2P RIB* was the corn variety that performed best under irrigation in 2019. Irrigated dry matter yields varied from 5.41 to 7.56 T/acre. P7958AM was the corn variety that performed best under non-irrigated management.  Dryland dry matter yields varied from 2.59 to 3.25 T/acre.

## Acknowledgements

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# 2019 Irrigated Corn Variety Demonstration for Grain Production

## Funding

Project funded by ICDC.

## Project Lead

- Joel Peru, PAg, Irrigation Agrologist, Saskatchewan Agriculture
- Garry Hnatowich, PAg, Research Director, ICDC

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Canada-Saskatchewan Irrigation Diversification Centre

## Objectives

The objective of this project was to demonstrate corn varieties with low heat unit requirements for grain yield potential under irrigation in Saskatchewan.

## Research Plan

The project was located on irrigated land rented from a producer on the SW-27-30-07-W3M. The soils on this parcel are made up of very fine sandy-loams from the Bradwell association

A randomized, replicated small plot design included 8 corn hybrids. Plot dimensions were 1.5 m by 6.0 m on 80 cm (30 inch) row spacing. Plots were replicated four times. Each plot consisted of two rows of corn. A seeding rate of 79,000 seeds/ha (32,000 seeds/acre) was targeted. Seeding rates were calculated on the basis of hybrid germination percentage and seed weight.

The trials were seeded on May 21. The varieties and CHU requirements are listed in table 1. Weed control consisted of spring pre-plant and post emergence applications of Roundup (glyphosate) supplemented by hand weeding. Grain yield was obtained by hand harvesting both rows to a length of 6m. Harvest date was October 30$^{th}$, it was noted that the cobs were very small and beginning to mold. Grain samples were dried and then stationary combined.

Growing season rainfall (May 21 to October 30$^{th}$) was 219 mm (8.6”) and an additional 274 mm (10.8”) was applied as irrigation. Cumulative Corn Heat Units (CHU) were 2385 for the period May 15 – September 30. Cumulative corn heat units were very close to average thanks to the late first fall frost. Temperatures were generally moderate and all monthly averages were well within 2.0°C of the 30-year averages.

Table 1. Grain corn varieties and CHU requirements included in 2019 ICDC trial.

| Company | Variety | CHU requirement |
|---|---|---|
| Dupont® | P7202AM | 2050 |
| Dupont® | P7211HR | 2050 |
| DEKALB® | 26-40 RIB | 2150 |
| DEKALB® | 23-17RIB | 2075 |
| DEKALB® | 29-89 RIB | 2275 |
| Legend Seeds® | LR 9573 | 2050 |
| Legend Seeds® | LR 9474 | 2225 |
| Legend Seeds® | LR 9972GT | 2125 |

## Results and Discussion

The Results of this demonstration are listed on table 2 and 3 for this year's irrigated trials.

Yields of all varieties were much lower than expected in 2019. This is possibly due to the late seeding date of May 21st combined with a wet cool fall with untimely rainfall and snow events. It is generally recommended to seed corn for grain production in Saskatchewan by May 15th and this goal was not met due to logistical challenges during the seeding season.

The plant stands in this trial exceeded the targeted number of 32000 plants/acre for all varieties. Yields in this trial ranged from 3483-5625kg/ha (56-90 bu/ac) which is considered a poor crop. According to the 2020 ICDC Irrigation Economics and Agronomics guide, a yield of 76 bu/ac needs to be grown to break even if corn prices are at $5.43/bu. Half of the varieties in this trial did exceed 76 bu/ac, but still did no provide enough yield to be economically attractive. This demonstration showed to local producers that even with new varieties requiring less CHUs, grain corn can be a risky crop when conditions are not right. The continued improvement of genetics and production practises will be necessary before producers widely adopt grain corn in Lake Diefenbaker's irrigated crop mix.

Table 2. Agronomic Data of Irrigated Grain Corn, 2019

| Hybrid | Yield @ 15.5% Moisture (kg/ha) | Yield @ 15.5% Moisture (bu/ac) | Oil (%) | Protein (%) | Starch (%) | Seed Weight (g/1000) |
|---|---|---|---|---|---|---|
| DKC23-17 RIB | 5155 | 82.1 | 5.2 | 10.8 | 68.8 | 161 |
| DKC26-40 RIB | 5625 | 89.6 | 5.3 | 10.0 | 69.7 | 154 |
| DKC29-89 RIB | 4229 | 67.4 | 5.8 | 10.5 | 70.5 | 146 |
| P7202YHR | 5812 | 92.6 | 5.2 | 10.1 | 69.8 | 189 |
| P7211HR | 5367 | 85.5 | 5.2 | 10.2 | 69.8 | 183 |
| LR 9474 VT2PRIB | 3483 | 55.5 | 5.3 | 11.3 | 68.7 | 138 |
| LR 9573 VT2PRIB | 4540 | 72.3 | 5.6 | 10.5 | 69.7 | 150 |

| | | | | | | |
|---|---|---|---|---|---|---|
| LR 9972GT | 4706 | 75.0 | 5.7 | 11.6 | 69.0 | 140 |
| LSD (0.05) | 777 | 12.4 | 0.3 | 0.3 | 0.6 | 10.5 |
| CV (%) | 10.9 | 10.9 | 3.3 | 2.1 | 0.6 | 4.5 |

Table 3. Agronomic Data of Irrigated Grain Corn, 2019

| Hybrid | 10% Anthesis (days) | 50% Silking (days) | Plant Stand (plants/ha) | Plant Stand (plants/ac) |
|---|---|---|---|---|
| DKC23-17 RIB | 75 | 76 | 71389 | 28891 |
| DKC26-40 RIB | 76 | 76 | 78611 | 31814 |
| DKC29-89 RIB | 80 | 82 | 76111 | 30802 |
| P7202YHR | 75 | 77 | 67778 | 27429 |
| P7211HR | 75 | 77 | 65556 | 26530 |
| LR 9474 VT2PRIB | 81 | 83 | 68889 | 27879 |
| LR 9573 VT2PRIB | 76 | 78 | 64444 | 26080 |
| LR 9972GT | 76 | 79 | 67500 | 27317 |
| LSD (0.05) | 0.9 | 1.9 | NS | NS |
| CV (%) | 0.8 | 1.6 | 11.8 | 11.8 |

NS = not significant


## Acknowledgements

- CSIDC and ICDC staff who assisted with the field and irrigation operations for this project
- Rory Cranston, providing DEKALB® seed
- Darrel Théroux, providing Legend Seeds® varieties

# Saskatchewan Dry Bean Narrow Row Regional Variety Trial

## Funding

Funded by the Irrigation Crop Diversification Corporation and the Saskatchewan Variety Performance Group

## Project Lead

- Garry Hnatowich
- Co-investigators: Dr. K. Bett, Crop Development Centre

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Crop Development Centre

## Objectives

Regional performance trials provide information on the various production regions available in Saskatchewan to assess productivity and risk of dry bean. This information is used by extension personnel, pulse growers and researchers across Saskatchewan to become familiar with these new pulse crops.

## Research Plan

A Dry Bean Narrow Row Regional variety trial was conducted in the spring of 2019 at CSIDC off-station Knapik location. A second location was intended for the ICDC off-station location at Rudy Agro. Unfortunately, the Rudy Agro was unintentionally seeded in wide rows, not narrow as was the intent. Therefore, only results from Knapik will be discussed separately.

<u>Knapik</u>

The trial was seeded May 30 at Knapik. Eighteen dry bean varieties consisting of six market classes (pinto, black, navy, yellow, cranberry and fleur de junio) were evaluate. Phosphorus fertilizer was side-banded at a rate of 25 kg $P_2O_5$/ha during the seeding operation. Granular inoculant was unavailable so nitrogen requirements were met by supplemental broadcast urea, applied and irrigated immediately, for a total application of 100 kg N/ha. At no time during dry bean growth did plants exhibit symptoms of nitrogen deficiencies. Weed control consisted of a pre-plant soil incorporated application of granular Edge (ethalfluralin) and a post-emergent application of Viper ADV (imazamox and bentazon) supplemented by periodic in-row hand weeding. Priaxor (fluxapyroxad & pyraclostrobin) for control/suppression of powdery mildew, mycosphaerella, downy mildew and white mold was applied July 27. Individual plots consisted of four rows with 25 cm row spacing and measured 0.8 m x 4 m. Yields were estimated by harvesting the entire plot. All rows in each plot were under-cut and windrowed, allowed to dry in the windrow and then threshed when seed moisture content was <20%. The trial was undercut on September 6, and harvested on September 19. In-season precipitation from May 15 through August was 180 mm and in-season irrigation at Knapik was 113 mm.

General observations of the 2019 growing season are warranted. The 2019 growing season began dry in terms of precipitation, however, this was not overly a concern as all three trials were irrigated. However,the daily temperatures were believed to be an issue. The values shown in Table 1 are cumulative growing degrees throughout the season based on 10° C, as dry bean do not develop and grow at temperatures less than 10° C. The optimal growing degree days was well below optimal for dry bean development. Added influence was that average night time temperatures were below normal throughout the entire growing season. Consequently, agronomic dry bean growth, at both sites, was less than normally experienced within the region. Plant canopies did not close at either test trial.

Table 1. Cumulative Growing Degree Days (Base 10°C) vs Long-Term Average, CSIDC Outlook Weather Station.

| | Year | | |
|---|---|---|---|
| **Month** | **2019** | **30 Year Average** | **% of Long-Term** |
| May | 52 | 60 | 87 |
| June | 231 | 242 | 95 |
| July | 479 | 510 | 94 |
| August | 671 | 754 | 89 |
| September | 737 | 821 | 90 |

## Results

*Knapik*

Results of the trials are shown in Table 2 for Knapik narrow row evaluation. Seed yields in general were very low and are directly related to the abnormal dry bean environmental conditions experienced. Seed yield obtained for the Yellow market class dry bean varieties were abysmal, as was OAC Racer Cranberry dry bean. Generally, the OAC (Ontario Agricultural College) performed poorly, the lower yields are also correlated to the low plant populations established with these varieties. No further discussion is warranted.

The results from these trials are used to update (if applicable) the irrigation variety database at ICDC and provide recommendations to irrigators on the best dry bean varieties suited to irrigation conditions.

Table 1. Saskatchewan Irrigated Dry Bean Narrow Row Regional Variety Trial, ICDC Off-Station Knapik Site, 2019.

| Variety | Yield (kg/ha) | Yield (lb/ac) | Seed weight (g/1000) | Plant Stand (plant/m$^2$) | Flower (days) | Maturity (days) | Lodge rating 1=upright 5=flat | Height (cm) |
|---|---|---|---|---|---|---|---|---|
| **Pinto** | | | | | | | | |
| ***AC Island*** | ***2027*** | ***1808*** | ***335*** | ***36*** | ***50*** | ***98*** | ***1*** | ***42*** |
| AAC Burdett | 2128 | 1898 | 368 | 35 | 52 | 98 | 1 | 42 |
| CDC WM-2 | 1673 | 1492 | 347 | 23 | 51 | 99 | 1 | 42 |
| CDC WM-3 | 1963 | 1492 | 347 | 26 | 49 | 97 | 1 | 38 |
| **Black** | | | | | | | | |
| CDC Blackstrap | 1458 | 1300 | 203 | 29 | 57 | 102 | 1 | 31 |
| CDC Superjet | 1232 | 1099 | 180 | 38 | 58 | 101 | 1 | 40 |
| OAC Vortex | 613 | 547 | 171 | 19 | 62 | 103 | 1 | 47 |
| **Navy** | | | | | | | | |
| AAC Shock | 1181 | 1053 | 180 | 35 | 52 | 101 | 1 | 40 |
| Bolt | 1085 | 968 | 179 | 30 | 54 | 102 | 1 | 41 |
| Envoy | 838 | 748 | 175 | 39 | 50 | 97 | 1 | 34 |
| Portage | 1282 | 1144 | 170 | 36 | 51 | 99 | 1 | 36 |
| 16-6 | 631 | 562 | 159 | 30 | 62 | 103 | 1 | 44 |
| 3458-7 | 1604 | 1431 | 198 | 34 | 52 | 96 | 1 | 34 |
| **Yellow** | | | | | | | | |
| CDC Sol | 350 | 312 | 284 | 32 | 55 | 103 | 1 | 32 |
| CDC Sunshine | 1037 | 925 | 382 | 37 | 48 | 97 | 1 | 29 |
| **Cranberry** | | | | | | | | |
| OAC Candycane | 1385 | 1236 | 520 | 25 | 49 | 97 | 1 | 31 |
| OAC Racer | 628 | 560 | 476 | 23 | 49 | 91 | 1 | 29 |
| **Fleur de Junio** | | | | | | | | |
| CDC Ray | 1219 | 1087 | 267 | 30 | 56 | 103 | 1 | 32 |
| LSD (0.05) | 351 | 313 | 16.7 | 9.6 | 1.8 | | NS | 4.3 |
| CV (%) | 13.5 | 13.5 | 3.5 | 18.8 | 2.0 | 1.3 | | 7.0 |

# Herbicide Tolerant Soybean Regional Variety Trial

## Funding

Funded by the Irrigation Crop Diversification Corporation, partial funding the Saskatchewan Pulse Growers

## Project Lead

- Garry Hnatowich
- Co-investigators: S. Phelps & L. Friesen, Saskatchewan Pulse Growers

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Saskatchewan Pulse Growers

## Objectives

The objectives of this study are:

(1) To evaluate the potential of soybean varieties for production in the irrigated west-central region of Saskatchewan
(2) To assess the suitability of soybean to irrigation as opposed to dry land production
(3) To create a data base on soybean for *Crop Varieties for Irrigation*

## Research Plan

ICDC Rudy Agro Site (SW27-30-07-W3): Bradwell fine sandy loam to loam (NW quadrant)

Soybean varieties were received through the Saskatchewan Pulse Growers for evaluation under both dry land and irrigation production assessment. The trialing was divided into two separate trials based on maturity – a short season and a long season evaluation. The short season trial included 30 entries, the long season 39 entries. These trials were established at the ICDC Rudy Agro off-station location. Plot size was 1.2 m x 4 m. All plots received 25 kg $P_2O_5$/ha as 12-51-0 as a sideband application during the seeding operation. Granular inoculant (Cell-Tech) with the appropriate *Rhizobium* bacteria strain *(Bradyrhizobium japonicum)* specific for soybean was seed placed during the seeding operation at a rate of 11.2 kg/ha. Both trials were seeded on May 22, under both irrigated and dryland production. Weed control consisted of a pre-plant soil incorporated application of granular Edge (ethalfluralin) and a post-emergence application of Roundup Transorb (glyphosate) supplemented by some hand weeding. First killing frost occurred on the morning of October 2. Most entries had not reached maturity. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and the seed moisture content was <20%. Both trials were harvested on October 16. In-season precipitation from mid-May through September was 218 mm, in-season irrigation at Rudy Agro 274 mm.

## Results

No results were obtained for dryland trials as emergence of soybean was suboptimal due to extremely dry soil moisture conditions and these trials were abandoned.

### Short Season Herbicide Tolerant Variety Trial

Thirty Roundup Ready soybean varieties were evaluated. Plant emergence and seedling development was adequate. Seed yield, quality and agronomic data collected for the irrigated soybean are shown in Table 1. Yields were low with a median yield of all thirty entries of 2210 kg/ha (32.9 bu/ac). Yields of irrigated soybean ranged from a low of 1487 kg/ha (22.1 bu/ac) to a high of 3191 kg/ha (47.4 bu/ac). Oil content varied among entries with a 3.3% content difference between the lowest and highest % oil entries. Median protein content was 30.7%, very low. Protein concentration ranged from 27.8 – 33.1%. Test weight and seed weight also exhibited a wide variance between entries. Average maturity cannot be made as few varieties reached physiological maturity (95% of pods had turned from green to yellow or brown) prior to the occurrence of a fall frost. Less than half the soybean entries obtained maturity. Plant height varied among entries with the shortest at 46 cm to the tallest at 70 cm, median plant height of all varieties was 53 cm. Lodging resistance in all entries was very good, with none exhibiting lodging scores > 1.0.

The results from this trial is used to update the variety database at ICDC and provide information to producers on soybean performance under west central Saskatchewan growing conditions. Annual testing of soybean varieties is essential for this potential crop.

Table 1. Agronomics of 2019 Soybean Regional Variety Trial - Irrigated Short Season.

| # | Variety | Yield (kg/ha) | % Oil | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | Maturity (days) | Height (cm) | Lodge (1-5) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | TH 33003R2Y | 3191 | 17.0 | 30.1 | 76.1 | 133 | DNM | 70 | 1 |
| 2 | PV 15s0009 R2X | 2078 | 16.0 | 31.7 | 75.5 | 126 | DNM | 59 | 1 |
| 3 | PV 11s001 RR2 | 1899 | 17.1 | 31.7 | 76.6 | 142 | DNM | 54 | 1 |
| 4 | PVEXP19-S1 | 2228 | 18.1 | 28.3 | 76.3 | 103 | 117 | 57 | 1 |
| 5 | XB0009G18X | 2558 | 16.9 | 32.8 | 75.0 | 132 | 117 | 50 | 1 |
| 6 | XB002G18X | 1503 | 17.1 | 32.2 | 75.4 | 120 | DNM | 51 | 1 |
| 7 | B0030L1 | 2268 | 15.6 | 32.9 | 76.0 | 134 | DNM | 65 | 1 |
| 8 | DKB0005-44 | 1487 | 16.1 | 29.6 | 74.7 | 128 | DNM | 47 | 1 |
| 9 | DKB0009-89 | 2087 | 15.8 | 29.7 | 75.5 | 146 | DNM | 58 | 1 |
| 10 | P0007A73X | 1588 | 15.3 | 33.1 | 76.1 | 133 | 119 | 52 | 1 |
| 11 | P000A52R | 2329 | 17.4 | 30.5 | 75.7 | 141 | DNM | 59 | 1 |
| 12 | P001A48X | 2793 | 17.4 | 29.4 | 76.2 | 137 | DNM | 61 | 1 |
| 13 | Varuna R2 | 2455 | 16.4 | 30.6 | 75.8 | 134 | 117 | 48 | 1 |
| 14 | Amirani R2 | 1638 | 17.6 | 30.7 | 76.1 | 134 | 116 | 46 | 1 |
| 15 | NocomaR2 | 2313 | 16.1 | 31.3 | 76.5 | 124 | 122 | 51 | 1 |
| 16 | Karpo R2 | 3148 | 15.4 | 30.7 | 76.1 | 121 | DNM | 61 | 1 |
| 17 | Notus R2 | 2613 | 16.2 | 30.0 | 77.2 | 155 | 124 | 50 | 1 |
| 18 | NSC EXP0005 RR2X | 1842 | 17.3 | 29.9 | 76.4 | 129 | 122 | 50 | 1 |
| 19 | NSC Watson RR2Y | 1924 | 18.3 | 27.8 | 75.5 | 132 | 123 | 48 | 1 |
| 20 | NSC Leroy RR2Y | 1982 | 16.9 | 31.5 | 75.8 | 121 | 118 | 53 | 1 |
| 21 | PS 00078 XRN | 2012 | 15.7 | 31.3 | 74.7 | 124 | DNM | 49 | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 22 | Torro R2 | 2010 | 15.9 | 32.2 | 75.2 | 123 | DNM | 59 | 1 |
| 23 | Devo R2X | 2393 | 17.7 | 30.8 | 76.6 | 120 | DNM | 58 | 1 |
| 24 | CBZ617AB3-C0DNN | 2618 | 16.7 | 31.3 | 75.9 | 137 | 120 | 51 | 1 |
| 25 | Fisher R2X | 1587 | 15.9 | 31.6 | 73.6 | 132 | DNM | 48 | 1 |
| 26 | Barron R2X | 1549 | 17.7 | 31.3 | 75.8 | 116 | DNM | 50 | 1 |
| 27 | S0007-B7X | 1810 | 18.1 | 27.9 | 75.9 | 120 | 112 | 47 | 1 |
| 28 | S0009-M2 | 2280 | 18.6 | 29.8 | 75.5 | 128 | 122 | 51 | 1 |
| 29 | CP000719RX | 2346 | 18.6 | 29.8 | 76.1 | 89 | 119 | 57 | 1 |
| 30 | RX000918 | 1999 | 16.6 | 28.7 | 74.7 | 129 | DNM | 50 | 1 |
| LSD (0.05) | | 666 | 0.8 | 2.2 | 1.4 | 10.2 | | 7.6 | NS |
| CV (%) | | 19.0 | 3.0 | 4.5 | 1.1 | 4.9 | | 8.7 | 0 |

NS = not significant
DNM = did not mature (all plots from each replication required to have reached maturity or listed DNM)

**Long Season Herbicide Tolerant Variety Trial**
Two additional varieties, Rx Cedo and Mani R2X, were evaluated that are excluded from the data presented in Table 2. Rx Cedo is a variety entered by error and is extremely long maturing, Mani R2X had very poor emergence.

Thirty-nine Roundup Ready soybean varieties were evaluated. Plant emergence and seedling development was adequate. Seed yield, quality and agronomic data collected for the irrigated soybean are shown in Table 1. Yields were low with a median yield of all thirty-nine entries of 2284 kg/ha (34.0 bu/ac). Yields of irrigated soybean ranged from a low of 1336 kg/ha (19.9 bu/ac) to a high of 3229 kg/ha (48.0 bu/ac). Oil content varied among entries with a 4.1% content difference between the lowest and highest % oil entries. Median protein content was 30.9%, very low. Protein concentration ranged from 28.2 – 34.4%. Test weight and seed weight also exhibited a wide variance between entries. Average maturity cannot be made as few varieties reached physiological maturity (95% of pods had turned from green to yellow or brown) prior to the occurrence of a fall frost. Only seven soybean entries obtained maturity. Plant height varied among entries with the shortest at 48 cm to the tallest at 72 cm, median plant height of all varieties was 60 cm. Lodging resistance in all entries was very good, with none exhibiting lodging scores > 1.0.

The results from this trial is used to update the variety database at ICDC and provide information to producers on soybean performance under west central Saskatchewan growing conditions. Annual testing of soybean varieties is essential for this potential crop.

Table 2. Agronomics of 2019 Soybean Regional Variety Trial - Irrigated Long Season.

| # | Variety | Yield (kg/ha) | % Oil | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | Maturity (days) | Height (cm) | Lodge (1-5) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | TH 33003R2Y | 2746 | 16.9 | 30.4 | 75.5 | 139 | DNM | 68 | 1 |
| 2 | PV 16s004 R2X | 2425 | 15.9 | 29.5 | 73.5 | 139 | DNM | 68 | 1 |
| 3 | PV 10s005 RR2 | 2215 | 17.0 | 31.3 | 70.1 | 127 | DNM | 59 | 1 |
| 4 | B0030L1 | 2293 | 15.5 | 32.9 | 75.4 | 122 | DNM | 64 | 1 |
| 5 | B0040L1 | 1789 | 16.8 | 33.1 | 72.4 | 134 | DNM | 57 | 1 |
| 6 | DKB003-29 | 1861 | 16.5 | 29.6 | 74.6 | 154 | DNM | 57 | 1 |
| 7 | P002A63R | 3229 | 16.1 | 32.9 | 75.2 | 146 | DNM | 69 | 1 |
| 8 | P003A97X | 2169 | 16.9 | 31.8 | 72.9 | 145 | DNM | 54 | 1 |
| 9 | P005A27X | 2403 | 16.5 | 32.6 | 72.1 | 148 | DNM | 55 | 1 |
| 10 | P005A83X | 2428 | 16.8 | 29.7 | 73.6 | 150 | DNM | 64 | 1 |
| 11 | Akras R2 | 2586 | 14.9 | 30.1 | 76.9 | 130 | DNM | 53 | 1 |
| 12 | Sunna R2X | 3219 | 15.8 | 30.9 | 74.7 | 136 | DNM | 61 | 1 |
| 13 | CFS19.05 R2D | 2505 | 16.4 | 28.6 | 76.1 | 114 | DNM | 61 | 1 |
| 14 | Lono R2 | 2948 | 16.0 | 30.1 | 76.2 | 133 | DNM | 63 | 1 |
| 15 | LS TRI8XT | 1984 | 15.5 | 31.0 | 75.5 | 127 | 126 | 54 | 1 |
| 16 | LS 001XT | 2182 | 16.0 | 30.0 | 74.6 | 135 | DNM | 60 | 1 |
| 17 | NSC Redvers RR2X | 2372 | 16.3 | 29.4 | 74.9 | 120 | DNM | 62 | 1 |
| 18 | NSC Watson RR2Y | 2273 | 17.8 | 29.6 | 75.2 | 137 | 119 | 52 | 1 |
| 19 | NSC Newton RR2X | 2199 | 16.5 | 32.4 | 74.5 | 131 | DNM | 69 | 1 |
| 20 | NS EXP002E | 1506 | 15.1 | 32.1 | 75.4 | 98 | DNM | 63 | 1 |
| 21 | PS 0044 XRN | 2489 | 16.5 | 29.7 | 74.9 | 128 | DNM | 67 | 1 |
| 22 | Torro R2 | 2298 | 16.3 | 31.0 | 75.7 | 123 | DNM | 61 | 1 |
| 23 | Devo R2X | 2853 | 16.4 | 33.9 | 7.0 | 129 | 127 | 69 | 1 |
| 24 | Dinero R2X | 1880 | 16.1 | 31.1 | 76.1 | 138 | DNM | 52 | 1 |
| 25 | Mahony R2 | 2865 | 16.6 | 31.2 | 74.1 | 151 | DNM | 63 | 1 |
| 26 | McLeod R2 | 2914 | 15.1 | 34.4 | 72.9 | 166 | DNM | 72 | 1 |
| 27 | Prince R2X | 2426 | 15.8 | 29.5 | 75.2 | 134 | DNM | 58 | 1 |
| 28 | SC19-2400 | 2190 | 15.8 | 29.7 | 74.3 | 142 | DNM | 66 | 1 |
| 29 | S0007-B7X | 2150 | 17.6 | 28.2 | 74.9 | 130 | 120 | 52 | 1 |
| 30 | S0009-M2 | 2392 | 18.2 | 30.7 | 74.1 | 128 | 124 | 58 | 1 |
| 31 | S003-Z4X | 2718 | 16.9 | 28.7 | 75.2 | 127 | 127 | 54 | 1 |
| 32 | S007-Y4 | 2697 | 16.0 | 30.1 | 73.8 | 140 | DNM | 61 | 1 |
| 33 | S006-M4X | 2540 | 14.1 | 32.4 | 75.3 | 119 | DNM | 54 | 1 |
| 34 | TH89004 R2X | 2249 | 16.3 | 30.0 | 75.0 | 124 | DNM | 58 | 1 |
| 35 | TH87003 R2X | 2331 | 16.4 | 31.0 | 74.0 | 140 | DNM | 60 | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 36 | TH890009 R2X | 1336 | 17.6 | 32.2 | 74.4 | 138 | 126 | 49 | 1 |
| 37 | CP000719RX | 2048 | 18.2 | 31.1 | 75.0 | 100 | DNM | 60 | 1 |
| 38 | RX000918 | 2011 | 16.8 | 29.5 | 73.6 | 124 | DNM | 48 | 1 |
| 39 | RX00218 | 1868 | 17.2 | 32.0 | 75.4 | 117 | DNM | 57 | 1 |
| LSD (0.05) | | 595 | 0.7 | 2.1 | 1.1 | 13.5 | | 7.8 | NS |
| CV (%) | | 15.6 | 2.8 | 4.2 | 0.9 | 6.3 | | 8.1 | 0 |

NS = not significant
DNM = did not mature (all plots from each replication required to have reached maturity or listed DNM)

# Conventional Soybean Variety Trial

## Funding

Funded by the Irrigation Crop Diversification Corporation, partial funding provided by the Saskatchewan Pulse Growers

## Project Lead

- Garry Hnatowich
- Co-investigators: S. Phelps & L. Friesen, Saskatchewan Pulse Growers

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Saskatchewan Pulse Growers

## Objectives

The objective of this study is

- To evaluate the potential of conventional soybean varieties for production in the irrigated west-central region of Saskatchewan.

## Research Plan

Thirteen conventional soybean varieties were received through the Saskatchewan Pulse Growers for evaluation under irrigation and dryland production assessment. Plot size was 1.2 m x 4 m. All plots received 25 kg $P_2O_5$/ha as 12-51-0 as a sideband application during the seeding operation. Granular inoculant (Cell-Tech) with the appropriate *Rhizobium* bacteria strain *(Bradyrhizobium japonicum)* specific for soybean was seed placed during the seeding operation at a rate of 11.2 kg/ha. Both trials were seeded on May 22. Weed control consisted of a pre-plant soil incorporated application of granular Edge (ethalfluralin) and a post-emergence application of Viper ADV (imazamox & bentazon) supplemented by some hand weeding. First killing frost occurred on the morning of October 2. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and the seed moisture content was <20%. Both trials were harvested on October 16. In-season precipitation from mid-May through September was 218 mm, in-season irrigation at Rudy Agro 274 mm.

## Results

No results were obtained for dryland trials as emergence of soybean was suboptimal due to extremely dry soil moisture conditions and these trials were abandoned.

Results of the conventional soybean irrigated trial is shown in Table 1. Experimental variability was quite high within the trial and yield differences between varieties not statistically different. The lowest yielding variety was Maxus, the highest experimental entry X5902-1-S1-2. The median yield of all entries was 1539 (22.9 bu/ac). Median oil content was 16.5% and median protein at 33.7%. Test weight and seed weights were not statistically differing between entries. Only three entries reached physiological maturity. Lodging was not an issue in 2019.

The results from this trial is used to update the variety database at ICDC and provide information to producers on soybean performance under west central Saskatchewan growing conditions. Annual testing of soybean varieties is essential for this potential crop.
Table 1. Agronomics of 2019 Soybean Regional Variety Trial – Irrigated Conventional Varieties.

| # | Variety | Yield (kg/ha) | % Oil | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | Maturity (days) | Height (cm) | Lodge (1-5) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | TH 33003R2Y | 1504 | 16.2 | 35.6 | 76.8 | 156 | DNM | na | 1 |
| 2 | Bennie | 1754 | 16.0 | 33.9 | 76.6 | 148 | DNM | na | 1 |
| 3 | X5895-1-S1-25 | 1417 | 16.8 | 33.4 | 76.7 | 147 | DNM | na | 1 |
| 4 | X5895-1-S1-35 | 1627 | 16.0 | 34.3 | 75.3 | 168 | 129 | na | 1 |
| 5 | X5897-1-S1-6 | 1831 | 16.3 | 34.3 | 76.2 | 143 | 124 | na | 1 |
| 6 | X5902-1-S1-2 | 2047 | 16.7 | 33.4 | 75.8 | 141 | DNM | na | 1 |
| 7 | NSC Watson RR2Y | 1677 | 16.5 | 33.9 | 76.1 | 142 | DNM | na | 1 |
| 8 | Siberia | 1447 | 16.3 | 34.7 | 76.4 | 152 | DNM | na | 1 |
| 9 | Maxus | 1322 | 16.1 | 35.9 | 75.5 | 167 | DNM | na | 1 |
| 10 | PR110212Z046 | 1810 | 16.3 | 35.2 | 76.7 | 144 | DNM | na | 1 |
| 11 | PR110187Z017 | 1695 | 16.5 | 32.7 | 76.6 | 145 | DNM | na | 1 |
| 12 | AAC Edward | 1534 | 16.6 | 34.4 | 76.3 | 154 | DNM | na | 1 |
| 13 | OAC Prudence | 1815 | 16.3 | 33.2 | 76.5 | 152 | DNM | na | 1 |
| LSD (0.05) | | NS | NS | NS | NS | NS | 130 | | NS |
| CV (%) | | 17.5 | 10.7 | 6.2 | 1.2 | 9.2 | | | 0 |

NS = not significant
DNM = did not mature (all plots from each replication required to have reached maturity or listed
na = observation not collected

# National Industrial Hemp Variety Evaluation

## Funding
Funded by the Canadian Hemp Trade Association and ICDC

## Project Lead
- Garry Hnatowich
- Co-investigators:  Joel Peru

## Organizations
- Irrigation Crop Diversification Corporation (ICDC)
- Canadian Hemp Trade Association

## Objectives
The objective of this study is
- To evaluate the potential of Hemp varieties for production under irrigation.

## Research Plan
Ten hemp varieties were provided by the Canadian Hemp Trade Association for evaluation under irrigation production.  The trial was seeded at the Rudy Agro off-station site.  Plot size was 6 m x 1.5 m. Each variety was replicated four times.  All plots received 20 kg N/ha as 46-0-0 side-banded and 20 kg $P_2O_5$/ha as 12-51-0 as a sideband application during the seeding operation.  The trial was seeded on May 24.  Weed control consisted of a pre-plant soil incorporated application of granular Edge (ethalfluralin).

## Results
This trial was discontinued due to very poor emergence of the hemp and meaningful results could not be obtained.  Planting depth was a concern and deeper than desired.  However, seed depth was not the only issue.  Subsequent electric conductivity assessment by the Ministry of Agriculture staff revealed this portion of the Rudy Agro off-station site was high in salinity.

Hemp is considered a potentially profitable crop for irrigation and future hemp evaluation warranted.

# AGRONOMIC TRIALS

## Malt vs Feed Barley Management

### Funding

Funded by the Saskatchewan Barley Development Commission

### Project Lead

- Project Lead: Michael Hall (ECRF)
- ICDC Lead: Garry Hnatowich (ICDC)

### Organizations

- East Central Research Foundation (ECRF)
- Irrigation Crop Diversification Corporation (ICDC)
- Conservation Learning Centre (CLC)
- Indian Head Research Foundation (IHARF)
- Northeast Agriculture Research Foundation (NARF)
- Western Applied Research Corporation (WARC)
- Southeast Agricultural Research Foundation (SERF)
- Saskatchewan Barley Development Commission

### Objectives

The objectives of this project are:

(1) to demonstrate that newer malt varieties can provide comparable yield to the best feed varieties.

(2) to demonstrate the importance of adequate plant populations for yield and malt acceptance.

(3) to demonstrate the differences in N management for malt versus feed of barley.

### Research Plan

The trial was seeded on May 14. Plot size was 1.5 m x 8.0 m. The trial was established as a 3 order factorial replicated four times. The 1$^{st}$ factor compares barley varieties, the 2$^{nd}$ factor will contrast seeding rate and the 3$^{rd}$ factor nitrogen fertilizer rate. The two varieties were AAC Synergy, a high yielding 2-row malt variety that yields 18% more than AC Metcalfe under irrigation, and CDC Austenson a feed barley yielding 18-21% more than AC Metcalfe under irrigation production. Each variety was seeded to achieve a theoretical plant stand of 200 or 300 seeds/m$^2$, seeding rate was adjusted for each variety to account for % germination and thousand kernel weight (TKW). The nitrogen fertilizer rates were 80, 120 and 160 lb N/ac. The combination of factors resulted in 12 treatments total as shown in Table 1. All nitrogen fertilizer applications were side-banded at the time of seeding. Each treatment also received a seed placed application of 22 lb $P_2O_5$/ac at seeding. Weed control consisted of a post-emergence applications, at recommended rates, of Infinity (bromoxynil +pyrasulfotole) plus Assert 300SC (imazamethabenz) plus pH adjuster on June 13. An in-crop fungicide application of Caramba (metconazole), at recommended rates, was foliar applied July 23. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. The trial was harvested on September 24. Total in-season irrigation was 128.5 mm (5.1”), and natural precipitation 186.6 mm (7.3”).

Table 1. Experimental Treatments for Malt vs Feed Barley Management Study

| Trt | Variety | Seeding Rate - seed/m2 (~bu/ac) | N Rate – lb N/ac |
|---|---|---|---|
| 1 | AAC Synergy | 200 seeds/$m^2$ (2 bu/ac) | 80 lb N/ac |
| 2 | AAC Synergy | 200 seeds/$m^2$ (2 bu/ac) | 120 lb N/ac |
| 3 | AAC Synergy | 200 seeds/$m^2$ (2 bu/ac) | 160 lb N/ac |
| 4 | AAC Synergy | 300 seeds/$m^2$ (3 bu/ac) | 80 lb N/ac |
| 5 | AAC Synergy | 300 seeds/$m^2$ (3 bu/ac) | 120 lb N/ac |
| 6 | AAC Synergy | 300 seeds/$m^2$ (3 bu/ac) | 160 lb N/ac |
| 7 | CDC Austenson | 200 seeds/$m^2$ (2 bu/ac) | 80 lb N/ac |
| 8 | CDC Austenson | 200 seeds/$m^2$ (2 bu/ac) | 120 lb N/ac |
| 9 | CDC Austenson | 200 seeds/$m^2$ (2 bu/ac) | 160 lb N/ac |
| 10 | CDC Austenson | 300 seeds/$m^2$ (3 bu/ac) | 80 lb N/ac |
| 11 | CDC Austenson | 300 seeds/$m^2$ (3 bu/ac) | 120 lb N/ac |
| 12 | CDC Austenson | 300 seeds/$m^2$ (3 bu/ac) | 160 lb N/ac |

## Results

Seed quality and agronomic plant characteristics collected from each treatment by ICDC are tabulated in Table 2. Bulked seed from each CDC Bow treatment (seed bulked from all four reps and subsampled) was submitted to Intertek Laboratory for quality analyses and results are presented in Table 3. Factorial statistical analysis is given in Table 4.

Table 2. Seed Yield, Quality and Plant Agronomic Characteristics, 2019.

| Trt | Variety | Yield (kg/ha) | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Emergence (plants/m2) | Heading (days) | Maturity (days) | Height (cm) | Lodge (1-10) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AAC Synergy | 7263 | 12.3 | 64.6 | 53.6 | 172 | 72 | 94 | 82 | 1.5 |
| 2 | AAC Synergy | 8287 | 12.7 | 65.4 | 54.2 | 185 | 71 | 97 | 92 | 2.0 |
| 3 | AAC Synergy | 7875 | 12.4 | 64.8 | 53.7 | 165 | 72 | 96 | 86 | 2.0 |
| 4 | AAC Synergy | 8333 | 12.6 | 64.9 | 51.8 | 247 | 72 | 93 | 87 | 2.5 |
| 5 | AAC Synergy | 7816 | 12.7 | 64.8 | 51.3 | 246 | 70 | 97 | 87 | 5.8 |
| 6 | AAC Synergy | 7881 | 12.6 | 65.0 | 51.9 | 204 | 71 | 98 | 91 | 5.0 |
| 7 | CDC Austenson | 7259 | 12.3 | 68.0 | 53.6 | 173 | 71 | 96 | 81 | 1.5 |
| 8 | CDC Austenson | 7159 | 12.2 | 67.9 | 55.8 | 158 | 70 | 98 | 85 | 2.0 |
| 9 | CDC Austenson | 8119 | 13.0 | 67.8 | 54.9 | 143 | 69 | 100 | 94 | 2.5 |
| 10 | CDC Austenson | 7596 | 11.3 | 67.9 | 52.8 | 259 | 70 | 94 | 75 | 1.0 |
| 11 | CDC Austenson | 7852 | 12.1 | 68.1 | 53.2 | 219 | 69 | 97 | 90 | 1.8 |
| 12 | CDC Austenson | 7367 | 11.6 | 67.5 | 53.2 | 232 | 71 | 95 | 70 | 1.3 |
| LSD (0.05) | | NS | NS | 1.0 | 2.2 | 46 | 1.6 | NS | NS | 1.6 |
| CV (%) | | 11.4 | 6.7 | 1.1 | 2.7 | 15.9 | 1.6 | 3.2 | 12.0 | 45.3 |

NS = not significant

Table 3. Seed Quality Results from Intertek Laboratory on bulk AAC Synergy treatments.

| Trt | Variety | Protein (%) | Moisture (%) | Plump (%) | Thin (%) | P&B (%) | TFM (%) | TWT (kg/hl) | Germination (%) | Chitted % |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | AAC Synergy | 12.4 | 12.2 | 98.7 | 0.1 | 25.2 | 0.0 | 69 | 96 | 16.5 |
| 2 | AAC Synergy | 12.4 | 12.2 | 98.2 | 0.1 | 25.2 | 0.0 | 69 | 94 | 17.5 |
| 3 | AAC Synergy | 12.8 | 12.0 | 98.4 | 0.1 | 22.9 | 0.0 | 68 | 98 | 15.5 |
| 4 | AAC Synergy | 12.7 | 12.1 | 98.2 | 0.1 | 21.5 | 0.0 | 68 | 97 | 19.5 |
| 5 | AAC Synergy | 13.2 | 12.2 | 98.0 | 0.2 | 24.8 | 0.1 | 69 | 98 | 20.0 |
| 6 | AAC Synergy | 12.8 | 12.7 | 97.6 | 0.2 | 21.2 | 0.0 | 69 | 96 | 15.0 |

Results as tabulated in Tables 2 & 3 will not be discussed in-depth but will be referred to within the discussion. The data presented in Tables 2 & 3 is also for data preservation and reference for possible future projects. The discussion will be based upon results as tabulated and analysed in Table 4.

Statistically, the mean grain yield of the two barleys did not differ. Numerically, the malt variety AAC Synergy was 350 kg/ha (6.5 bu/ac) higher than that obtained for the feed barley variety CDC Austenson. These results express the advancements achieved in the plant breeding efforts of malt barley in western Canada. Numerical grain yield was greater with the 300 seeds/$m^2$ seeding rate, although not statistically significant. Similarly, increasing rates of fertilizer N numerically increased grain yield but these differences were not statistically significant. The lack of a statistical, or larger numerical differences, in grain yield from fertilizer N applications is surprizing. Soil testing indicated that the total available N in the 0 – 60cm (0-24”) depth was only 17 kg N/ha (data not shown). This is deemed low and a strong fertilizer N response might be expected. The reason for the lack of response is not understood. Some fields on the research station have been found to have significant soil-N quantities at depth (below 60cm), given the extremely dry spring it is possible that some of this possible N was brought up to shallower depths by wick action? Factor interactions (i.e. variety, seeding rate, N fertilizer rate) were not significant, indicating that varieties yield responded the same to seeding rates and N fertilizer rates. Grain yield for each treatment is illustrated in Figure 1 and mean values for variety, seeding rate and fertilizer N rates shown in Figure 2.

Grain protein did not differ between varieties, seeding rates nor between fertilizer N rates. Protein obtained for AAC Synergy was on the extreme high end of malt acceptance, maltsters desiring a protein level of between 11.0 – 12.5%. CDC Austenson produced higher test weight and seed weights compared to AAC Synergy. AAC Synergy had a higher degree of lodging than CDC Austenson. Seeding rate had little impact on other agronomic measurements obtained other than a slight increase in lodging with the higher seeding rate. Higher N fertilizer applications did extend days to maturity, plant height and result in higher lodging values.

Differences were slight in the seed quality parameters measured by Intertek Laboratory for the malt variety AAC Synergy (Table 3).

Once all participating sites have analysed their respective results a combined analysis of this trial will be conducted and a multi-site report prepared and posted to the Agri-ARM web site.


## Acknowledgements

Financial support was provided by the Saskatchewan Barley Development Commission. All funding is gratefully acknowledged.


Table 4. Factorial Analysis of Variety, Seeding Rate and N Fertilizer Application on Seed Quality & Agronomics of Barley, 2019.

| Treatment | Yield (kg/ha) | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | Emergence (plants/m2) | Heading (days) | Maturity (days) | Height (cm) | Lodge (1-10) |
|---|---|---|---|---|---|---|---|---|---|
| **Variety** | | | | | | | | | |
| AAC Synergy | 7909 | 12.5 | 64.9 | 52.7 | 203 | 71 | 96 | 87 | 3.1 |
| CDC Austenson | 7559 | 12.1 | 67.8 | 53.9 | 197 | 70 | 96 | 82 | 1.7 |
| LSD (0.05) | NS | NS | 0.4 | 0.9 | NS | 0.7 | NS | NS | 0.7 |
| **Seeding Rate (seeds/m²)** | | | | | | | | | |
| 200 seeds/m² | 7660 | 12.5 | 66.4 | 54.3 | 166 | 71 | 97 | 87 | 1.9 |
| 300 seeds/m² | 7807 | 12.1 | 66.4 | 52.4 | 234 | 71 | 96 | 83 | 2.9 |
| LSD (0.05) | NS | NS | NS | 0.9 | 18.7 | NS | NS | NS | 0.7 |
| **N Fertilizer Rate – lb N/ac** | | | | | | | | | |
| 80 lb N/ac | 7613 | 12.1 | 66.3 | 52.9 | 213 | 71.2 | 94 | 81 | 1.6 |
| 120 lb N/ac | 7778 | 12.4 | 66.5 | 53.6 | 202 | 70.0 | 97 | 88 | 2.7 |
| 160 lb N/ac | 7810 | 12.4 | 66.3 | 53.4 | 186 | 70.6 | 97 | 85 | 2.9 |
| LSD (0.05) | NS | NS | NS | NS | NS | 0.8 | 2.2 | NS | 0.9 |
| **Variety x Seed Rate Interaction** | | | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | S | NS | NS | S |
| **Variety x N Rate Interaction** | | | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Seed Rate x N Rate Interaction** | | | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| **Variety x Seed Rate x N Rate Interaction** | | | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS | S | NS |
| Trial CV (%) | 11.5 | 7.0 | 1.1 | 2.9 | 15.9 | 1.6 | 3.2 | 12.0 | 52.2 |

S = Significant
NS = not significant

Figure 1. Barley Grain Yield as illustrated by treatment means.

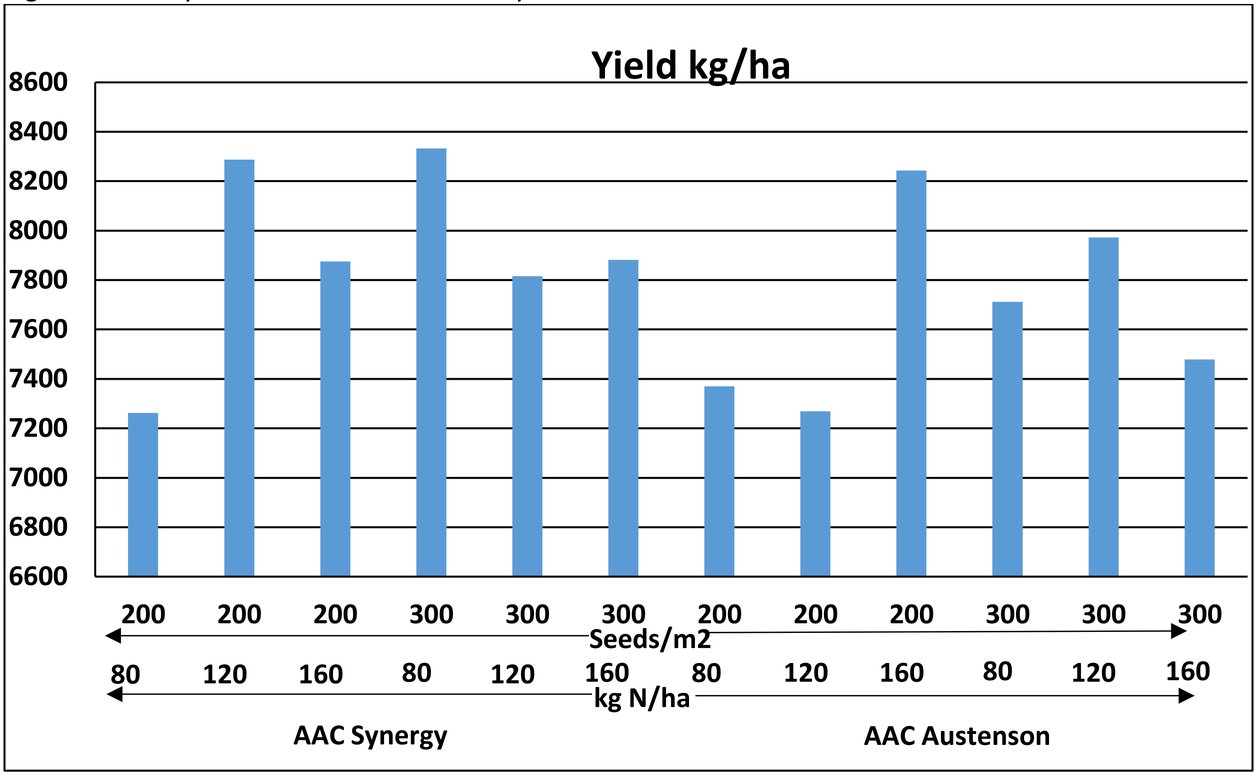
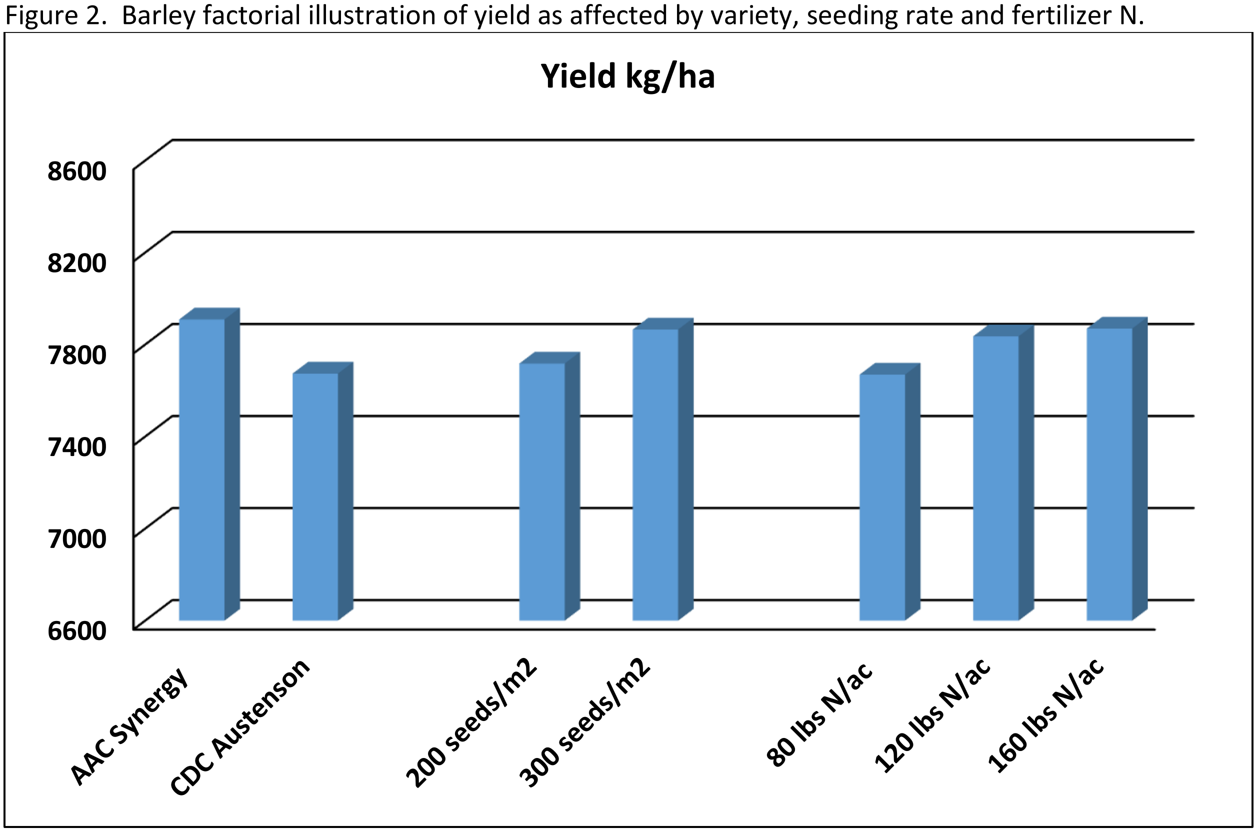



Figure 2. Barley factorial illustration of yield as affected by variety, seeding rate and fertilizer N.



# Increasing Wheat Protein with a Post Emergent Applications of UAN vs Dissolved Urea

## Funding

Funded by Saskatchewan Wheat Development Commission.

## Project Lead

- Project P.I: Mike Hall (ECRF)
- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- East Central Research Foundation (ECRF)
- South East Research Foundation (SERF)
- Indian Head Research Foundation (IHARF)
- Western Applied Research Corporation (WARC)
- Northern Applied Research Foundation (NARF)
- Wheatland Conservation Association (WCA)

## Objectives

Recently, producers have been disappointed by low levels of grain protein. When area wide protein levels are low, the premiums offered for high protein wheat tend to increase. This has left producers wondering what they could do to increase protein levels in the future. Post emergent application of N fertilizer is one of the only options to increase grain protein during the growing season. The results from this practice vary but it is more likely to be economical when yield potential is high and soil N is inadequate to maintain high protein levels. Applying nitrogen as a broadcast foliar spray is convenient for producers and some may feel that this is an efficient way to get N into the plant quickly late in the season; however, applying N in this manner comes with a higher risk of leaf burn and subsequent yield loss. To reduce this risk, producers can dilute the UAN 50:50 with water and try to avoid spraying during the heat of the day, but this may not always be realistic. Dribble banding reduces the risk of crop damage due to less fertilizer coming into direct contact with the leaves and may be a better alternative. However, UAN (28-0-0) produces large drops that do not disperse on the leaf surface because they have a high surface tension and tend to roll off. Dilution may reduce surface tension and actually increase leaf burn.

Foliar sprays with dissolved urea, instead of UAN may prove to be more beneficial. Amy Mangin with the University of Manitoba recently found foliar sprays of dissolved urea sprayed post-anthesis not only resulted in less leaf burn but also produced greater yields and higher grain protein compared to UAN. Dissolved urea is a standard product used for foliar applications in the UK and is considered to be safer on the crop then UAN. While both UAN and dissolved urea were applied at 30 lb N/ac in Mangin's study, the % N concentration of the solutions differed between the products. The UAN solution was 14%, whereas the urea solution was only 9%. This may have also contributed to the greater crop safety observed with dissolved urea. In this demonstration, dissolved urea and UAN will be compared at a 14% solution of N. Producers can create their own solution of urea on farm, however, care must be taken as dissolving urea is extremely endothermic and can freeze lines. Urea should be dissolved slowly into warm water and not into cold water pulled from a well for example. In addition, producers should only dissolve urea with less than 1% biuret. Biuret is a by-product that can cause severe leaf burning but it is normally removed from North American production.

The overall objective of this project is to demonstrate the potential of an additional 30 lb N/ac applied late season to increase either wheat yield or grain protein compared to applying all N at seeding. The impact of nitrogen source, crop staging and application method will be compared.

Specifically, the following concepts will be demonstrated:

(1) Dribble banded applications of UAN cause less leaf burn than broadcast foliar sprays post-anthesis.

(2) Dribble banding UAN at the earlier boot stage causes less leaf burn than when applied post-anthesis.

(3) Diluting dribble band applications of UAN is not necessary and may actually increase leaf burn.

(4) When broadcast foliar sprays are applied post-anthesis, dissolved urea will result in less leaf burn than UAN applied as a solution of 14% nitrogen.

(5) Strategies resulting in less leaf burn will produce a better yield/protein response (ie: more protein/ac).

## Research Plan

The trial was established on canola stubble at the Canada-Saskatchewan Irrigation Diversification Center (CSIDC) at Outlook on Field #4 (NE). A total of 9 treatments were arranged in a four replicate randomized complete block design (RCBD) trial. Treatments are shown in Table 1, all fertilizer applications are in Imperial measurements (ie: pounds, acres, gallons (US). UAN (28-0-0) treatments were cut in half with water to create 14-0-0. Likewise, 14-0-0 was created with urea by adding 1.66 kg of 46-0-0 to every US gallon of water. Urea with less than 1% biuret was used to ensure optimum crop safety. All post-emergent applications of nitrogen were sprayed to deliver an extra 30 lb N/ac to a base rate of 70 lb N/ac side-banded at seeding. These treatments were compared to base rates of 70 and 100 lb N/ac (treatments 1 and 2) to determine if there are any benefits from split applying N. Comparisons between treatments 3 to 9 will determine if N source, application method or timing influences crop safety and in turn the resulting yield and protein.

AAC Brandon CWRS wheat was seeded into canola stubble at a seeding rate of 300 seeds/m2 (adjusted for % germination and seed weight) on May 15. Individual plot size was 8m x 2.0m. Each plot consisted of 6 rows of AAC Brandon and 2 outside guard rows of winter wheat. Row spacing was 25 cm (10”). Each treatment received an application of 30 lb P2O5/ac as 11-52-0. Weed control consisted of a post-emergence tank mix application Simplicity (pyroxsulam) and Badge II (bromoxynil +MCPA ester) at recommended rates on June 10. A foliar fungicide application of Caramba (metconaole) at 50% anthesis of wheat heads occurred on July 15. Boot stage applications were conducted July 6, post-anthesis N applications July 19. Leaf burn assessment was conducted July 21. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. The trial was harvested on September 24.

Soil available nutrients are provided in Table 2.

Total in-season rainfall from May through September 15 was 204.4 mm. Total in-season irrigation at CSIDC was 128.5 mm.

Table 1. Experimental Treatments for Post Emergent Applications of UAN and Urea.

| Trt # | Seeding | Post Emergent Applications | | | | |
|---|---|---|---|---|---|---|
| | lb N/ac side-banded urea | N (lb/ac) | Product | %N | Method | Stage |
| 1 | 70 | na | na | na | na | na |
| 2 | 100 | na | na | na | na | na |
| 3 | 70 | 30 | UAN | 14 | dribble[1] | boot |
| 4 | 70 | 30 | UAN | 28 | dribble[2] | boot |
| 5 | 70 | 30 | UAN | 14 | dribble[1] | post-anthesis |
| 6 | 70 | 30 | UAN | 28 | dribble[2] | post-anthesis |
| 7 | 70 | 30 | Urea Sol'n | 14 | dribble[3] | post-anthesis |
| 8 | 70 | 30 | UAN | 14 | foliar[4] | post-anthesis |
| 9 | 70 | 30 | Urea Sol'n | 14 | foliar[5] | post-anthesis |

[1] Sprayed with dribble band nozzle at 20 ga/ac (10 ga/ac UAN + 10 ga/ac water = 14% N solution)

[2] Sprayed with dribble band nozzle at 10 ga/ac (undiluted UAN =28% N solution)

[3] Sprayed with dribble band nozzle at 20 ga/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)

[4] Sprayed with 02 flat fan nozzles at 20 ga/ac (10 ga/ac UAN + 10 ga/ac water = 14% N solution)

[5] Spray with 02 flat fan nozzles at 20 ga/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)

Table 2. Soil Testing Report, Agvise Labs, Sampled Spring 2019.

| Depth (cm) | $NO_3$-N (lb/ac) | P (ppm) | K (ppm) | $SO_4$-S (lb/ac) |
|---|---|---|---|---|
| 0 - 15 | 6 | 15 | 132 | 120+ |
| 15 - 30 | 3 | | | 120+ |
| 30 - 60 | 6 | | | |
| Organic Matter | 2.6% | | | |
| pH (0 - 15 cm) | 8.3 | | | |
| pH (15 - 60 cm) | 8.5 | | | |
| Soluble Salts (0 - 15 cm) | 0.94 mmho/cm | | | |
| Soluble Salts (15 - 60 cm) | 1.15 mmho/cm | | | |

## Results

Seed yield and seed quality parameters measured are shown in Table 3, agronomic observations are shown in Table 4.

Statistically yields did not differ between treatments. Soil test available N was low in the top 0-60 cm depth and a possible statistically significant response might be expected to increasing the side-band urea from 70 to 100 lb N/ac. It is suspected that this field may have had higher levels of available N, below 60 cm depth, that wheat was able to utilize. This would account for the lack of a significant response to the additional side-band 30 lb N/ac but also the high yields obtained to the modest (by irrigation standards) base fertilizer level of 70 lb N/ac. A numerical yield did occur with the side-band 100 lb N/ac application obtaining a yield gain of 696 kg/ha (10.4 bu/ac) above the yield obtained with side-band 70 lb N/ac application. No post-emergent application of an additional 30 lb N/ac achieved the yield obtained with the side-band 100 lb N/ac application. This is in-line with an abundance of prior research in western Canada that has illustrated maximum yields are obtained when fertilizer N is applied prior, or at, the time of seeding. In-season N applications rarely are able to optimize grain yield compared to having the N applied earlier. Wheat yield response to treatments applied is shown in Figure 1. Post-emergent applications did generally result in higher seed protein content than the base fertilizer level of 70 lb N/ac. The 20 gal/ac post-anthesis dribble band urea solution did not result in a protein increase? The reason for this is not readily apparent. The post-anthesis dribble band of UAN using 10 gal/ac resulted in a grain protein content significantly higher than all other treatments. Likewise, protein on a per acre bases was highest for this treatment. No conclusion can be made from these results based on this single year of investigation. Post-emergent applications had minor influences on test weight, seed weight, maturity, plant height or lodging. Flag leaf burn increased significantly for those treatments applied post-anthesis and UAN resulted in higher leaf burn than solution urea.

These results will be combined with trials conducted at other Agri-ARM locations and a final report prepared for the Saskatchewan Wheat Development Commission. The final report should be made available on either the Saskatchewan Wheat Development Commission or Agri-ARM websites.


## Acknowledgements

Financial support was provided by the Saskatchewan Wheat Development Commission. All funding is gratefully acknowledged.


Table 3. Influence of Initial N Application and In-Season N Applications on Yield and Seed Quality.

| **Seeding N** | **Post Emergent** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sideband N (lb/ac)** | **N Rate/Source (lb/ac)** | **%N** | **Method /Stage** | **Yield (kg/ha)** | **Yield (bu/ac)** | **Protein (%)** | **Protein (lb/ac)** | **Test weight (kg/hl)** | **1K Seed weight (gm)** |
| 70 | na | | | 7213 | 107.2 | 12.0 | 790 | 81.5 | 43.0 |
| 100 | na | | | 7909 | 117.6 | 12.2 | 867 | 82.0 | 42.9 |
| 70 | 30 UAN | 14 | dbl-boot[1] | 7489 | 111.3 | 12.3 | 832 | 82.2 | 44.7 |
| 70 | 30 UAN | 28 | dbl-boot[2] | 7795 | 115.9 | 12.7 | 893 | 82.4 | 44.8 |
| 70 | 30 UAN | 14 | dbl-post anthesis[1] | 7623 | 113.3 | 12.9 | 882 | 82.5 | 44.9 |
| 70 | 30 UAN | 28 | dbl-post anthesis[2] | 7722 | 114.8 | 13.8 | 961 | 82.8 | 45.3 |
| 70 | 30 Urea Sol'n | 14 | dbl-post anthesis[3] | 7199 | 107.0 | 12.0 | 776 | 81.8 | 43.0 |
| 70 | 30 UAN | 14 | Foliar-post anthesis[4] | 7182 | 106.7 | 12.5 | 807 | 82.4 | 44.3 |
| 70 | 30 Urea Sol'n | 14 | Foliar-post anthesis[5] | 7437 | 110.6 | 12.1 | 817 | 81.9 | 44.3 |
| | | | LSD (0.05) | NS | NS | 0.7 | 107 | 0.7 | 1.4 |
| | | | CV (%) | 6.7 | 6.7 | 4.0 | 8.6 | 0.6 | 2.2 |

1] Sprayed with dribble band nozzle at 20 ga/ac (10 ga/ac UAN + 10 ga/ac water = 14% N solution)
[2] Sprayed with dribble band nozzle at 10 ga/ac (undiluted UAN =28% N solution)
[3] Sprayed with dribble band nozzle at 20 ga/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)
[4] Sprayed with 02 flat fan nozzles at 20 ga/ac (10 ga/ac UAN + 10 ga/ac water = 14% N solution)
[5] Spray with 02 flat fan nozzles at 20 ga/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)
NS = not significant

Table 4. Influence of Initial N Application and In-Season N Applications on Yield and Seed Quality.

| **Seeding N** | **Post Emergent** | | | | **Plant** | | **% Flag** |
|---|---|---|---|---|---|---|---|
| **Sideband N (lb/ac)** | **N Rate/Source (lb/ac)** | **%N** | **Method /Stage** | **Days to Maturity** | **Height (cm)** | **Lodging (1-9)** | **Leaf Burn** |
| 70 | na | | | 97 | 81 | 1.0 | 0.5 |
| 100 | na | | | 100 | 86 | 1.3 | 0.4 |
| 70 | 30 UAN | 14 | dbl-boot[1] | 96 | 85 | 1.3 | 0.5 |
| 70 | 30 UAN | 28 | dbl-boot[2] | 97 | 86 | 1.0 | 0.8 |
| 70 | 30 UAN | 14 | dbl-post anthesis[1] | 98 | 86 | 1.0 | 1.8 |
| 70 | 30 UAN | 28 | dbl-post anthesis[2] | 101 | 84 | 1.0 | 10.5 |
| 70 | 30 Urea Sol'n | 14 | dbl-post anthesis[3] | 96 | 86 | 1.0 | 8.6 |
| 70 | 30 UAN | 14 | Foliar-post anthesis[4] | 99 | 84 | 1.0 | 26.8 |
| 70 | 30 Urea Sol'n | 14 | Foliar-post anthesis[5] | 96 | 84 | 1.3 | 12.1 |
| | | | LSD (0.05) | 2.4 | NS | NS | 3.3 |
| | | | CV (%) | 1.7 | 3.0 | 23.1 | 33.0 |

1] Sprayed with dribble band nozzle at 20 ga/ac (10 ga/ac UAN + 10 ga/ac water = 14% N solution)
[2] Sprayed with dribble band nozzle at 10 ga/ac (undiluted UAN =28% N solution)
[3] Sprayed with dribble band nozzle at 20 ga/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)
[4] Sprayed with 02 flat fan nozzles at 20 ga/ac (10 ga/ac UAN + 10 ga/ac water = 14% N solution)
[5] Spray with 02 flat fan nozzles at 20 ga/ac (1.66 Kg of urea dissolved in 1 US gallon of water = 14% N solution)
NS = not significant

Figure 1. Influence of Fertilizer Rate, Timing and Method of Application on Wheat Grain Yield.

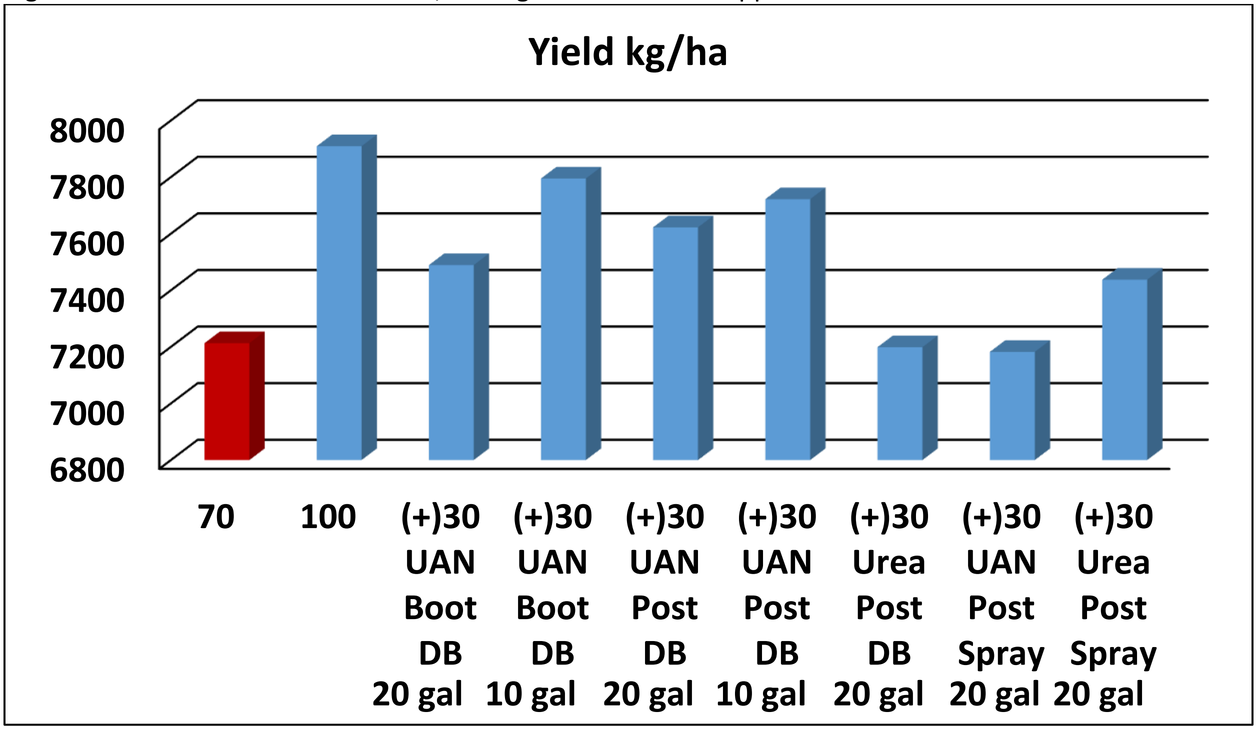
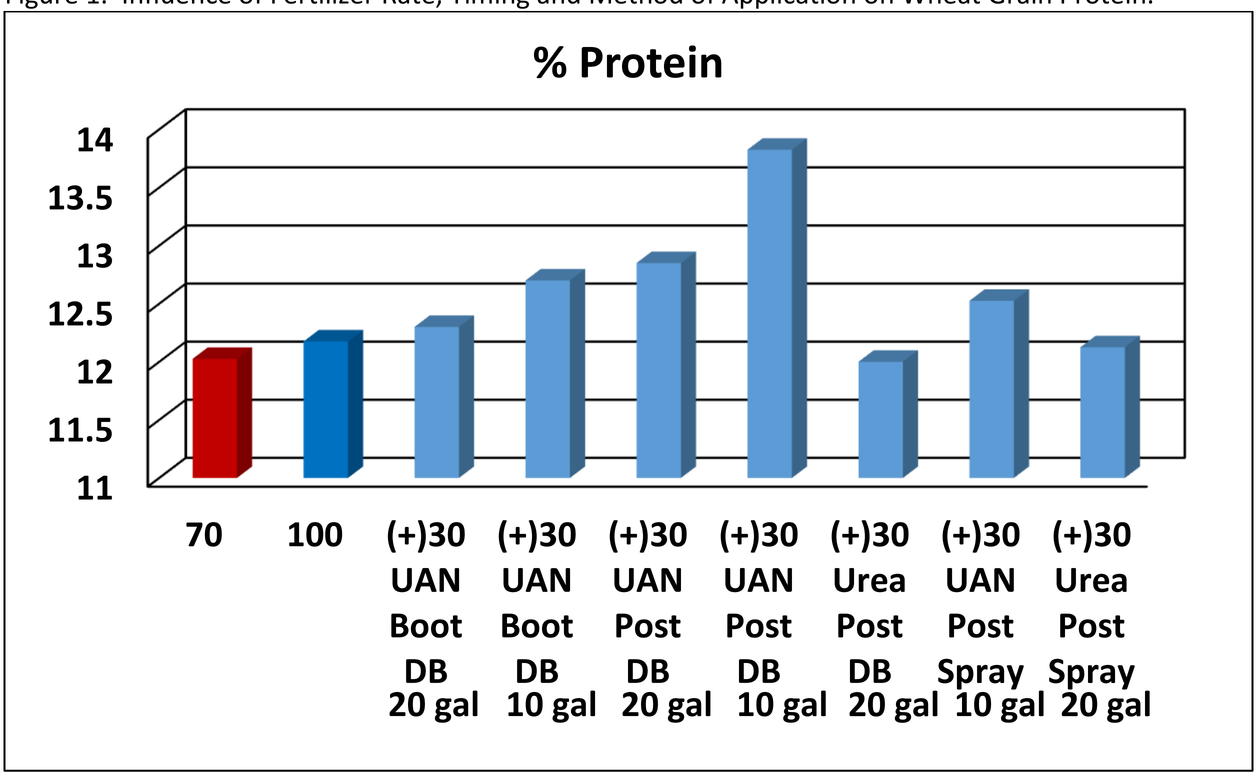



Figure 1. Influence of Fertilizer Rate, Timing and Method of Application on Wheat Grain Protein.



# Can Farm Saved Seed Wheat (*Triticum aestivum* L.) Perform As Well As Certified Seed in Saskatchewan?

## Funding

Funded by the Agriculture Development Fund (ADF)

## Project Lead


- Project P.I: Mike Hall (ECRF)
- ICDC Lead: Garry Hnatowich


## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- East Central Research Foundation (ECRF)
- South East Research Foundation (SERF)
- Indian Head Research Foundation (IHARF)
- Western Applied Research Corporation (WARC)
- Northern Applied Research Foundation (NARF)
- Wheatland Conservation Association (WCA)
- Conservation Learning Center (CLC)

## Objectives

While the yield loss from growing saved seed from hybrid crops such as canola has been well documented, little research has compared yields between certified and farmer-saved seed for wheat and particularly for oats in western Canada.

Certified seed is "true to type" which means it has retained all the genetic benefits developed by the breeder. To be "certified", seed must meet high standards of varietal purity, germination and freedom from impurities, which are determined by an officially recognized third-party agency. Producers of cereal grains are not required to use certified seed and may retain seed from their own farm for planting. This retained seed is commonly referred to as "farmer-saved seed" (FSS). Despite the guaranteed quality of certified seed, a phone survey of 800 producers in 2004 determined approximately 70 to 80% of cereal acres in western Canada were seeded with farmer-saved seed. The survey was conducted by Blacksheep Strategy Inc. The lowest use of certified seed occurred in Alberta and Saskatchewan with only 10 to 20% of wheat, barley, oat and pea acres being seeded with certified seed. Manitoba was closer to 40% due to greater disease concerns. The survey found that high income producers were more likely to use certified seed. Two thirds of producers who didn't frequently use certified seed cited "reduced costs" and "knowing what is in the seed" as reasons for preferring FSS. Another 25% felt the quality of FSS was close enough to certified. Many believe the quality of saved seed can be as good as certified seed. Producers will typically grow FSS for 2-3 years and then purchase certified seed to introduce better varieties to the farm.

Farmer-saved seed is typically a cheaper seed source than certified seed. A 13-year study in Alberta between 2003 and 2016 found the average price premium for certified wheat seed over FSS was $3.75/bu. There was only 1 year out of 13 in the study where the cost of producing FSS was more expensive than purchasing certified seed. Economically, the bottom line must take into consideration the relative yield performance of FSS and certified seed in the field. Assuming a modest 1.5 bu/ac yield benefit from using a new variety of certified seed, the report determined "purchasing certified seed was only economically beneficial two out of the thirteen years". The report made no justification for the magnitude of the proposed yield benefit.

Studies with winter wheat in central Oklahoma found FSS could often perform as well as certified seed. In 2003, they observed only 9 out of 19 lots of farmer-saved seed were inferior for grain production compared to the best certified seed source. In 2004, only 2 out of 27 farmer-saved samples were inferior and only 4 out of 17 were inferior in 2005. The authors concluded, "that if farmers use quality control measures similar to those required for certified seed, farmer-saved wheat seed can produce forage and grain yield comparable to that of certified seed".

There are a number of seed labs, which offer vigor testing and disease screenings to help producers determine the suitability of a seed lot for seeding. Vigor tests are superior to the standard germination test as they will give a better indication of crop emergence and vigor under adverse conditions. A fungal screen can determine the presence of a number of seed-borne pathogens that can also affect the vigor of a seed lot. Low vigor seed lots with high fungal screens can be retested with seed treatment to determine if vigor can be improved[7]. Seed treatment will often improve the vigor of a seed lot by 10%. However, the level of seed borne disease may be such that locating a better seed lot would be advisable.

The quality of farmer-saved seed lots are likely to be more variable in quality than certified seed which must meet exacting standards. The intent of this proposal is to randomly compare the vigor and yield potential of FFS relative to certified seed in Saskatchewan over the next 3 years. We want to sample seed lots as broad as possible. For that reason, the same varieties will not likely be grown at each location and year. Vigor tests and fungal screens for all seed lots will be conducted to help explain any differences observed in the field.

The objectives of this study are to;

(1) Compare the yield and vigor performance of various lots of farm-saved wheat seed relative to the same varieties of certified seed and
(2) To determine if a seed treatment can improve the yield and vigor of the farm-saved and certified seed.

## Research Plan

The trial was established in a 2 x 3 x 2 level factorial in a randomized complete block design with 4 replicates. The first factor will contrast treated and untreated seed. The seed treatment selected to treat all seed lots was Cruiser Vibrance Quatro (thiamethoxam + difenoconazole + sedaxane + metalaxyl-M + fludioxonil). The seed treatment was applied at a rate of 325 ml per 100 kg of seed. The second factor will contrast 3 different variety pairings. The same variety must be used within a variety pairing and varieties will differ between pairings. The 3rd factor contrasts certified versus farmer-saved seed. The following 12 treatments were established.

Table 1. Treatment list

| Trt # | Seed Treatment | Variety Pairing | Seed Type |
|---|---|---|---|
| 1 | Untreated | AC Brandon (A) | Certified |
| 2 | Untreated | AC Brandon (A) | Farm-Saved Seed |
| 3 | Untreated | AC Brandon (B) | Certified |
| 4 | Untreated | AC Brandon (B) | Farm-Saved Seed |
| 5 | Untreated | Cardale (C) | Certified |
| 6 | Untreated | Cardale (C) | Farm-Saved Seed |
| 7 | Treated | AC Brandon (A) | Certified |
| 8 | Treated | AC Brandon (A) | Farm-Saved Seed |
| 9 | Treated | AC Brandon (B) | Certified |
| 10 | Treated | AC Brandon (B) | Farm-Saved Seed |
| 11 | Treated | Cardale (C) | Certified |
| 12 | Treated | Cardale (C) | Farm-Saved Seed |

Farm-saved seed samples were provided by ICDC Board of Director members David Bagshaw, Jeff Ewen and Larry Lee, certified seed was obtained from Ardell Seeds and P3 Seeds. Samples of all seed obtained were submitted to Discovery Seed Labs for seed assessment, Results are provided in Table 2.

Table 2. Seed Analysis Results

| Variety | Seed Type | Germination % | Vigor % | Dead Seed % | Abnormal Seed % | Fusarium % | 1K Seed weight (gm) |
|---|---|---|---|---|---|---|---|
| AAC Brandon (A) | Certified | 99 | 93 | 1 | 0 | 1.0 | 39.96 |
| AAC Brandon (A) | Farm-Saved | 99 | 93 | 1 | 0 | 1.5 | 32.96 |
| AAC Brandon (B) | Certified | 99 | 91 | 1 | 0 | 0 | 34.80 |
| AAC Brandon (B) | Farm-Saved | 98 | 92 | 1 | 1 | 0 | 32.12 |
| Cardale (C) | Certified | 99 | 92 | 1 | 0 | 0.5 | 35.96 |
| Cardale (C) | Farm-Saved | 99 | 92 | 1 | 0 | 0 | 36.96 |

This trial was established on ICDC rented land adjacent to CSIDC. All varieties were seeded into canola stubble at a seeding rate of 300 viable seeds/m$^2$, adjusted for % vigor and seed weight, on May 14. Individual plot size was 10 m x 2.0 m. Each plot consisted of 6 rows of the treatment variety and 2 outside guard rows of winter wheat. Row spacing was 25 cm (10”). All treatments received 130 kg N/ha as 46-0-0 and 40 kg $P_2O_5$/ha as 11-52-0, all fertilizer was side-banded at seeding. Emergence counts to determine plant population within each plot was obtained by counting the number of emerging plants from two 0.5 m lengths of 2 rows from both the front and back of each plot. Plant vigor was rated on a subjective visual scale of 1 – 10, with 10 exhibiting the most vigor. Weed control consisted of a post-emergence tank mix application Simplicity (pyroxsulam) and Badge II (bromoxynil +MCPA ester) at recommended rates on June 10. A foliar fungicide application of Caramba (metconaole) at 50% anthesis of wheat heads occurred on July 15. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. The trial was harvested on September 24. Harvested plot size was 8.0 m x 1.5 m. All yield samples were cleaned to remove foreign material on stationary seed cleaners and cleaned seed yield and seed quality characteristics determined.

Total in-season rainfall from May through September 24 was 205.6 mm (8.1”). Total in-season irrigation applied was 233.7 mm (9.2”).

## Results

Seed yield and seed quality parameters measured are shown in Table 3, agronomic observations are shown in Table 4.

In general yields were lower than typical for irrigation production. Irrigation was interrupted on this trial for a portion of June and July due to an underground water line rupture requiring significant excavation to repair. This inability to irrigate reduced yield potential. Further stand establishment of all treatments was lower than typically obtained, which would influence final yield. However, results obtained are deemed valid.

Seed treatment had no influence on seed yield in 2019 (Table 3). This result is not surprizing given the early season environmental conditions of 2019. Compared to the 30 year average this trial received <24% of normal expected precipitation and the first irrigation application did not occur until May 29. Over-winter snow accumulation was sparse and seed bed moisture conditions at planting very suboptimal. Therefore, seedling disease, particularly root diseases, were not observed and no benefit obtained for seed treatment. There was also no statistical difference between varieties nor between certified versus farm-saved seed. No statistical interactions were obtained between any of the three factors evaluated; seed treatment, variety pairing or seed type. Results indicate that for the 2019 growing season farm-saved seed did not experience a yield drag in comparison to certified seed. Seed treatment had no effect on remaining seed quality parameters of seed protein, test weight or seed weight. Differences between variety pairing were found between variety pairings but differences can be explained agronomically. For example, the AC Brandon (B) pairing had the lowest % seed protein but the highest yield. The inverse relationship between yield/protein explains results obtained in seed quality.

Seed treatment did not benefit plant emergence but both variety pairing and seed type did. Within the variety pairing AC Brandon (B) combined emergence was significantly less than the other two pairings. Certified seed did significantly have a greater number of seeds emerge as compared to the farm-saved seed. It is premature, without further years of testing, to ascertain if this will be repeated or this year simply due to experimental variability. Seed treatment also had no effect on plant vigor, dayes to heading and maturity, plant height or plant lodging. Certified seed did reach heading and maturity and produced taller plants as compared to farm-saved seed.

This is the first year of a multi-site, multi-year trial. Results from ICDC will be combined with those of other participating sites for an interim report of results for 2019. This trial will be repeated in 2020.

## Acknowledgements

Financial support was provided by the Agricultural Development Fund (ADF) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. All funding is gratefully acknowledged. We would like to thank the following members of ICDC for donation of farm-saved seed used in this trial;

- Mr. David Bagshaw, Birsay SK.
- Mr. Jeff Ewen, Riverhurst SK.
- Mr. Larry Lee, Macrorie SK.


Table 3. Influence of Treatments on Yield and Seed Quality Parameters.

| Treatment | Yield (kg/ha) | Yield (bu/ac) | % Protein | Test weight (kg/hl) | Seed weight (g/1000) |
|---|---|---|---|---|---|
| **Seed Treatment** | | | | | |
| Untreated | 4286 | 63.7 | 12.7 | 79.3 | 39.8 |
| Treated | 4306 | 64.0 | 12.6 | 79.3 | 39.9 |
| LSD (0.05) | NS | NS | NS | NS | NS |
| CV (%) | 7.4 | 7.4 | 4.5 | 0.6 | 5.0 |
| **Variety Pairing** | | | | | |
| AC Brandon (A) | 4180 | 62.1 | 12.9 | 79.8 | 39.8 |
| AC Brandon (B) | 4430 | 65.8 | 12.3 | 80.1 | 42.9 |
| Cardale (C) | 4277 | 63.6 | 12.7 | 78.1 | 36.8 |
| LSD (0.05) | NS | NS | 0.4 | 0.4 | 1.4 |
| **Seed Type** | | | | | |
| Certified | 4344 | 64.6 | 12.9 | 79.3 | 39.0 |
| Farm-Saved Seed | 4247 | 63.1 | 12.4 | 79.3 | 40.7 |
| LSD (0.05) | NS | NS | 0.3 | NS | 1.2 |
| **Seed Treatment x Variety Pairing Interaction** | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS |
| **Seed Treatment x Seed Type Interaction** | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS |
| **Variety Pairing x Seed Type Interaction** | | | | | |
| LSD (0.05) | NS | NS | S | NS | S |
| **Seed Treatment x Variety Pairing x Seed Type Interaction** | | | | | |
| | NS | NS | NS | NS | NS |

S = significant

NS = not significant

Table 4. Influence of Treatments on Agronomic Observations.

| Treatment | Plant Emergence (plant/m²) | Plant Vigor (1 – 10) | Days to Heading | Days to Mature | Plant Height (cm) | Lodging Belgian Scale |
|---|---|---|---|---|---|---|
| **Seed Treatment** | | | | | | |
| Untreated | 212 | 9.1 | 62 | 101 | 90 | 0.2 |
| Treated | 196 | 9.3 | 62 | 102 | 89 | 0.2 |
| LSD (0.05) | NS | NS | NS | NS | NS | NS |
| CV (%) | 27 | 9.2 | 1.2 | 3.9 | 4.5 | 1 |
| **Variety Pairing** | | | | | | |
| AC Brandon (A) | 219 | 8.5 | 63 | 101 | 85 | 0.2 |
| AC Brandon (B) | 168 | 9.6 | 63 | 103 | 94 | 0.2 |
| Cardale (C) | 224 | 9.5 | 61 | 100 | 90 | 0.2 |
| LSD (0.05) | 40 | 0.6 | 0.5 | NS | 3.0 | NS |
| **Seed Type** | | | | | | |
| Certified | 225 | 9.3 | 61 | 99 | 93 | 0.2 |
| Farm-Saved Seed | 182 | 9.2 | 63 | 103 | 87 | 0.2 |
| LSD (0.05) | 32 | NS | 0.4 | 2.3 | 2.4 | NS |
| **Seed Treatment x Variety Pairing Interaction** | | | | | | |
| LSD (0.05) | NS | NS | S | NS | NS | NS |
| **Seed Treatment x Seed Type Interaction** | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS |
| **Variety Pairing x Seed Type Interaction** | | | | | | |
| LSD (0.05) | NS | NS | S | S | S | NS |
| **Seed Treatment x Variety Pairing x Seed Type Interaction** | | | | | | |
| | NS | NS | NS | NS | NS | NS |

S = significant
NS = not significant

# Effect of Increasing Seed Density on Weed Competition and Late Season Regrowth in Spring Wheat

## Funding

Funded by the Strategic Field Program (SFP)

## Project Lead


- Project P.I: Corey Jacob and Clark Brenzil, SK Ministry of Agriculture
- ICDC Lead: Garry Hnatowich


## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Indian Head Research Foundation (IHARF)
- Wheatland Conservation Association (WCA)
- Conservation Learning Center (CLC)
- South East Research Foundation (SERF)

## Objectives

Historically crop management would include the use of many cultural practices to allow a crop to compete against weeds such as tillage, fallow, varying of seeding date, high crop densities, narrow rows, integration of livestock and forages, and others. For over 50 years, herbicides have been a mainstay of weed management in Saskatchewan, with newer products becoming more effective and safer to the environment and human health. With the advent of such effective and safe herbicides, producers have placed less importance on many of the cultural weed management practices above, to reduce the negative environmental impacts of some (tillage), the economic costs of others (high seed densities and narrow rows) and/or the need to specialize as a way to improve efficiency.

To implement some of these practices, producers need to make decisions when making equipment purchases. These purchases often take into account engineering benefits of wider row spacing and the impact on acres per hour, fuel use, and residue clearance over the benefits to the agronomic conditions within the field as well as a minor benefit in foliar disease management. Unfortunately, resistance to herbicides is increasing at a concerning pace with 60% of wild oat populations in the province exhibiting resistance to Group 1 herbicides and 32% of wild oat populations exhibiting resistance to Group 2 herbicides; nearly double what it was a decade ago. These two of the most widely used Groups of herbicides, placing heavy selection pressure for the development of resistance to them. Another consequence of low density seeding is that cereal crops tend to have more secondary growth in the form of late tillers and weeds emerging after in crop herbicide treatment, that need to be terminated using harvest aid herbicides. These herbicides are not only an addition cost to producers but there is increasing public scrutiny on their use just prior to harvest. Young agronomists and producers have come into the industry with a largely herbicide only mindset, and little experience with agronomic practices as way to manage weeds. Much of the work on competition was done several decades ago and in the new era of rapid communication, new information is held in more regard than old. It is important to revisit the use of seeding rates and row spacing with new varieties so that agronomists, including ministry staff, are comfortable in recommending these

The objective of this study is to collect current data on seeding rates and row spacing in spring wheat to demonstrate the impact that this can have on weed management and as well as yield and quality parameters.

## Research Plan

A field demonstration with spring wheat was established in the fall of 2018 on ICDC land rented from the town of Outlook and adjacent to the federal CSIDC Research Station. The trial was established in a factorial randomized complete block design, each treatment was replicated 4 times. The first factor was row spacing – either 25 cm or 50 cm (10" or 20"). The second factor was planting rates where viable seeds were planted at 203, 270, 405 and 540 seeds/m$^2$ (rates correspond to 82, 109, 163 and 218 kg/ha or 1.2, 1.6, 2.4 and 3.2 bu/ac). Seeding rates were adjusted to account for seed germination and seed weight. The variety of CWRS used was AAC Brandon. Prior to seeding the entire plot area received a pre-seed burn-off of glyphosate to control perrennial weeds, winter annuals or variable natural populations. Individual seeded plot size was 10 m in length and 1.5 m wide. Prior to seeding wheat; tame oats and mustard were seeded across all plots purpendicular to the direction of wheat seeding. Tame oats and mustard were used to simulate weed presence (further refered to as "weeds") and each was seeded at 20 viable seeds/m$^2$, adjusted for % germination and seed weights. All three crops were seeded on May 16. All treatments received 130 kg N/ha as 46-0-0 and 40 kg $P_2O_5$/ha as 11-52-0, all fertilizer was side-banded at seeding. No in-season herbicide or fungicides were applied throughout the remainder of the study. Wheat and "weed" biomass was obtained 6 weeks after planting on June 6. All plants from two 0.5 m$^2$ areas of each treatment plot (front and back) were removed and separated into their respective groups, fresh weights recorded and plants dried in forced-air heated dryers. Wheat tiller number was determined by collecting 10 random plants from inner rows of each plot after heading. Average length of each plant head was recorded. Head density was determined by counting the number of heads in two 1.0 m lengths of row from each treatment plot (front and back) and heads per m$^2$ calculated. Plots were harvested September 24, plot harvest area was 8 m in length by 1.5 m wide. Wheat and weeds were attempted to be harvested. Most of the oat "weed" portion was captured, mustard was expelled from the back of the small plot combine. Grain samples were dried and yields adjusted to 14.5% moisture. Wheat and oat were separated by a laboratory seed cleaner at the University of Saskatchewan.

Total in-season rainfall from May through September 24 was 205.6 mm (8.1"). Total in-season irrigation applied was 233.7 mm (9.2").

## Results

Wheat seed yield and seed quality parameters and determined agronomic observations are shown in Table 1 & Table 2.

This project was a demonstration to show that controllable factors such as seeder row spacing and seeding rate can influence presence, or absence, of weed populations. Weed growth in this study was appallingly high due to irrigation and the lack of in-season herbicide use. Wheat yields were severely reduced due to weed competition and would be classified as a crop loss. Wheat yield was reduced as row spacing so was the yield of oat "weeds" harvested. Higher wheat seeding rates increased yield as seeding rate increased. However, oat "weed" yield did not significantly differ due to wheat seeding rate. Wheat seed quality parameters were not generally influenced by either row spacing or seeding rate. Wheat early season biomass was significantly reduced as row spacing increased, conversely, weed biomass was significantly higher as row spacing increased. As would be expected, wheat biomass increased as seeding rate increased which resulted in lower oat "weed" biomass. Wheat tiller development and tiller length were not influenced by either row spacing or seeding rate. Spike numbers increased as row spacing increased and seeding rate increased.

Results from this ICDC trial will be combined with those of other participating sites for an interim report of results for 2019. This trial will be repeated at a number of dryland Argi-ARM sites in 2020 but ICDC will not be participating.

## Acknowledgements

Financial support was provided by the Strategic Field Program (SFP). All funding is gratefully acknowledged.

Table 1. Wheat Yield, Protein, Test Weight and TKW; Oat "Weed" Yield and % Wheat in each plot.

| Row Spacing/Plant Seed Rate | Wheat | | | | | Oat "Weed" Yield (kg/ha) | % Wheat in Total Grain Harvest |
|---|---|---|---|---|---|---|---|
| | Yield (kg/ha) | Yield (bu/ac) | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | | |
| **Row Spacing** | | | | | | | |
| 25 cm | 1254 | 18.6 | 12.5 | 366 | 38.0 | 1517 | 45.2 |
| 50 cm | 1019 | 15.1 | 12.6 | 330 | 38.8 | 1332 | 43.8 |
| LSD (0.05) | 169 | 2.5 | NS | NS | NS | NS | NS |
| CV (%) | 20.2 | 20.2 | 2.5 | 16.4 | 7.2 | 20.1 | 13.1 |
| **Seed Rate** | | | | | | | |
| 203 seed/m$^2$ | 923 | 13.7 | 12.5 | 343 | 40.8 | 1355 | 40.4 |
| 270 seed/m$^2$ | 1084 | 16.1 | 12.7 | 357 | 38.7 | 1369 | 45.4 |
| 405 seed/m$^2$ | 1257 | 18.7 | 12.5 | 367 | 37.1 | 1644 | 43.0 |
| 540 seed/m$^2$ | 1283 | 19.1 | 12.5 | 325 | 37.2 | 1329 | 49.2 |
| LSD (0.05) | 238 | 3.5 | NS | NS | 2.9 | NS | 6.1 |
| **Row Spacing x Seed Rate Interaction** | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |

NS = not significant

Table 2. Wheat Yield, Protein, Test Weight and TKW; Oat "Weed" Yield and % Wheat in each plot.

| Row Spacing/Plant Seed Rate | Wheat Biomass $gm/m^2$ | Weed Biomass $gm/m^2$ | Wheat Tillers | Wheat Tiller Length (cm) | Wheats Spikes ($m^2$) |
|---|---|---|---|---|---|
| **Row Spacing** | | | | | |
| 25 cm | 126 | 45 | 1.8 | 7.1 | 347 |
| 50 cm | 93 | 67 | 1.6 | 7.0 | 551 |
| LSD (0.05) | 10.1 | 8.9 | NS | NS | 56 |
| CV (%) | 12.6 | 21.7 | 24.7 | 6.6 | 17.0 |
| **Seed Rate** | | | | | |
| 203 seed/$m^2$ | 85 | 66 | 1.8 | 7.4 | 347 |
| 270 seed/$m^2$ | 96 | 61 | 1.9 | 7.1 | 376 |
| 405 seed/$m^2$ | 120 | 47 | 1.6 | 6.8 | 510 |
| 540 seed/$m^2$ | 137 | 50 | 1.4 | 6.9 | 564 |
| LSD (0.05) | 14.3 | 12.6 | NS | NS | 79 |
| **Row Spacing x Seed Rate Interaction** | | | | | |
| | NS | NS | NS | NS | NS |

NS = not significant

# Demonstrating 4R Nitrogen Management Principals for Spring Wheat

## Funding

Funded by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) & Fertilizer Canada.

## Project Lead

- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)

## Objectives

Developing Best Management Practices (BMPs) for nutrient applications has long been focussed on the 4R principles which refer to using the: 1) right source, 2) right rate, 3) right time and 4) right placement. These factors are not necessarily independent of each other. For example, depending on the source, application times or placement options that would normally be considered high risk can become viable. The objective of this trial is to demonstrate the feasibility of various nitrogen (N) management strategies and overall N rate response using spring wheat as a test crop. Nitrogen rates included in the demonstration range from nil 1.75x a conservative soil test recommendation. The management strategies vary with regard to timing (fall versus spring), placement (surface broadcast versus in-soil band), and formulation (untreated urea, ESN®, Agrotain® treated urea, and SuperU®). The demonstration encompasses all four considerations (source, rate, time and placement) for 4R nutrient management.

## Research Plan

A field demonstration with spring wheat was established in the fall of 2018 on ICDC land rented from the town of Outlook and adjacent to the federal CSIDC Research Station. The trial was established in a randomized complete block design, each treatment was replicated 4 times. Seeded plot size was 8 m in length and 1.5 m wide. The demonstration consisted of two separate components but was managed as a single entity for both efficiency and to aid in the interpretation of results in the nitrogen (N) source/timing/placement component. To assist in understanding of the trial design, the field plot arrangement is shown in Figure 1. In the first trial component, N rates, urea was side-banded at seeding at 7 rates; 0x, 0.5x, 0.75x, 1x, 1.25x, 1.5x and 1.75x of the soil test adjusted rate of 150 kg/ha total N (residual $NO_3$-N + fertilizer N). The second component focused on N management options and consisted of a factorial combination of three timing/placement options (fall broadcast, side-band, and spring surface broadcast) and four N sources (untreated urea, ESN®, Agrotain® treated urea, and SuperU®). One treatment (1x side-banded untreated urea) will be shared between the two components. The treatment list of both study components is provided in Table 1. Fall broadcast applications were applied on October 24, 2018. Spring fertilizer applications and seeding all occurred on May 13, 2019. The total N rate used will be equivalent to the 1x rate (150 kg N/ha) in the first component (adjusted for residual $NO_3$-N and N provided by MAP (11-52-0). MAP was seed placed at a rate of 30 kg $P_2O_5$/ha. Plots were direct seeded with AAC Brandon, CWRS spring wheat, into canola stubble. Seed was planted at 300 viable seeds/m$^2$, after adjusting for % germination and seed size. Plant populations were obtained by counting seedlings from within 1/2 m$^2$ portions of both the front and back of each treatment plot. Lodging was evaluated at the day of maturity of each plot using the Belgian lodging scale (area (1-10) x intensity (1-5) x 0.2).

Weed control consisted of a post-emergence tank mix application Simplicity (pyroxsulam) and Badge II (bromoxynil +MCPA ester) at recommended rates on June 10, 2019. A foliar fungicide application of Caramba (metconaole) at 50% anthesis of wheat heads occurred on July 15, 2019. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. The trial was harvested on September 6, 2019. Plot samples were cleaned and yields adjusted to 14.5% moisture.

Soil test analyses results for the trial area taken in the fall of 2018 are shown in Table 2. Soil available N and P were both extremely low.

Seasonal and 30 year historic precipitation and growing degree days at CSIDC are outlined in Tables 3 & 4. Seasonal precipitation was significantly lower in May, higher in June, and lower throughout the growing period compared to 30 year averages, seasonal precipitation on the trials by seasons end was significantly less than long term averages. Seasonal Cumulative Growing Degree Days were cooler through the growing period, particularly at the start in May and at the end of the season. In-season precipitation was 186 mm (7.3”), total irrigation applied was 234 mm (9.2”).

Figure 1. Generalized plot layout for proposed ADOPT-Fertilizer Canada 4R N Management Demonstration.

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 212 | 213 | 214 | 215 | 216 | 217 | 218 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 |

| | | |
|---|---|---|
| Random Trial #1 Treatments (side-banded untreated urea rates) | Trial #1 & 2 Shared Treatment (1x side-banded untreated urea) | Random Trial # 2 Treatments (N timing/placement/form options) |

Table 1. 4R Nitrogen Management Principals in Spring Wheat Treatment List, 2019.

| **Trial #1: Right Rate*** | **Trial #2: Right Time, Right Place, Right Form** |
|---|---|
| 1) 0X Urea (no added N fertilizer) ** | 1) Fall Broadcast – untreated Urea |
| 2) 0.5X Urea (75 kg total N/ha) | 2) Fall Broadcast - ESN |
| 3) 0.75X Urea (112.5 kg total N/ha) | 3) Fall Broadcast - Agrotain |
| 4) 1.0X Urea (150 kg total N/ha) | 4) Fall Broadcast – SuperU |
| 5) 1.25X Urea (187.5 kg total N/ha) | 5) Side Banded – untreated Urea |
| 6) 1.50X Urea (225 kg total N/ha) | 6) Side Banded - ESN |
| 7) 1.75X Urea (262.5 kg total N/ha) | 7) Side Banded - Agrotain |
| | 8) Side Banded - SuperU |
| 1.0X rate (soil + fertilizer =150 kg N/ha) in all trts | 9) Spring Broadcast – untreated Urea |
| All treatments received 6 kg N/ha from 11-52-0 | 10) Spring Broadcast – ESN |
| | 11) Spring Broadcast – Agrotain |
| | 12) Spring Broadcast - SuperU |

Table 2. Soil Testing Report, Agvise Labs, Sampled fall 2018

| **Depth (cm)** | **$NO_3$-N (lb/ac)** | **P (ppm)** | **K (ppm)** | **$SO_4$-S (lb/ac)** |
|---|---|---|---|---|
| 0 - 15 | 2 | 2 | 196 | 30 |
| 15 - 30 | 1 | | | 44 |
| 30 - 60 | 2 | | | |
| Organic Matter | 2.2% | | | |
| pH (0 - 15 cm) | 7.9 | | | |
| pH (15 - 60 cm) | 8.2 | | | |
| Soluble Salts (0 - 15 cm) | 0.33 mmho/cm | | | |
| Soluble Salts (15 - 60 cm) | 0.31 mmho/cm | | | |

Table 3. 2019 Growing Season Precipitation vs Long-Term Average, CSIDC.

| | **Year** | | |
|---|---|---|---|
| **Month** | **2019 mm (inches)** | **30 Year Average mm (inches)** | **% of Long-Term** |
| May | 13.2 (0.5) | 46.0 (1.8) | 29 |
| June | 90.2 (3.6) | 67.0 (2.6) | 135 |
| July | 43.8 (1.7) | 57.0 (2.2) | 77 |
| August | 39.2 (1.5) | 46.0 (1.8) | 85 |
| **Total** | 186.4 (7.3) | 216.0 (8.4) | **86** |

Table 4. Cumulative Growing Degree Days (Base°C) vs Long-Term Average, CSIDC.

| | Year | | |
|---|---|---|---|
| **Month** | **2019** | **30 Year Average** | **% of Long-Term** |
| May | 211 | 224 | 94 |
| June | 691 | 708 | 98 |
| July | 1249 | 1290 | 97 |
| August | 1750 | 1844 | 94 |

## Results

General Comments

Irrigated yields obtained were low, this can be attributed in large part, to a breakdown of the linear irrigation system providing water to this trial. The system had an underground rupture that required major excavation, and irrigation was not available through much of June and early July. This was a critical period for wheat development, plant stress became apparent and undoubtedly yields were impacted. A second possible contributing factor may have been the very low levels of available soil P. While 30 kg $P_2O_5$/ha was applied with the seed of all treatments, it is possible that this nutrient became limiting and consequently limited yield. Plants did not exhibit any visual indications of P deficiency, but insufficiency of P supply is possible. A surface broadcast application prior, or after, seeding was considered but deemed unlikely to be effective without deep incorporation. This would have disrupted fall fertilizer applications. Side band applications were not possible due to equipment limitations. A third contributing factor is the low plant population established. Seedbed conditions were poor at the time of seeding and lower than normal plant population established in the trial. All factors collectively, may have resulted in the lower than expected yields obtained, the median of all treatments being 4664 kg/ha (70.5 bu/ac). The yields obtained are approximately 30-40% below what might be reasonably expected. These yields are more in align with dryland wheat yields in a wet growing season and results presented might be viewed as such. However, while the magnitude of treatment differences might have been reduced, the differences that did occur are deemed valid.

Fertilizer N Rates

The influence of increasing rates of side-band N on yield and seed/plant characteristics measured are shown in Table 5.

Soil testing procedures revealed very low levels of available soil N at this site and recommended fertilizer was 161 kg N/ha (144 lb N/ha), we moved this target recommendation downwards, to 150 kg N/ha, in order to achieve the 1.75x rate (1.75x rate of 161 kg N/ha = 282 kg N/ha which was beyond equipment metering capability). That stated, data suggests that the 1x rate of 150 kg N/ha was optimal for wheat grain yield achieved. Yields statistically increased with each fertilizer rate increase up to the 1.0x rate applied, no additional yield benefit occurred with rates in excess of the 1.0x rate. Yield response to fertilizer N additions is illustrated in Figure 1. Results obtained support the use of soil testing in order to determine levels of N application near optimal, thereby preventing under fertilization and the associated yield loss, nor over fertilization and its negative impact on the environment. Seed protein content did continue to respond in a statistically significant manner until the application of the 1.25x rate and then leveled. Further support of soil testing procedures is evident in that only at the 1.0x rate of N did protein contents achieve a desired marketable level of 13.5% or higher. Seed protein response to fertilizer N additions is illustrated in Figure 2.

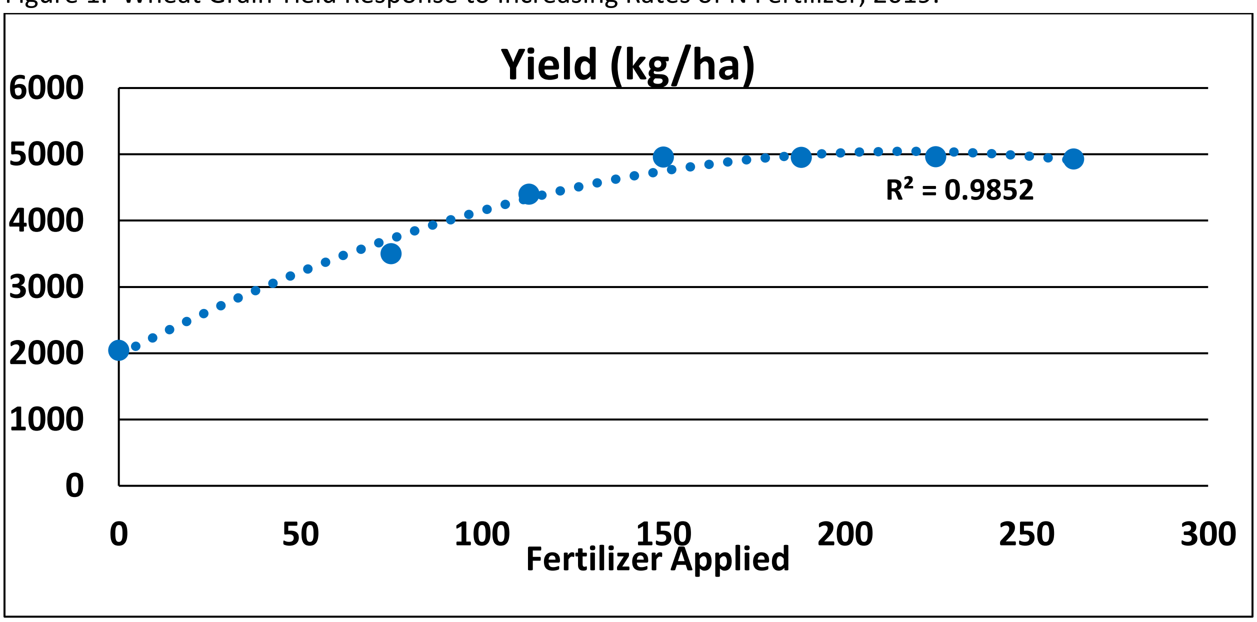
Test weight was not influenced by N rate additions and seed weights were variable but tended to increase with higher rates of N applied. Side-banded urea applications did not have any negative effect on plant population in this trial, even at the very high rates of N applied, indicating sufficient seed-fertilizer separation occurred. Plant populations were poor due to an extremely dry seed bed at seeding. Days to maturity generally were delayed as fertilizer N rates increased, however, the optimal rate of 1x only increased maturity compared to the unfertilized control by 2 days. This is an acceptable trade off in terms of the yield gains and not likely a concern in harvest management. Plant height was increased with the first increment of N fertilizer applied, with no further height gains with additional N rates. Lodging was not an issue in 2019 and N rates did not influence it.

Table 5. Influence of N Fertilizer Rate on Spring Wheat Yield, 2019.

| N Rate* | Yield (kg/ha) | Yield (bu/ac) | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | Plants $m^2$ | Maturity (days) | Height (cm) | Belgium Lodging Scale |
|---|---|---|---|---|---|---|---|---|---|
| 0X | 2038 | 30.8 | 10.8 | 80.4 | 38.1 | 122 | 90 | 66 | 0.2 |
| 0.5X | 3499 | 52.9 | 11.4 | 80.8 | 39.0 | 120 | 92 | 84 | 0.2 |
| 0.75X | 4397 | 66.5 | 12.6 | 81.1 | 39.9 | 130 | 93 | 85 | 0.2 |
| 1.0X | 4955 | 74.9 | 13.8 | 80.9 | 39.2 | 120 | 92 | 83 | 0.2 |
| 1.25X | 4949 | 74.8 | 14.9 | 81.2 | 41.6 | 116 | 97 | 82 | 0.2 |
| 1.5X | 4960 | 74.9 | 14.9 | 80.9 | 41.2 | 92 | 97 | 84 | 0.2 |
| 1.75X | 4928 | 74.5 | 14.7 | 80.9 | 41.2 | 116 | 98 | 85 | 0.2 |
| LSD (0.05) | 520 | 7.9 | 0.7 | NS | 1.7 | NS | 1.1 | 4.5 | NS |
| CV (%) | 8.2 | 8.2 | 3.8 | 0.5 | 2.8 | 14.0 | 0.8 | 3.7 | 0 |

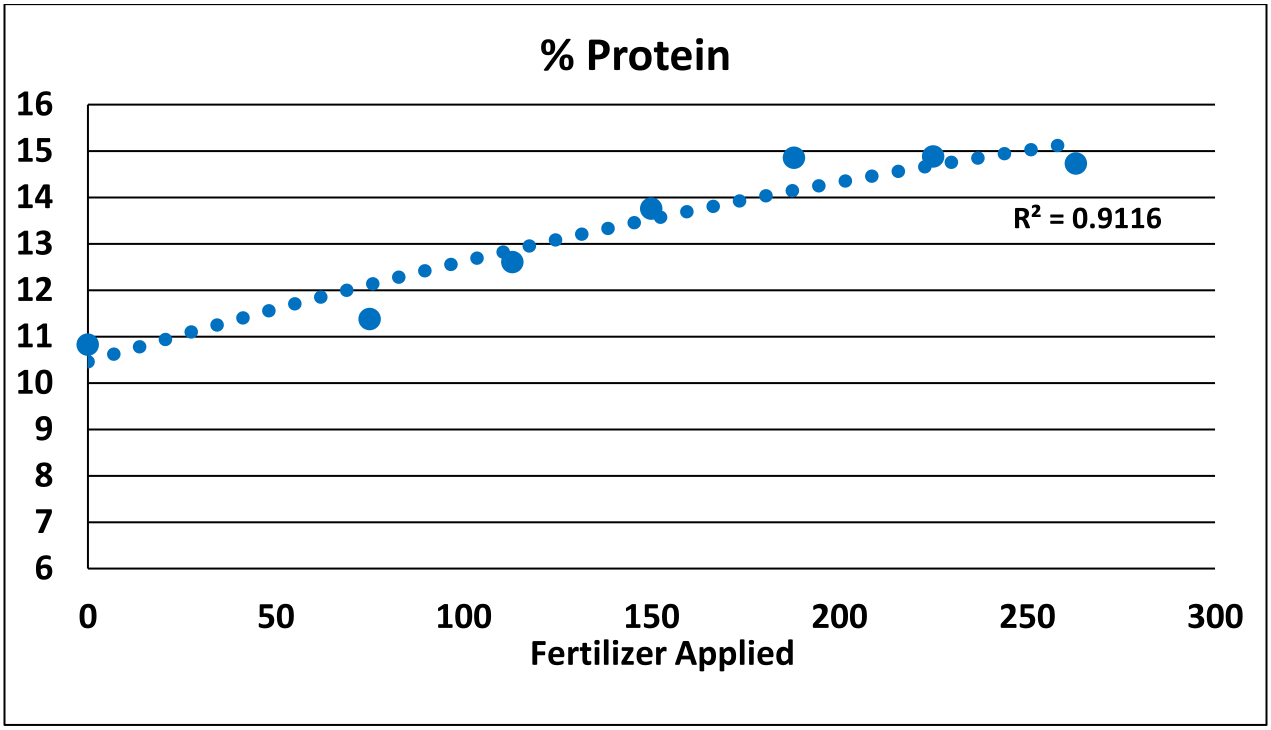
N Rate* = 150 kg N/ha total all sources (fertilizer N from 46-0-0 + fertilizer N from 11-52-0 + soil N
NS = not significant

Figure 1. Wheat Grain Yield Response to Increasing Rates of N Fertilizer, 2019.




1.0x rate = 150 kg N/ha

Figure 2. Wheat Grain Protein Response to Increasing Rates of N Fertilizer, 2019.




1.0x rate = 150 kg N/ha

Fertilizer N Application Timing, Placement and Source

The influence of N application timing, placement and source on yield and seed/plant characteristics measured are shown in Table 6.

Fall broadcast applications did statistically elevate yield in comparison to the unfertilized control providing, on average, an additional 1810 kg/ha (26.9 bu/ac). The mean yield of fall broadcast applications was 3848 kg/ha (57.2 bu/ac). However, fall broadcast applications were statistically lower yielding compared to all spring applications. Spring broadcast and spring side band applications were not statistically differing. The average yield of spring broadcast applications was 4707 kg/ha (70.0 bu/ac) and spring side band applications 4864 kg/ha (72.3 bu/ac). Yield response to the various treatments within this component of the study are illustrated in Figure 3. It is apparent that possible over-winter losses may have occurred with the fall broadcast applications. Conversely, the dry spring conditions may have mitigated N losses to spring broadcast applications. The relatively small yield differences between spring broadcast and side band applications was surprizing. It is assumed that the yield limiting factors discussed prior may have restricted the full yield of side band applications to be expressed? The enhanced fertilizer products Agrotain®, SuperU® and ESN® offered no yield benefit within this study.

## Acknowledgements

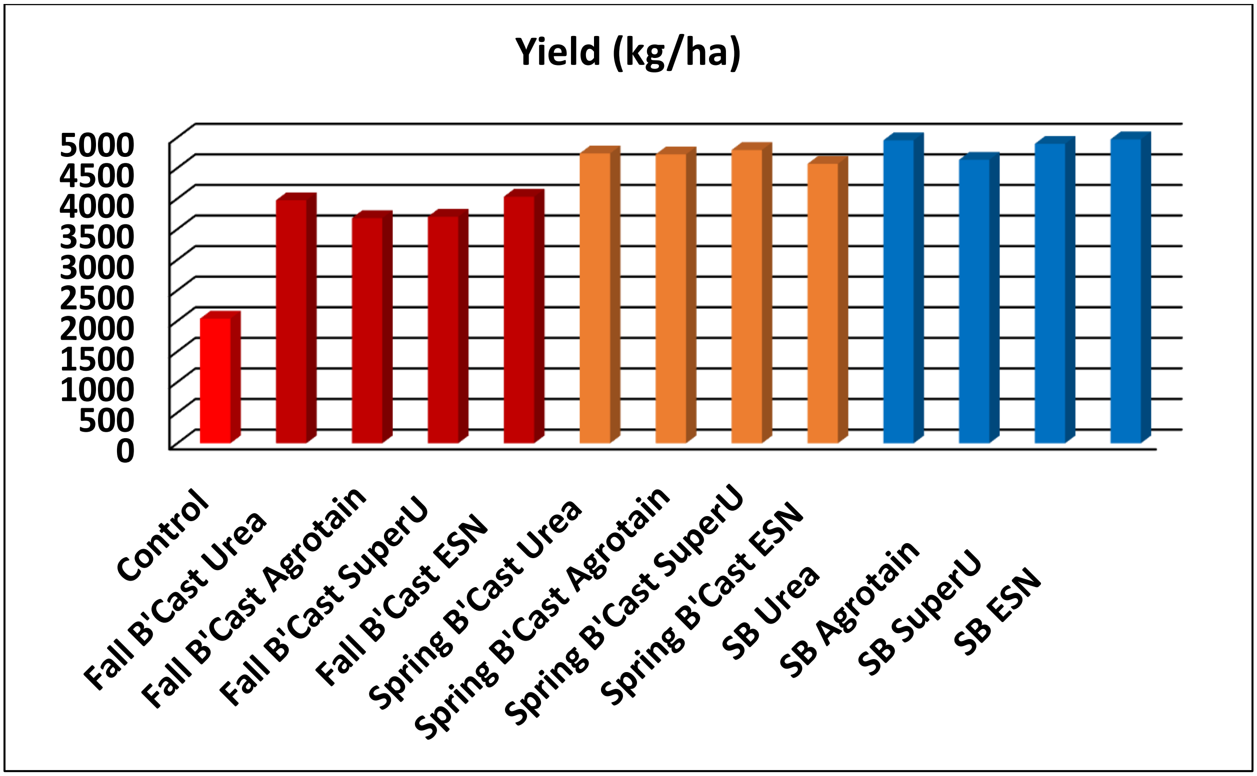
Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement and by Fertilizer Canada. All funding is gratefully acknowledged.

Table 6. Influence of N Fertilizer Time of Application, Placement & Form on Spring Wheat, 2019.

| N Time, Place & Form* | Yield (kg/ha) | Yield (bu/ac) | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | Plants $m^2$ | Maturity (days) | Height (cm) | Belgium Lodging Scale |
|---|---|---|---|---|---|---|---|---|---|
| Control - unfertilized | 2038 | 30.8 | 10.8 | 80.4 | 38.1 | 122 | 90 | 66 | 0.2 |
| Fall B'Cast – Urea | 3974 | 60.0 | 11.2 | 80.8 | 38.8 | 137 | 91 | 82 | 0.2 |
| Fall B'Cast – ESN | 4032 | 60.9 | 10.8 | 80.8 | 39.4 | 116 | 91 | 84 | 0.2 |
| Fall B'Cast - Agrotain | 3682 | 55.7 | 10.5 | 80.5 | 38.8 | 131 | 91 | 83 | 0.2 |
| Fall B'Cast - SuperU | 3705 | 56.0 | 11.2 | 80.2 | 38.7 | 119 | 92 | 80 | 0.2 |
| Spring Side Band – Urea | 4955 | 74.9 | 13.8 | 80.9 | 39.2 | 120 | 92 | 83 | 0.2 |
| Spring Side Band - ESN | 4970 | 75.1 | 12.1 | 81.1 | 40.2 | 125 | 93 | 83 | 0.2 |
| Spring Side Band - Agrotain | 4636 | 70.1 | 12.3 | 80.7 | 40.0 | 126 | 93 | 83 | 0.2 |
| Spring Side Band - SuperU | 4897 | 74.0 | 13.2 | 81.2 | 40.5 | 106 | 93 | 83 | 0.2 |
| Spring B'Cast - Urea | 4739 | 71.6 | 12.6 | 80.8 | 39.5 | 120 | 92 | 86 | 0.2 |
| Spring B'Cast – ESN | 4569 | 69.0 | 12.2 | 81.0 | 39.9 | 109 | 92 | 85 | 0.2 |
| Spring B'Cast - Agrotain | 4724 | 71.4 | 12.5 | 81.3 | 39.8 | 117 | 92 | 83 | 0.2 |
| Spring B'Cast - SuperU | 4796 | 72.5 | 12.5 | 81.0 | 39.9 | 123 | 92 | 86 | 0.2 |
| LSD (0.05) | 417 | 6.3 | 0.8 | 0.5 | 1.2 | NS | 0.9 | NS | NS |
| CV (%) | 6.8 | 6.8 | 4.4 | 0.5 | 2.1 | 13.1 | 0.7 | 3.6 | 0 |

N Rate* = 150 kg N/ha total all sources (fertilizer N from 46-0-0 + fertilizer N from 11-52-0 + soil N). Soil test N 0 -60 cm = 25 kg N/ha: fertilizer N from 11-52-0 = 6 kg N/ha.
NS = not significant

Figure 3. Wheat Grain Yield Response to N Fertilizer Application Timing, Placement & Source, 2019.



# Revisiting Nitrogen Fertilizer Recommendations for SK: Are We Measuring the Right Soil Nitrogen Pool?

## Funding

Funded by the Agriculture Development Fund (ADF)

## Project Lead


- Dr.'s Richard Ferrell & Fran Walley, Dept. Soil Science, University of Saskatchewan
- ICDC Lead: Garry Hnatowich


## Organizations

- University of Saskatchewan
- Irrigation Crop Diversification Corporation (ICDC)
- Indian Head Applied Research Foundation (IHARF)
- East Central Research Foundation (ECRF)
- Western Applied Research Corporation (WARC)
- North East Research Foundation (NARF)
- Wheatland Conservation Association (WCA)
- Conservation Learning Center (CLC)

## Objectives

Nitrogen (N) fertilizer represents one of the highest single input costs for wheat and canola growers, yet there is a growing concern that the current soil N tests and fertilizer N recommendations do not provide, or are no longer accurate, in assisting in making fertilizer rate decisions. This project is a large, multi-objective study where the University will evaluate soil testing procedures and soil N fractions. Participating Agri-ARM locations will evaluate rate response to N fertilizer in both what and canola.

## Research Plan

Both wheat and canola were evaluated and will be reported on separately.

<u>Wheat Trial</u>

A field demonstration with spring wheat was established in the fall of 2018 on ICDC land rented from the town of Outlook and adjacent to the federal CSIDC Research Station. The trial was established in a randomized complete block design, each treatment was replicated 4 times. Seeded plot size was 8 m in length and 1.5 m wide. The trial area was composite soil sampled, a subsample was provided to the University of Saskatchewan and the remainder submitted to Agvise Laboratories for available soil nutrient determinations. Soil test results are shown in Table 1. Nitrogen fertilizer was applied at rates of 0, 0.5X, 1.0X, 1.5X and 2.0X to determine N rate response. Fertilizer rates were established by the ability to accurately meter the 2.0X rate of N fertilizer through fertilizer boxes, once determined, the 1.0X rate was established as 130 kg N/ha. Spring fertilizer applications and seeding all occurred on May 13, 2019. All N fertilizer was side-banded as urea (46-0-0) and all treatments received 30 kg $P_2O_5$/ha seed placed as monoammonium phosphate (11-52-0). Plots were direct seeded with AAC Brandon, CWRS spring wheat, into canola stubble. Seed was planted at 300 viable seeds/$m^2$, after adjusting for % germination and seed size.

Weed control consisted of a post-emergence tank mix application Simplicity (pyroxsulam) and Badge II (bromoxynil +MCPA ester) at recommended rates on June 10, 2019. A foliar fungicide application of

Caramba (metconaole) at 50% anthesis of wheat heads occurred on July 18, 2019. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. The trial was harvested on September 24, 2019. Plot samples were cleaned and yields adjusted to 14.5% moisture.

In-season precipitation was 186 mm (7.3”), total irrigation applied was 234 mm (9.2”).

Canola Trial

A field demonstration with spring wheat was established in the fall of 2018 on the federal CSIDC Research Station (Field #12). The trial was established in a randomized complete block design, each treatment was replicated 4 times. Seeded plot size was 8 m in length and 1.5 m wide. The trial area was composite soil sampled, a subsample was provided to the University of Saskatchewan and the remainder submitted to Agvise Laboratories for available soil nutrient determinations. Soil test results are shown in Table 1. Nitrogen fertilizer was applied at rates of 0, 0.5X, 1.0X, 1.5X and 2.0X to determine N rate response. Fertilizer rates were established by the ability to accurately meter the 2.0X rate of N fertilizer through fertilizer boxes, once determined, the 1.0X rate was established as 130 kg N/ha. Spring fertilizer applications and seeding all occurred on May 13, 2019. All N fertilizer was side-banded as urea (46-0-0) and all treatments received 30 kg $P_2O_5$/ha seed placed as monoammonium phosphate (11-52-0). Plots were direct seeded with L252 hybrid canola, into cereal stubble. Seed was planted at 200 viable seeds/$m^2$, after adjusting for % germination and seed size.

Weed control consisted of a pre-emergent application of Edge (ethalfluralin) and post-emergent tank-mix application of Liberty 150SN (glufosinate) and Centurion (clethodim) on June 17, 2019, supplemented by periodic hand weeding. The trial received a foliar application of Priaxor (fluxapyroxad & pyraclostrobin) applied July 15 at the 50% bloom for disease control or suppression. Individual plots were mechanically separated, swathed on August 29, and harvested with a small plot combine September 24.

Total in-season rainfall from May through September was 225 mm (8.8”). Total in-season irrigation was 93.5 mm (3.7”).

Table 1. Soil Test Analyses Results Wheat & Canola.

| $NO_3$-N kg/ha (0-60cm) | Olsen-P ppm (0-15cm) | K ppm (0-15cm) | S kg/ha (0-30cm) | Soil Organic Matter (%) | Soil pH (0-15cm) | Soil pH (15-60cm) | Sol. Salts mmho/cm (0-15cm) | Sol. Salts mmho/cm (15-30cm) |
|---|---|---|---|---|---|---|---|---|
| **Wheat** | | | | | | | | |
| 6 | 2 | 392 | 83 | 2.2 | 7.9 | 8.2 | 0.33 | 0.31 |
| **Canola** | | | | | | | | |
| 25 | 2 | 159 | 240 | 2.3 | 7.9 | 8.5 | 0.44 | 0.54 |

## Results

Wheat Trial

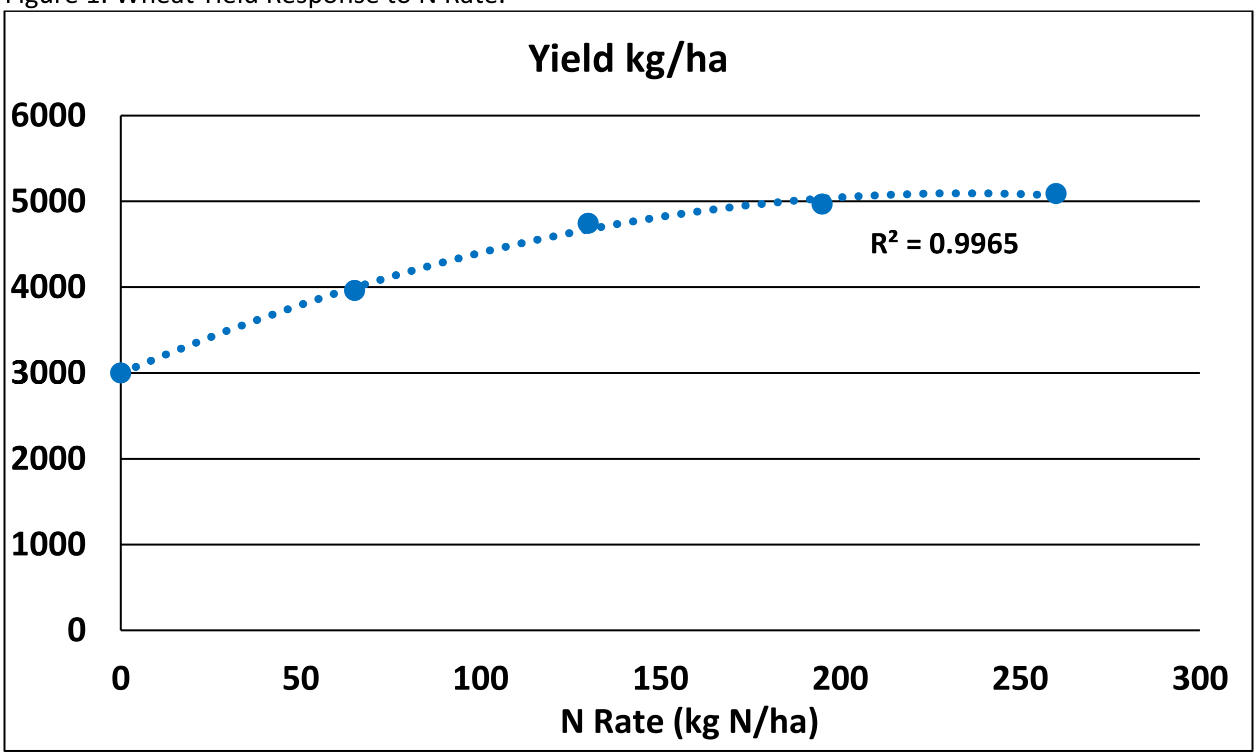
The effect of N fertilizer rates on the yield, seed quality and plant growth characteristics of wheat are shown in Table 2. Wheat grain yield increased with each increase of applied N fertilizer, yields increases were statistically significant up to the 1.0X N application rate. Yields beyond the 1.0X N rate increased numerically but were not statistically different from the 1.0X N rate. Yield was strongly correlated to N fertilizer rate as is illustrated in Figure 1. Grain protein increased as N rates increased beyond the 0.5X N rate. Test weight was highest at the 1.0X N rate, but fertilizer rate did not influence seed weight. Both days to heading and maturity were increased with higher rates of N fertilizer, as did plant height. No plant lodging occurred within treatments in 2019.

Table 2. Influence of N Rate on Wheat

| N Rate | Yield (kg/ha) | Yield (bu/ac) | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | Heading (days) | Maturity (days) | Height (cm) | Lodging (1-9) |
|---|---|---|---|---|---|---|---|---|---|
| 0X N | 3002 | 44.6 | 12.1 | 79.1 | 40.0 | 55 | 91 | 73 | 1 |
| 0.5X N | 3962 | 58.9 | 11.8 | 79.4 | 39.2 | 56 | 92 | 81 | 1 |
| 1.0X N | 4746 | 70.6 | 12.8 | 79.9 | 39.7 | 57 | 94 | 84 | 1 |
| 1.5X N | 4969 | 73.9 | 13.3 | 79.8 | 39.9 | 58 | 94 | 82 | 1 |
| 2.0X N | 5091 | 75.7 | 14.3 | 79.6 | 40.1 | 59 | 100 | 85 | 1 |
| LSD (0.05) | 705 | 10.48 | 0.99 | 0.49 | NS | 1.2 | 2.9 | 6 | NS |
| CV (%) | 9.9 | 9.9 | 4.9 | 0.4 | 2.8 | 1.3 | 1.9 | 4.2 | |

1.0X = 130 kg N/ha
NS = not significant

Figure 1. Wheat Yield Response to N Rate.




Canola Trial

The effect of N fertilizer rates on canola yield, seed quality and plant growth characteristics are shown in Table 2. Canola seed yield increased statistically up to the 1.0X N application rate, then leveled. Yields Yield were correlated to N fertilizer rate as is illustrated in Figure 1. Seed oil content and test weights were not influenced by N rate. Both days to flowering and maturity were increased with higher rates of N fertilizer, as did plant height. Higher plant lodging increased with the highest rate of N applied.

This trial is being repeated with both wheat and canola in 2020.

## Acknowledgements

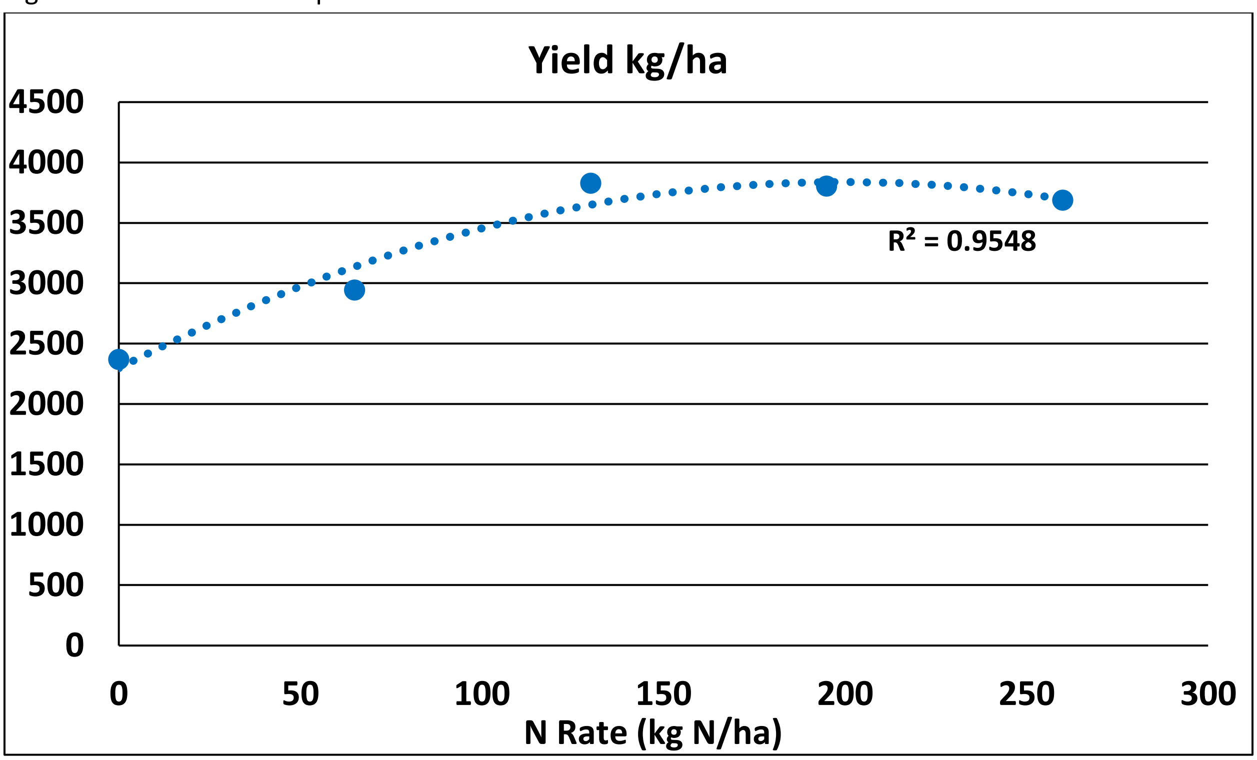
Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. Funding is gratefully acknowledged.

Table 3. Influence of N Rate on Canola

| N Rate | Yield (kg/ha) | Yield (bu/ac) | % Oil | Test weight (kg/hl) | Seed weight (g/1000) | Flowering (days) | Maturity (days) | Height (cm) | Lodging (1-9) |
|---|---|---|---|---|---|---|---|---|---|
| 0X N | 2366 | 42.2 | 52.2 | 63.9 | | 48 | 99 | 100 | 1.8 |
| 0.5X N | 2941 | 52.5 | 52.2 | 63.5 | | 49 | 99 | 105 | 1.8 |
| 1.0X N | 3826 | 68.2 | 52.0 | 63.7 | | 49 | 101 | 118 | 1.8 |
| 1.5X N | 3801 | 67.8 | 52.2 | 63.8 | | 49 | 100 | 119 | 1.8 |
| 2.0X N | 3686 | 65.8 | 51.7 | 63.9 | | 50 | 104 | 121 | 2.3 |
| LSD (0.05) | 526 | 9.4 | NS | NS | | 0.6 | 1.9 | 11 | NS |
| CV (%) | 10.3 | 10.3 | 1.3 | 0.3 | | 0.9 | 1.2 | 6.1 | 31.2 |

1.0X = 130 kg N/ha
NS = not significant

Figure 2. Canola Yield Response to N Rate.



# Demonstrating 4R Nitrogen Management Principals for Winter Wheat

## Funding

Funded by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) & Fertilizer Canada.

## Project Lead

- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)

## Objectives

Developing Best Management Practices (BMPs) for nutrient applications has long been focussed on the 4R principles which refer to using the: 1) right source, 2) right rate, 3) right time and 4) right placement. This can create unique challenges for winter cereals, however, since the growing season is much longer and crop requirements for N are relatively small for the 8- to 9-month period after seeding. Consequently, and especially when considering that establishment of winter cereals can be variable from year-to-year, it is often recommended that N applications be split between fall side- or mid-row band applications and an early spring surface broadcast. This results in extra cost / labour for producers; however, N applied in the fall can be more prone to losses prior to crop uptake (especially in wet falls) while spring applied N can also be subject to loss and is not always available early enough to prevent early season deficiencies and subsequent yield loss. Consequently, split applications tend to be the least risky option when averaged over time and across a broad range of conditions.

A key objective of this project is to demonstrate the relative winter wheat responses to varying N fertilizer rates when all of the fertilizer is applied either as side-banded urea, early spring broadcast urea, or a split application where 50% of the supplemental N fertilizer is side-banded and the remainder is applied in an early season broadcast application. While the source is not being specifically varied in this demonstration, urea is the most commonly used N formulation in western Canada and an appropriate choice to illustrate differences amongst the rates and placement/timing options being evaluated.

## Research Plan

A field demonstration with winter wheat was established in the fall of 2018 on ICDC land rented from the town of Outlook and adjacent to the federal CSIDC Research Station. The trial was established in a randomized complete block design, each treatment was replicated 4 times. Seeded plot size was 8 m in length and 1.5 m wide. The trial was direct seeded into canola stubble on September 19, 2018. Fertilizer treatments are shown in Table 1. Fall fertilizer applications occurred at the time of seeding. Fertilizer N as side banded 25 cm to the side and 25 cm below the seed furrow. Soil testing procedures revealed a total of 5.6 kg N/ha available in the 0 – 60 cm soil profile depth. All fertilizer applications were calculated to account for this value of soil available N. All N fertilizer applications were applied as urea (46-0-0). At seeding all plots also received 30 kg $P_2O_5$/ha as seed placed monoammonium nitrate (11-52-0). Spring broadcast applications were conducted on May 3, 2019.

Weed control consisted of a pre-seed application of glyphosate and a post-emergence tank mix application of Simplicity (pyroxsulam) and Buctril M (bromoxynil +MCPA ester) on June 1, 2019. On June

7, while the winter wheat was in the stem elongation stage of development normalized difference vegetative index (NDVI) remote sensing measurements were conducted using a hand held instrument swept along the length of each plot at the same height. No foliar fungicides were applied for either leaf disease or Fusarium Head Blight. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. Harvest plot size was 6 m x 1.5 m. The trial was harvested August 8, 2019. Harvested samples were cleaned into respective crops and yields adjusted to a moisture content of 14.5%. Total in-season precipitation was 186.4 mm (7.3"). An additional 234 mm (9.2") was applied by irrigation to the irrigated production system from May 31 to September 30.

Table 1. Fertilizer Rate, Time of Application and Fertilizer Placement for Winter Wheat, 2019.

| Trt # | Total N Rate (soil + fertilizer) | Timing/Placement |
|---|---|---|
| 1 | 0X (no added N fertilizer) | N/A |
| 2 | 60 kg soil + fertilizer N/ha | Fall Side Band |
| 3 | 90 kg soil + fertilizer N/ha | Fall Side Band |
| 4 | 120 kg soil + fertilizer N/ha | Fall Side Band |
| 5 | 150 kg soil + fertilizer N/ha | Fall Side Band |
| 6 | 180 kg soil + fertilizer N/ha | Fall Side Band |
| 7 | 60 kg soil + fertilizer N/ha | Spring Broadcast |
| 8 | 90 kg soil + fertilizer N/ha | Spring Broadcast |
| 9 | 120 kg soil + fertilizer N/ha | Spring Broadcast |
| 10 | 150 kg soil + fertilizer N/ha | Spring Broadcast |
| 11 | 180 kg soil + fertilizer N/ha | Spring Broadcast |
| 12 | 60 kg soil + fertilizer N/ha | Split Application (50% fall side band + 50% spring broadcast) |
| 13 | 90 kg soil + fertilizer N/ha | Split Application (50% fall side band + 50% spring broadcast) |
| 14 | 120 kg soil + fertilizer N/ha | Split Application (50% fall side band + 50% spring broadcast) |
| 15 | 150 kg soil + fertilizer N/ha | Split Application (50% fall side band + 50% spring broadcast) |
| 16 | 180 kg soil + fertilizer N/ha | Split Application (50% fall side band + 50% spring broadcast) |

Seasonal and 30 year historic precipitation and growing degree days at CSIDC are outlined in Tables 2 & 3. Seasonal precipitation was significantly lower in May, higher in June, and lower throughout the growing period compared to 30 year averages, seasonal precipitation on the trials by seasons end was significantly less than long term averages. Seasonal Cumulative Growing Degree Days were cooler through the growing period, particularly at the start in May and at the end of the season.

Table 2. 2019 Growing Season Precipitation vs Long-Term Average, CSIDC.

| | Year | | |
|---|---|---|---|
| **Month** | **2019 mm (inches)** | **30 Year Average mm (inches)** | **% of Long-Term** |
| May | 13.2 (0.5) | 46.0 (1.8) | 29 |
| June | 90.2 (3.6) | 67.0 (2.6) | 135 |
| July | 43.8 (1.7) | 57.0 (2.2) | 77 |
| August | 39.2 (1.5) | 46.0 (1.8) | 85 |
| **Total** | 186.4 (7.3) | 216.0 (8.4) | **86** |

Table 3. Cumulative Growing Degree Days (Base°C) vs Long-Term Average, CSIDC.

| | Year | | |
|---|---|---|---|
| **Month** | **2019** | **30 Year Average** | **% of Long-Term** |
| May | 211 | 224 | 94 |
| June | 691 | 708 | 98 |
| July | 1249 | 1290 | 97 |
| August | 1750 | 1844 | 94 |

## Results

Complete results obtained for agronomic observations collected, with RCBD statistical analyses, for the trial are shown in Table 4. This table is included so individual treatment values are available and recorded. Results as presented in Table 4 will not be discussed. Analysis of the same data using a Factorial analyses separating the N rate and the Time/Placement provides a clearer understanding of the treatment effects of this study are shown in Table 5. The general discussion that follows will be based on the analysis presented in Table 5.

Irrigated yields obtained were low, this can be attributed directly, in large part, to a breakdown of the linear irrigation system providing water to this trial. The system had an underground rupture that required major excavation, and irrigation was not available through much of June and early July. This was a critical period for winter wheat seed development and filling. Hence the low yields obtained. However, the magnitude of treatment differences might have been reduced but the differences that did occur are deemed valid.

Table 4: Influence of N Fertilizer Rate & Time/Placement on Winter Wheat, 2019.

| | **Yield (kg/ha)** | **Yield (bu/ac)** | **% Protein** | **Test weight (kg/hl)** | **Seed weight (g/1000)** | **NDVI** | **Maturity (days)** | **Height (cm)** | **Lodge (1-9)** |
|---|---|---|---|---|---|---|---|---|---|
| 0 N | 2217 | 33.0 | 8.2 | 81.1 | 37.1 | 0.30 | July 26 | 64 | 1 |
| 60 N Fall Side Band | 3437 | 51.1 | 7.6 | 80.1 | 40.4 | 0.48 | July 26 | 77 | 1 |
| 90 N Fall Side Band | 4460 | 66.3 | 7.5 | 78.5 | 37.4 | 0.60 | July 28 | 85 | 1 |
| 120 N Fall Side Band | 4400 | 65.4 | 7.8 | 80.8 | 37.6 | 0.63 | July 28 | 83 | 1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 150 N Fall Side Band | 5467 | 81.3 | 8.5 | 81.6 | 38.3 | 0.67 | July 29 | 93 | 1 |
| 180 N Fall Side Band | 5862 | 87.2 | 9.3 | 80.2 | 38.4 | 0.74 | July 30 | 93 | 1 |
| 60 N Spring Broadcast | 3540 | 52.7 | 7.6 | 80.5 | 37.7 | 0.49 | July 28 | 75 | 1 |
| 90 N Spring Broadcast | 3831 | 57.0 | 7.6 | 80.5 | 37.3 | 0.51 | July 28 | 76 | 1 |
| 120 N Spring Broadcast | 4510 | 67.1 | 8.0 | 80.0 | 37.6 | 0.56 | July 29 | 79 | 1 |
| 150 N Spring Broadcast | 4982 | 74.1 | 8.3 | 81.0 | 37.7 | 0.56 | July 29 | 84 | 1 |
| 180 N Spring Broadcast | 5440 | 80.9 | 8.8 | 80.3 | 38.2 | 0.65 | July 30 | 83 | 1 |
| 60 N Split Application | 3362 | 50.0 | 7.3 | 80.1 | 38.1 | 0.47 | July 27 | 75 | 1 |
| 90 N Split Application | 3968 | 59.0 | 7.5 | 80.4 | 37.7 | 0.53 | July 27 | 79 | 1 |
| 120 N Split Application | 3888 | 57.8 | 7.4 | 80.7 | 37.2 | 0.54 | July 29 | 79 | 1 |
| 150 N Split Application | 4359 | 64.8 | 7.6 | 80.4 | 38.2 | 0.57 | July 28 | 81 | 1 |
| 180 N Split Application | 4655 | 69.2 | 8.0 | 80.3 | 37.5 | 0.58 | July 28 | 83 | 1 |
| LSD (0.05) | 453 | 6.7 | 0.4 | NS | NS | 0.07 | 1.2 days | 5.9 | NS |
| CV (%) | 7.5 | 7.5 | 3.7 | 1.3 | 4.7 | 8.5 | 0.4 | 5.2 | - |

Although results will be discussed as presented in Table 5 it is worthy of indicating that all fertilizer N applications, regardless of rate, time of application and time of application significantly increased winter wheat grain yield as indicated in Table 4 and illustrated in Figure 1.

Winter wheat seed yield responded positively to each increase in fertilizer N applied, in most cases this rate response was statistically significant (Table 5). The yield difference between the mean response to 60 kg N/ha to 180 kg N/ha was 1873 kg/ha or 27.9 bu/ac. Although purely speculative, it is reasonable to suspect that had the appropriate irrigation scheduling been able to be applied the magnitude of the yield differences to N rate would have been greater. In general, the mean effect of increased N rates resulted in higher grain protein content, increased NDVI measurements (indirectly indicating that plants did acquire additional N into plant tissue as N rates increased), plant height and delayed maturity with applications up to 150 kg N/ha. Test weight and thousand kernel weight (TKW) were not influenced in this study by N fertilizer rates.

The mean effects of fertilizer N time/placement indicated that applying fertilizer as a fall side band application statistically increase seed yield compared to the spring broadcast application and the split timing applications. This is possibly a result of a relatively dry fall and a very dry spring. It is worth noting that irrigation is generally unavailable from mid-September until mid-May within the South Saskatchewan River Irrigation District in which this trial was conducted. Further, the spring broadcast application was statistically higher than the split fertilizer applications. The relatively poor performance of the split application is not apparent. It is possible that the lower rates of N applied as a spring broadcast application (i.e. 50% vs full spring broadcast) was impacted greater by the lack of available irrigation? Results from this study both conform with results found at other locations with respect to fall fertilizer N applications while simultaneously differ with respect to split applications (IHARF ADOPT project #20120308 - http://iharf.ca/wp-content/uploads/2016/04/Nitrogen-Fertilizer-Management-Options-for-Winter-Wheat.pdf).

The split application produced significantly lower seed protein than when either fertilizer was fall banded or spring broadcast. This further suggests the possibility that this method of fertilizer additions may have been more adversely influenced by the lack of irrigation available through seed development. The fall side band applications resulted in statistically higher NDVI measurements than either of the other time and placement treatments. This measurement, with yield, indicates that this time and placement method was the most efficient method given the experimental conditions of 2018-19. Fall side band applications also produced taller plants. Little difference in other agronomic measurements were observed to time/placement of fertilizer N.

This trial will be repeated, fall fertilizer applications and seeding occurred on September 18, 2019.

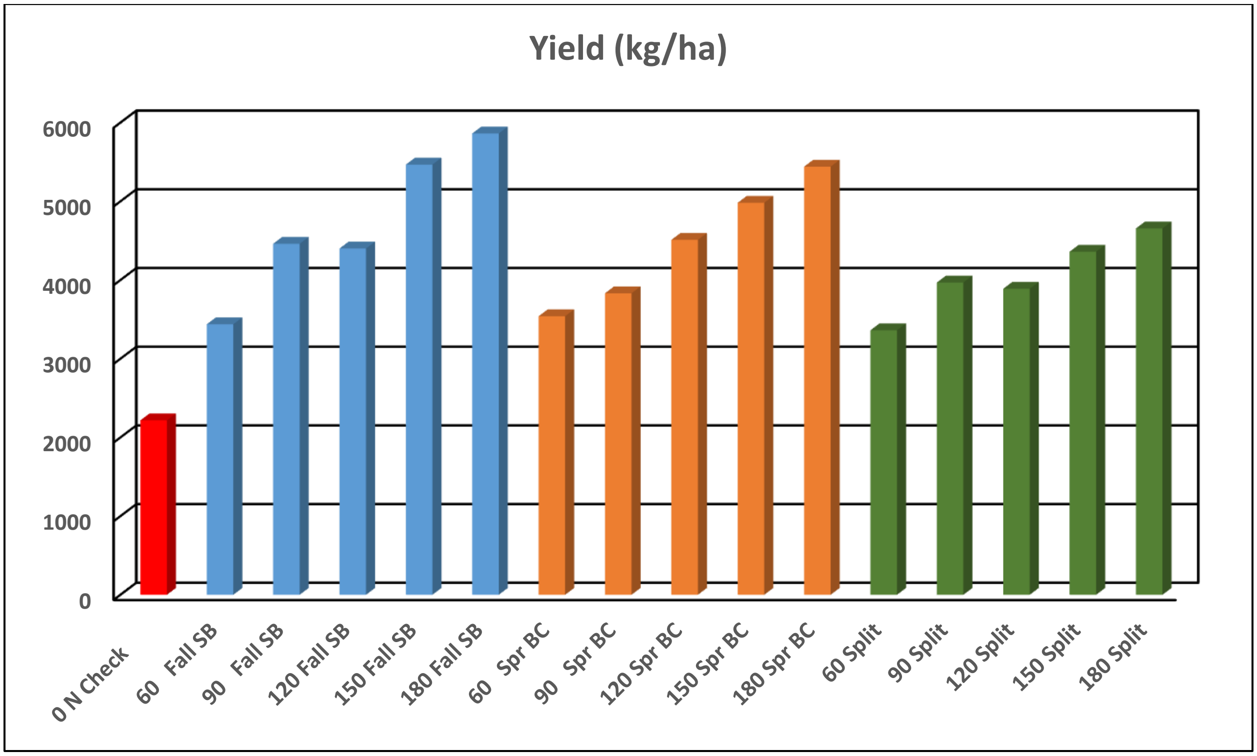

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement and by Fertilizer Canada. All funding is gratefully acknowledged.


Table 5: Influence of N Fertilizer Rate & Time/Placement on Winter Wheat, 2019.

| N Fertilizer Rate/Time/Placement | Yield (kg/ha) | Yield (bu/ac) | % Protein | Test weight (kg/hl) | Seed weight (g/1000) | NDVI | Maturity (days) | Height (cm) | Lodge (1-9) |
|---|---|---|---|---|---|---|---|---|---|
| **N Rate** | | | | | | | | | |
| 60 kg N/ha | 3446 | 51.2 | 7.5 | 80.2 | 38.8 | 0.48 | July 27 | 76 | 1 |
| 90 kg N/ha | 4087 | 60.8 | 7.5 | 79.8 | 37.5 | 0.55 | July 27 | 80 | 1 |
| 120 kg N/ha | 4266 | 63.4 | 7.7 | 80.5 | 37.5 | 0.58 | July 28 | 80 | 1 |
| 150 kg N/ha | 4936 | 73.4 | 8.1 | 81.0 | 38.0 | 0.60 | July 29 | 86 | 1 |
| 180 kg N/ha | 5319 | 79.1 | 8.7 | 80.3 | 38.0 | 0.66 | July 29 | 86 | 1 |
| LSD (0.05) | 267 | 4.0 | 0.2 | NS | NS | 0.04 | 0.7 days | 3.5 | NS |
| CV (%) | 7.3 | 7.3 | 3.7 | 1.3 | 4.9 | 8.5 | 0.4 | 5.3 | - |
| **Time/Placement** | | | | | | | | | |
| Fall Side Band | 4725 | 70.2 | 8.1 | 80.2 | 38.4 | 0.62 | July 28 | 86 | 1 |
| Spring Broadcast | 4460 | 66.3 | 8.1 | 80.4 | 37.7 | 0.55 | July 29 | 79 | 1 |
| Split Application | 4047 | 60.2 | 7.5 | 80.4 | 37.7 | 0.54 | July 28 | 79 | 1 |
| LSD (0.05) | 207 | 3.1 | 0.2 | NS | NS | 0.03 | 0.5 days | 2.7 | - |
| **N Rate x Time/Placement** | | | | | | | | | |
| LSD (0.05) | S | S | S | NS | NS | NS | NS | NS | NS |

Figure 1: Influence of N Fertilizer Rate, Time and Placement on Winter Wheat Yield, 2019



# Demonstration of Nitrogen Rate Responses of Irrigated Conventional and Hybrid Fall Rye

## Funding
Funded by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT).

## Project Lead
- ICDC Lead: Garry Hnatowich

## Organizations
- Irrigation Crop Diversification Corporation (ICDC)

## Objectives
Fall cereals in general have numerous rotational benefits including reduced disease, better weed control, increased water and nutrient use, and improved habitat for water fowl. At present producers are seeking cropping options to maintain their cereals in rotation but mitigate the problem of high Fusarium Head Blight associated with spring cereal production. Fall rye may provide a suitable choice. Fall rye has not been widely produced as quality for milling markets has been inconsistent and spring and winter wheat tends to displace it in the feed market. However, with the development of hybrid fall rye, with higher falling number than conventional rye, opportunities maybe available in the milling and distillers markets. The higher yields associated with hybrid over conventional rye may also enhance its ability for ethanol and feed market opportunities.

Since there is a lack of suitable fertilizer recommendations in general, and none for irrigation or higher moisture fall rye production, a demonstration of nitrogen fertilizer rate response is well warranted. Depending upon results obtained this demonstration could lead to and expanded fertility research program.

The objective is to demonstrate the nitrogen rate response of irrigated fall rye varieties to optimize yield and protein. In addition, to provide information that can be used to create nitrogen fertilizer recommendations for irrigated fall rye production.

## Research Plan
The trial was established at the ICDC rented land adjacent to the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC). The trial was established in a randomized factorial design with three replications. Seed of two registered fall rye varieties, the conventional open-pollinated variety Hazlet and the hybrid variety Bono, were evaluated. Varieties were direct seeded into canola stubble on September 14, 2018. Seeded plot size was 6 m in length and 1.5 m wide (6 rows @ 0.25 m spacing). Nitrogen fertilizer as urea (46-0-0) was applied to each variety at rates of 0, 50, 100, 150, 200 and 250 kg N/ha. All nitrogen fertilizer was sideband at seeding, 25 kg P2O5/ha seed placed monoammonium nitrate (11-52-0) was applied with the seed. Weed control involved a single fall preseed application of glyphosate, with an in-season tank mix application of Bison (tralkoxydim) and Buctril M (bromoxynil +MCPA ester). Periodic hand weeding was required through the growing season. On June 7, while the fall rye was at the 50% heading stage of development (NDVI 1), and again June 17 at post-anthesis (NDVI 2), normalized difference vegetative index (NDVI) remote sensing measurements were conducted using

a hand held instrument swept along the length of each plot at the same height. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh and seed moisture content was <20%. Harvest occurred on August 15, 2018. Plot size harvested was 4 m in length and 1.5 m wide. Harvested samples were cleaned into respective crops and yields adjusted to a moisture content of 14.5%. An additional 234 mm (9.2 inches) was applied by irrigation to the irrigated production system to harvest.

Seasonal and 30 year historic precipitation and growing degree days at CSIDC are outlined in Tables 1 & 2. Seasonal precipitation was significantly lower in May, higher in June, and lower throughout the growing period compared to 30 year averages, seasonal precipitation on the trials by seasons end was significantly less than long term averages. Seasonal Cumulative Growing Degree Days were cooler through the growing period, particularly at the start in May and at the end of the season.

**Table 1. 2019 Growing Season Precipitation vs Long-Term Average, CSIDC**

| | **Year** | | |
|---|---|---|---|
| **Month** | **2019 mm (inches)** | **30 Year Average mm (inches)** | **% of Long-Term** |
| May | 13.2 (0.5) | 46.0 (1.8) | 29 |
| June | 90.2 (3.6) | 67.0 (2.6) | 135 |
| July | 43.8 (1.7) | 57.0 (2.2) | 77 |
| August | 39.2 (1.5) | 46.0 (1.8) | 85 |
| **Total** | 186.4 (7.3) | 216.0 (8.4) | **86** |

**Table 2. Cumulative Growing Degree Days (Base 0°C) vs Long-Term Average, CSIDC Outlook Weather Station**

| | **Year** | | |
|---|---|---|---|
| **Month** | **2019** | **30 Year Average** | **% of Long-Term** |
| May | 211 | 224 | 94 |
| June | 691 | 708 | 98 |
| July | 1249 | 1290 | 97 |
| August | 1750 | 1844 | 94 |

## Results

Agronomic data collected in the study is tabulated in Table 3 (analysis of variance procedures conducted on entire data set as a RCB design) and shown for record posterity only and will not be discussed.

The discussion will be based on results of each factorial treatment within the test which is summarized in Table 4. Yields in general were lower than would be reasonably expected for irrigated production. This can be attributed, in large part, to a breakdown of the linear irrigation system providing water to this trial. The system had an underground rupture that required major excavation, and irrigation was not available through much of June and early July. This was a critical period for winter wheat seed development and filling. Hence the low yields obtained. However, the magnitude of treatment differences might have been reduced but the differences that did occur are deemed valid.

As might be expected the hybrid variety, Bono, was significantly higher yielding than the conventional variety, Hazlet. Mean Hazlet yields were 77% of that of Bono. In general, statistically significant yield gains were obtained with each additional application of 50 kg N/ha. Statistically no variety by N fertilizer interaction occurred suggesting that both varieties behaved in a similar manner to incremental fertilizer additions. Statistical yield response curves for each varieties as influenced by fertilizer N rates are illustrated in Figure 1. The response curve of Bono appears to rise at a steeper rate than Hazlet to 150 kg N/ha. It is interesting to note that in 2019 the Bono yield obtained at 100 kg N/ha had exceeded the yield obtained with Hazlet to 250 kg N/ha. However, statistical analyses procedures did not indicate a variety by N fertilizer rate interaction suggesting that both varieties responded to N additions similarly.

Bono % seed protein was significantly lower than Hazlet, as is often the occurrence with high yielding varieties. Mean protein levels were somewhat variable within the 0 to 150 kg N/ha application rates, with large increases in protein occurring only at the two highest rates of N applied. This is illustrated in Figure 2, showing both varieties behaved similarly. It is believed this could be due to a dilution effect as fertilizer additions resulted in rapid yield increases up to the 150 kg N/ha rate. Figure 3 shows the total N removed in fall rye grain for the two varieties (data not shown). Responses are linear, but the slope of the line is steeper for the hybrid variety. Yield, protein and N removal values all indicate that N fertilizer additions were effectively being accessed and utilized by both fall rye varieties. This is further borne out in NDVI measurements obtained at 50% anthesis and post-anthesis. No great differences were obtained between varieties but the mean influence of N fertilizer applications resulted in higher recorded values. Hazlet produced higher test weight and larger seed than Bono. Both varieties matured at the same time but Bono produced shorter plants and tillered less than Hazlet. N fertilizer applications had no large influence on test weight or seed weight, delayed maturity at only the two highest N fertilizer rates but did significantly increase plant height and tillering. Ergot was not a serious problem in 2019. Varieties did not differ in ergot infection nor was the presence of ergot influenced by N fertilizer rate (data collected but not shown).

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. All funding is gratefully acknowledged.

Table 3. Yield and Agronomic Parameters Measured for Fall Rye 2019 (RCBD)

| Variety | N Rate (kg N/ha) | Yield (kg/ha) | Yield (bu/ac) | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | NDVI 1 | NDVI 2 | Date Mature | Height (cm) | Heads (spikes/m2) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Hazlet | 0 | 2299 | 36.6 | 9.5 | 70.9 | 37.4 | 0.32 | 0.30 | July 28 | 100 | 217 |
| Hazlet | 50 | 3197 | 50.9 | 9.2 | 73.3 | 38.9 | 0.42 | 0.37 | July 28 | 111 | 229 |
| Hazlet | 100 | 5071 | 80.8 | 8.5 | 72.9 | 36.3 | 0.62 | 0.55 | July 28 | 119 | 351 |
| Hazlet | 150 | 5393 | 85.9 | 9.5 | 73.7 | 36.6 | 0.67 | 0.58 | July 29 | 119 | 352 |
| Hazlet | 200 | 5907 | 94.1 | 10.6 | 70.0 | 37.5 | 0.71 | 0.62 | July 30 | 119 | 348 |
| Hazlet | 250 | 6221 | 99.1 | 11.2 | 71.1 | 38.4 | 0.72 | 0.62 | July 30 | 111 | 367 |
| Bono | 0 | 3273 | 52.1 | 8.6 | 67.9 | 35.6 | 0.30 | 0.28 | July 28 | 89 | 222 |
| Bono | 50 | 4099 | 65.3 | 8.3 | 69.8 | 35.8 | 0.39 | 0.37 | July 28 | 99 | 301 |
| Bono | 100 | 6654 | 106.0 | 8.0 | 70.9 | 34.4 | 0.65 | 0.56 | July 28 | 105 | 423 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bono | 150 | 7434 | 118.4 | 9.1 | 69.9 | 34.7 | 0.68 | 0.60 | July 28 | 108 | 457 |
| Bono | 200 | 7483 | 119.2 | 10.2 | 71.0 | 34.3 | 0.67 | 0.61 | July 29 | 106 | 436 |
| Bono | 250 | 7584 | 120.8 | 10.8 | 70.2 | 34.2 | 0.69 | 0.61 | July 29 | 101 | 473 |
| LSD (0.05) | | 655 | 10.4 | 0.3 | NS | 1.3 | 0.04 | 0.03 | 1.4 | 10.0 | 42 |
| CV (%) | | 8.5 | 8.5 | 2.5 | 6.3 | 2.6 | 4.6 | 4.7 | 0.5 | 6.5 | 8.5 |

NS = not significant

Table 4. Yield and Agronomic Parameters Measured for Fall Rye 2019 (Factorial)

| Treatment | Yield (kg/ha) | Yield (bu/ac) | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) | NDVI 1 | NDVI 2 | Date Mature | Height (cm) | Heads (spikes/m2) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Variety** | | | | | | | | | | |
| Hazlet | 4681 | 74.6 | 9.7 | 72.0 | 37.5 | 0.58 | 0.50 | July 29 | 113 | 310 |
| Bono | 6088 | 97.0 | 9.2 | 70.0 | 34.8 | 0.56 | 0.50 | July 28 | 101 | 385 |
| LSD (0.05) | 268 | 4.3 | 0.1 | NS | 0.5 | 0.01 | NS | NS | 4.1 | 17 |
| **N Rate** | | | | | | | | | | |
| 0 kg N/ha | 2786 | 44.4 | 9.1 | 69.4 | 36.5 | 0.31 | 0.29 | July 29 | 95 | 219 |
| 50 kg N/ha | 3648 | 58.1 | 8.7 | 71.6 | 37.4 | 0.40 | 0.37 | July 29 | 105 | 265 |
| 100 kg N/ha | 5863 | 93.4 | 8.2 | 71.9 | 35.3 | 0.63 | 0.55 | July 29 | 112 | 387 |
| 150 kg N/ha | 6413 | 102.2 | 9.3 | 71.8 | 35.6 | 0.67 | 0.59 | July 29 | 113 | 404 |
| 200 kg N/ha | 6695 | 106.6 | 10.4 | 70.5 | 35.9 | 0.69 | 0.61 | July 30 | 113 | 392 |
| 250 kg N/ha | 6903 | 109.9 | 11.0 | 70.6 | 36.3 | 0.70 | 0.61 | July 30 | 106 | 420 |
| LSD (0.05) | 463 | 7.4 | 0.2 | NS | 0.9 | 0.03 | 0.02 | 0.9 | 7.1 | 30 |
| CV (%) | 8.5 | 8.5 | 2.5 | 6.3 | 2.6 | 4.6 | 4.7 | 0.5 | 6.5 | 8.5 |
| **Variety x N Rate Interaction** | | | | | | | | | | |
| LSD (0.05) | NS | NS | NS* | NS | NS | NS | NS | NS | NS | S |

S = significant
NS = not significant
NS* = not significant at P < 0.05 but significant at P<0.10

Figure 1. Influence of N Fertilizer Rates on Fall Rye Variety Grain Yields, 2019

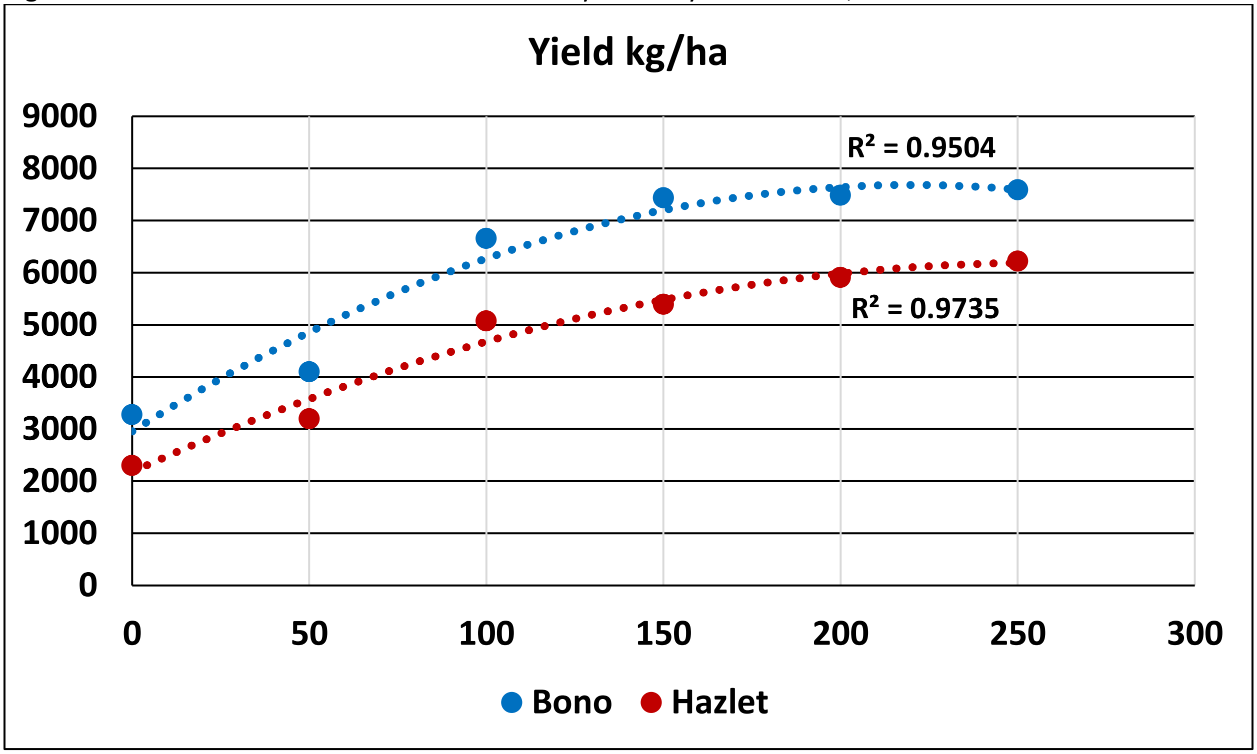



Figure 2. Influence of N Fertilizer Rates on Fall Rye Variety Protein, 2019

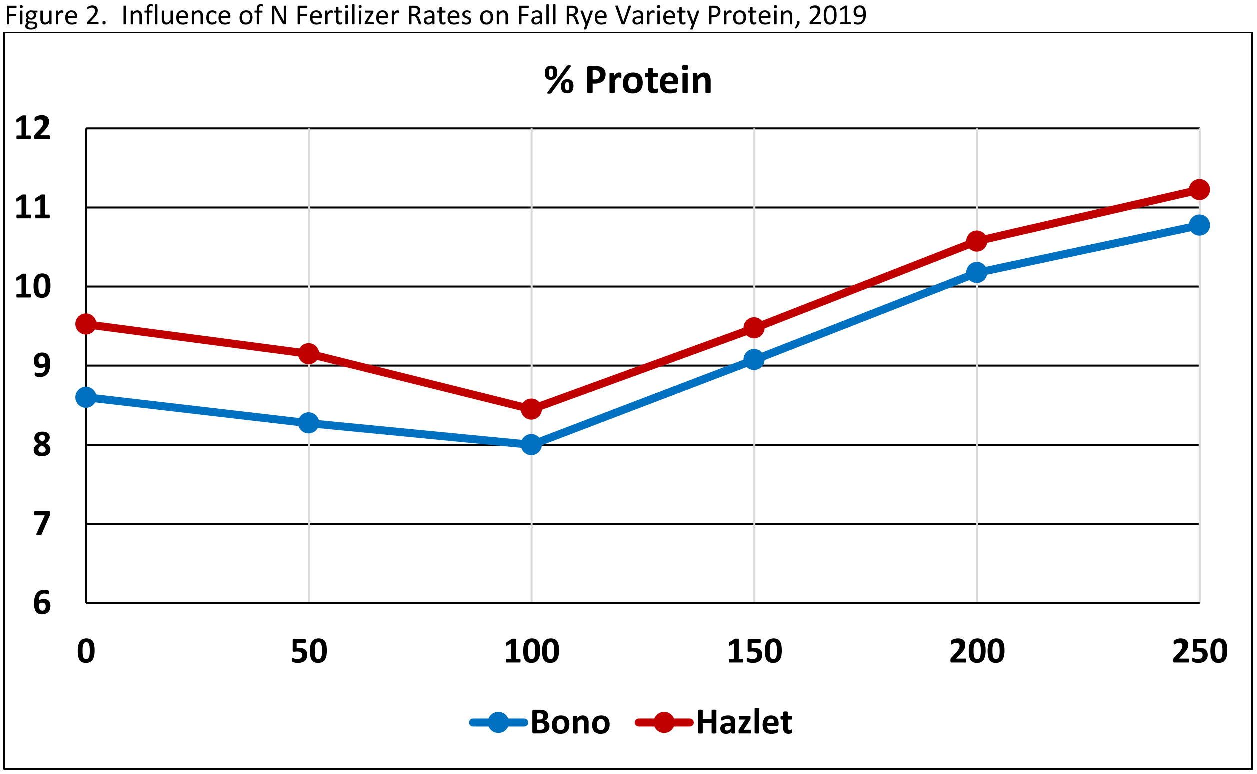
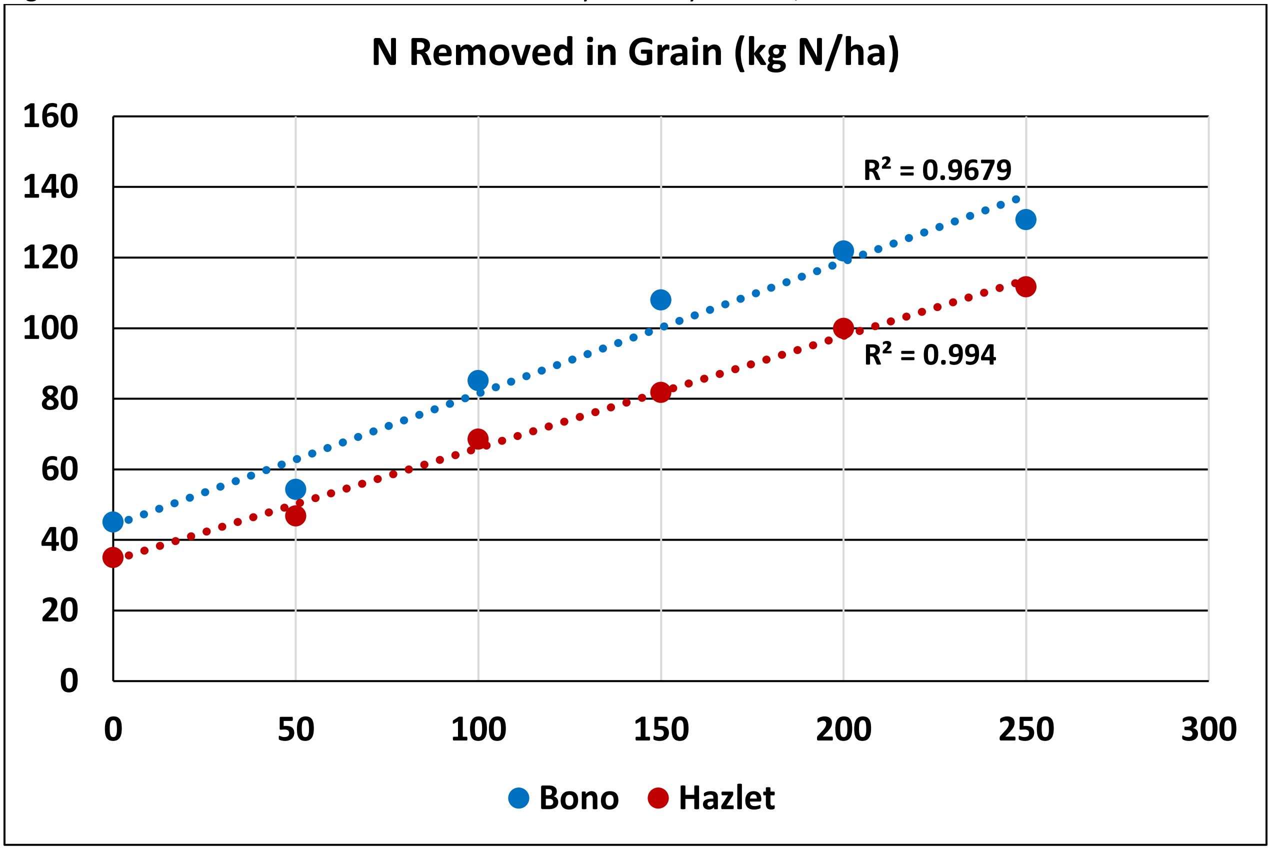


Figure 3.  Influence of N Fertilizer Rates on Fall Rye Variety Protein, 2019



# Double Cropping Irrigated Winter Cereals for Silage

## Funding

Funded by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT).

## Project Lead

- Travis Peardon, Livestock & Feed Extension Agronomist, SK Ministry of Agriculture
- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)

## Objectives

The ability to grow two crops in a single growing season is a great attraction to cattle producers. Stamp Seeds, Enchant Alberta, reports that commercial fall rye has been producing 15-18 tons/ac silage production under irrigation. This amount of silage production rivals corn with potentially better net returns due to cheaper production costs. If this yield could be augmented with an additional forage harvest of spring barley the economic returns could possible greatly exceed the returns of a single cut of an annual cereal forage production system. In the irrigated are of the South Saskatchewan Irrigation Development District the ability of planting fall cereals onto either potato or dry bean harvested ground could have large environmental benefits in the prevention of soil erosion from wind drift. A double crop production system would also facilitate custom harvesting in that custom operators are typically available in early July having completed the first cut of alfalfa and waiting for the annual cereal harvest.

The study will evaluate how hybrid fall rye compares to a convention fall rye, fall triticale and winter wheat in silage yield and their potential to integrate into a double cropping system with spring barley.

## Research Plan

The trial was established at the ICDC rented land adjacent to the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC). The trial was established in a randomized factorial design with three replications. Two varieties each of fall rye (Hazlet – conventional fall rye and Bono – hybrid fall rye), winter wheat (Pintail and Wildfire) and winter triticale (Louma and Metzger) were seeded on September 14, 2018. Seeded plot size was 8m x 1.5m. All winter cereals were seeded at a rate of 300 viable seeds/m$^2$ after adjustment for % germination and seed weight. Each winter cereal was fertilized with 110 kg N/ha as 46-0-0 and 25 kg $P_2O_5$/ha as 11-52-0. Nitrogen fertilizer was side-banded; phosphorus fertilizer was seed placed. On May 6, 2019 spring barley (CDC Maverick) was planted adjacent to the winter cereals, winter and spring cereals were separated by a guard plot of spring barley and fall rye. Spring barley was also seeded at a rate of 300 viable seeds/m$^2$ after adjustment for % germination and seed weight. Spring barley received the identical fertilizer supplementations as the winter cereals. An additional 45 kg N/ha was surface broadcast across the entire plot area on April 17, 2019. Selection of winter cereal and spring barley varieties was based on their biomass potential for forage production. Weed control involved a single fall pre-seed application of glyphosate, with an in-season tank mix application of Bison (tralkoxydim) and Buctril M (bromoxynil +MCPA ester) on June 1, 2019. The winter cereals were cut for forage using a Hege small plot forage combine on July 2. The harvest was timed to the winter cereal that first reached the soft dough growth stage. Plot harvest size was 6m x 1.5m. Total plot weight was recorded and subsamples obtained for forage material moisture content. Immediately after winter cereal forage harvest occurred the winter cereal plots were sprayed with 0.67 L/ac glyphosate and immediately re-planted with CDC Maverick spring barley. Forage harvest of the May 6 planted spring barley occurred on July 29 in the identical manner as described above. Dried forage harvest biomass was subsampled and ground in a Wiley-Mill to pass through 2 mm sieves using stainless steel blades. Ground plant material was submitted to Central Testing Laboratories in Winnipeg, MB for feed quality analyses. Shortly after this the trial was discontinued – see results below.

## Results

Unfortunately, the trial was discontinued mid-July when it was apparent that very poor establishment was occurring with spring barley re-planted into harvested winter cereal residue plots. Planting depth is believed to be a contributing factor, seed was planted 5.0-7.5cm deep. However, the plot was irrigated with 71 mm of irrigation in total within the first 13 days after planting. The soil was sufficiently moist that the barley was expected to emerge even from this depth. It did not. The spotty and uneven emergence that did occur cannot be fully explained but has the investigators questioning the possibility of an allelopathic effect from the winter cereals. This is speculative but worthy of further investigation, hopefully, to disprove.

Further irrigated yields obtained were lower than normally might be expected, this can be attributed in large part, to a breakdown of the linear irrigation system providing water to this trial. The system had an underground rupture that required major excavation, and irrigation was not available through much of June and early July. This was a critical period for winter cereal development, plant stress became apparent and undoubtedly yields were impacted. Spring barley biomass was also adversely influenced.

Although the trial was not completed there is merit to review the information that was collected. Results of forage yield are summarized in Table 1, with statistical analyses for only yield conducted. Forage yield was greatest for the spring barley. Within the winter cereals, the fall rye obtained the highest biomass and established itself as the most likely candidate for double cropping as it reached the soft dough stage well before either winter wheat or winter triticale. The criteria used for this study was to cut all winter cereals when the first winter cereal crop reached the desired forage growth stage. Obviously the dates to soft dough were not obtained for winter wheat and winter triticale varieties but observationally they were quite far behind fall rye in physiological development. Therefore, if double cropping is feasible in Saskatchewan fall rye is best suited on the basis of maturation. The forage yield of the hybrid fall rye was numerically, but not statistically higher, than the conventional fall rye variety.

Forage quality analyses are outlined in Table 2. Crude protein of all samples ranged from a low of 6.52% in the Hazlet fall rye to a high of 8.19% in the Pintail winter wheat. This is lower than expected as usually cereal silage will have a crude protein in the 11 to 13 % range. This is attributed to problems with the irrigation system during kernel formation that affected filling. Total Digestible Nutrients (TDN) also had a wide variance from a high of 65.26 in the CDC Maverick barley to a low of 50.20 in the Louma winter triticale. TDN in cereal silage usually ranges from 60 to 65 percent. The observed variance experienced in this trial is attributed to maturity differences between varieties at time of harvest. Varieties with better kernel development tended to have higher TDN. Calcium levels also varied greatly among varieties while other macronutrients remained fairly constant.

This trial has been modified and re-established with winter cereals planted on September 17, 2019. In this new study 3 varieties of fall rye were used; Hazlet a conventional open pollinated variety, Gatano a hybrid variety and Propower, a potential forage hybrid. These will be compared to spring seeded forage barley, oat and millet. These spring cereals will each be planted into the winter cereal residue after they have been harvested.

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. Funding is gratefully acknowledged.

Table 1. Forage Yield and Maturity of Fall Cereals and Spring Barley.

| Cereal | Variety | Yield kg/ha | Yield t/ac | % Yield of spring wheat | Julian days to soft dough | Average plant height on June 25 |
|---|---|---|---|---|---|---|
| Fall Rye | Hazlet - conventional | 6481 | 2.89 | 62 | 183 | 108 |
| Fall Rye | Bono - hybrid | 6947 | 3.10 | 66 | 183 | 95 |
| Winter Wheat | Pintail | 5776 | 2.58 | 55 | >183 | 85 |
| Winter Wheat | Wildfire | 6144 | 2.74 | 58 | >183 | 83 |
| Winter Triticale | Louma | 5611 | 2.50 | 53 | >183 | 132 |
| Winter Triticale | Metzger | 5801 | 2.59 | 55 | >183 | 115 |
| Spring Barley | CDC Maverick | 10519 | 4.69 | 100 | 207 | 73 |
| | LSD (0.05) | 982 | 0.44 | | | |
| | CV (%) | 8.2 | 8.2 | | | |

Table 2. Forage Feed Quality Analysis of Varieties.

| Cereal | Variety | Crude Protein | Nutrients | | | | | ADF | NDF | TDN |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ca | P | Mg | K | Na | | | |
| | | % | | | | | | | | |
| Fall Rye | Hazlet | 6.52 | 0.18 | 0.13 | 0.11 | 1.43 | 0.01 | 35.89 | 56.11 | 60.30 |
| Fall Rye | Bono | 7.10 | 0.17 | 0.14 | 0.11 | 1.34 | 0.01 | 33.38 | 52.40 | 62.97 |
| Winter Wheat | Pintail | 8.19 | 0.11 | 0.15 | 0.11 | 1.39 | 0.01 | 36.05 | 56.46 | 60.12 |
| Winter Wheat | Wildfire | 8.16 | 0.12 | 0.15 | 0.11 | 1.38 | 0.01 | 35.48 | 55.69 | 60.73 |
| Winter Triticale | Louma | 7.49 | 0.11 | 0.14 | 0.08 | 1.61 | 0.01 | 45.33 | 67.71 | 50.20 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Winter Triticale | Metzger | 7.46 | 0.14 | 0.14 | 0.08 | 1.67 | 0.01 | 44.04 | 64.82 | 51.58 |
| Spring Barley | CDC Maverick | 7.97 | 0.23 | 0.15 | 0.16 | 1.60 | 0.07 | 31.24 | 50.25 | 65.26 |
| | LSD (0.05) | 0.67 | 0.02 | NS | 0.01 | 0.16 | >0.001 | 2.13 | 2.3 | 2.3 |
| | CV (%) | 5.0 | 6.9 | 7.5 | 6.7 | 5.9 | 20.4 | 3.2 | 2.2 | 2.2 |

ADF = Acid Detergent Fibre
NDF = Neutral Detergent Fibre
TDN = Total Digestible Nutrients
NS = Not Significant

# Lentil Input Study

## Funding

Funded by the Agriculture Development Fund (ADF)

## Project Lead

- Project P.I: Jessica Weber (WARC)
- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Western Applied Research Corporation (WARC)
- Indian Head Research Foundation (IHARF)
- East Central Research Foundation (ECRF)
- Wheatland Conservation Area Inc. (WCA)

## Objectives

The objective of the study is to;

(1) Determine which combination of common agronomic practices (seeding rate, herbicides and fungicides) produce the greatest lentil yield and
(2) Determine which agronomic practices provide the best economic return to producers.

## Research Plan

The trial was established land assigned to ICDC at CSIDC (Field #12 NE). The trial was established in a 3 x 3 x 2 way factorial combination of three seeding rates (130, 190 and 260 viable seeds/m2), three fungicide treatments (no application, single application, two applications) and two herbicide management practices (pre-seed burn off + pre-emergent + in-crop and pre-seed burn off + in-crop) for a total of 18 treatments with four replications. Pre-seed burn off was with a glyphosate application at a rate of 0.67 L/ac as Roundup Transorb HC by itself or in combination with Focus (pyroxasulfone + carfentrazone) at 280 ml/ha on May 8. The trial was seeded into cereal stubble on May 14. Seeded plot size was 10 m x 1.5 m. In-crop applications of Ares (imazamox + imazapyr) at 244 ml/c + Merge at 0.5L/100L occurred on June 17 followed by Centurion (clethodim) at 75 ml/ac + Amigo at 0.5L/100L on June 20. Fungicidal application was either a single application of Priaxor (fluxapyroxad + pyraclostobin) at 180 ml/ac on July 15 or with selected treatments receiving an additional application of Lance WDG (boscalid) at 170 g/ac on July 22. A foliar application of Matador (lambda-cyhalothrin) at 94 ml/ac was applied July 27 for control of aphids. The trial was desiccated with Reglone (diquat) at 0.81 L /ac on August 25 and plots were harvested by direct cutting the plot with a small plot combine on August 20. Harvest plot area was 8 m x 1.5 m. All yield samples were cleaned to remove foreign material on stationary seed cleaners and cleaned seed yield and seed quality characteristics determined. Yields were adjusted to 14.0% moisture.

CDC Maxim, a small red lentil, was used as the test variety in the trial. Seeding rates were determined after adjusting for % germination, seed weight and an assumed 90% emergence. Emergence counts, used to determine plot plant populations were conducted by counting seedlings from 1 m length of two rows from each of the front and back portion of each plot. Weed populations were obtained from a 1m$^2$ area from front and back portions of each plot, weeds were divided into grass and broadleaf categories. Disease ratings were evaluated using a subjective visual rating scale of 0 – 10, with 10 = 90-100% infection. Plant biomass yield was obtained by harvesting a 0.25 m$^2$ area from both front and back portions of each plot, and separating lentil from weeds and retaining both samples. Biomass samples were dried and biomass yield expressed as dry weight.

Total in-season precipitation at CSIDC from May through to August 20 was 160 mm (6.3”). Total in-season irrigation applied to this trial was 56 mm (2.2”). Irrigation applications were light and intended to relieve plant moisture stress but minimize potential disease issues, so it mimicked commercial practices.

A treatment description is provided in Table 1.

Table 1. Seeding Rate, Herbicide and Fungicide Treatments

| Treatment | Seeding Rate (seed/$m^2$) | Fungicide | Herbicide | |
|---|---|---|---|---|
| | | | Pre | Post |
| 1 | 130 | None | Glyphosate + Focus | Ares + Centurion |
| 2 | 130 | None | Glyphosate | Ares + Centurion |
| 3 | 130 | Priaxor | Glyphosate + Focus | Ares + Centurion |
| 4 | 130 | Priaxor | Glyphosate | Ares + Centurion |
| 5 | 130 | Priaxor + Lance WDG | Glyphosate + Focus | Ares + Centurion |
| 6 | 130 | Priaxor + Lance WDG | Glyphosate | Ares + Centurion |
| 7 | 190 | None | Glyphosate + Focus | Ares + Centurion |
| 8 | 190 | None | Glyphosate | Ares + Centurion |
| 9 | 190 | Priaxor | Glyphosate + Focus | Ares + Centurion |
| 10 | 190 | Priaxor | Glyphosate | Ares + Centurion |
| 11 | 190 | Priaxor + Lance WDG | Glyphosate + Focus | Ares + Centurion |
| 12 | 190 | Priaxor + Lance WDG | Glyphosate | Ares + Centurion |
| 13 | 260 | None | Glyphosate + Focus | Ares + Centurion |
| 14 | 260 | None | Glyphosate | Ares + Centurion |
| 15 | 260 | Priaxor | Glyphosate + Focus | Ares + Centurion |
| 16 | 260 | Priaxor | Glyphosate | Ares + Centurion |
| 17 | 260 | Priaxor + Lance WDG | Glyphosate + Focus | Ares + Centurion |
| 18 | 260 | Priaxor + Lance WDG | Glyphosate | Ares + Centurion |

## Results

Seed quality and agronomic plant characteristics collected from each treatment are tabulated in Tables 2, 3 & 4. Factorial statistical analysis is given in Tables 5 & 6.

Results as tabulated in Tables 2, 3 & 4 will not be discussed and are presented for data preservation purposes. The discussion will be based upon results as tabulated and analysed in Tables 5 & 6.

Lentil seed yield was influenced by seeding rate, pre-seed herbicide and, to a lesser extent, fungicide application. Within seeding rates, highest yield was obtained with the low 130 seeds/$m^2$ rate. Yield declined by approximately 300 kg/ha (267 lbs/ac or 4.5 bu/ac) for each increase in seeding rate. It is believed that both the dry growing season (combined natural precipitation plus irrigation), and the development of late season disease, favored the low seeding rate. The glyphosate pre-seed treatment yielded higher than the glyphosate plus Focus application, the reason for this is not apparent? Fungicide application did provide a statistically significant yield at P = 0.059 confidence level. The application of Priaxor provided an additional 161 kg/ha (144 lbs/ac or 2.4 bu/ac) yield. The dual fungicide application of Priaxor plus Lance WDG offered no further advantage compared to the single Priaxor application. Neither test weights nor seed weight was influenced by any factor. Treatments had no meaningful or practical agronomic influence on days to flower or maturity. Seed rate naturally influenced plant populations but herbicide or fungicide applications did not. Final plant populations were perfectly correlated to target seeding rates. Lentil biomass was not statistically influenced by seeding rate, however, numerically biomass yield declined with increasing seeding rates. Pre-seed herbicide application did influence biomass and June weed populations with the Focus addition resulting in lower biomass, less disease but higher weeds. Once again, the reasons for this is unknown? Both fungicide applications provided a significant increase in biomass yield although no benefit occurred to a dual application versus the single application of Priaxor. Fungicide applications did significantly reduce disease incidence where applied. Anthracnose was the initial disease present and its suppression probably the major influence of the fungicides, a secondary infection of apparent stemphylium did occur later in the season post-fungicide application.

This was the third and final year trial of this trial. Results from ICDC will be compiled with results obtained from cooperating Agri-ARM locations and a final report prepared by Jessica Weber (WARC). The final report will be able to be accessed from the SK Ministry of Agricultures Agriculture Development Fund webpage, WARC and possibly the Agri-ARM website. A summary may be prepared and to follow in ICDC's 2020 Research & Development Annual Report.

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. Funding is gratefully acknowledged.

Table 2. Impact of Treatments on Seed Yield and Seed Characteristics,2019

| Trt | Seed Rate (seed/m$^2$) | Fungicide Application | Pre-seed Herbicide Application | Yield (kg/ha) | Test weight (kg/hl) | 1K Seed weight (gm) |
|---|---|---|---|---|---|---|
| 1 | 130 | None | Glyphosate + Focus | 1939 | 80.8 | 34.4 |
| 2 | 130 | None | Glyphosate | 1484 | 80.8 | 33.4 |
| 3 | 130 | Single | Glyphosate + Focus | 2118 | 80.6 | 34.4 |
| 4 | 130 | Single | Glyphosate | 1781 | 80.4 | 33.7 |
| 5 | 130 | Dual | Glyphosate + Focus | 2248 | 80.4 | 30.7 |
| 6 | 130 | Dual | Glyphosate | 1703 | 80.5 | 34.0 |
| 7 | 190 | None | Glyphosate + Focus | 1626 | 80.8 | 34.0 |
| 8 | 190 | None | Glyphosate | 1268 | 80.7 | 33.7 |
| 9 | 190 | Single | Glyphosate + Focus | 2040 | 80.9 | 33.2 |
| 10 | 190 | Single | Glyphosate | 1410 | 80.5 | 33.3 |
| 11 | 190 | Dual | Glyphosate + Focus | 1933 | 80.6 | 33.8 |
| 12 | 190 | Dual | Glyphosate | 1301 | 80.5 | 33.3 |
| 13 | 260 | None | Glyphosate + Focus | 1466 | 80.7 | 33.0 |
| 14 | 260 | None | Glyphosate | 1092 | 80.7 | 33.4 |
| 15 | 260 | Single | Glyphosate + Focus | 1456 | 80.5 | 33.1 |
| 16 | 260 | Single | Glyphosate | 1043 | 80.5 | 33.7 |
| 17 | 260 | Dual | Glyphosate + Focus | 1558 | 80.8 | 30.3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 18 | 260 | Dual | Glyphosate | 1170 | 80.6 | 32.7 |
| LSD (0.05) | | | | 389 | NS | NS |
| CV | | | | 17.2 | 0.4 | 7.4 |

NS = Not significant

Table 3. Impact of Treatments on Lentil Maturation and Plant Stand, 2019.

| Trt | Seed Rate (seed/m$^2$) | Fungicide Application | Pre-seed Herbicide Application | Days to Flower | Days to Mature | Plant Stand (plant/m$^2$) |
|---|---|---|---|---|---|---|
| 1 | 130 | None | Glyphosate + Focus | 51 | 87 | 144 |
| 2 | 130 | None | Glyphosate | 51 | 87 | 135 |
| 3 | 130 | Single | Glyphosate + Focus | 51 | 87 | 129 |
| 4 | 130 | Single | Glyphosate | 52 | 87 | 136 |
| 5 | 130 | Dual | Glyphosate + Focus | 51 | 86 | 142 |
| 6 | 130 | Dual | Glyphosate | 52 | 87 | 134 |
| 7 | 190 | None | Glyphosate + Focus | 52 | 86 | 192 |
| 8 | 190 | None | Glyphosate | 52 | 86 | 186 |
| 9 | 190 | Single | Glyphosate + Focus | 52 | 87 | 192 |
| 10 | 190 | Single | Glyphosate | 52 | 87 | 195 |
| 11 | 190 | Dual | Glyphosate + Focus | 51 | 87 | 184 |
| 12 | 190 | Dual | Glyphosate | 52 | 87 | 194 |
| 13 | 260 | None | Glyphosate + Focus | 51 | 87 | 250 |
| 14 | 260 | None | Glyphosate | 52 | 87 | 250 |
| 15 | 260 | Single | Glyphosate + Focus | 52 | 87 | 266 |
| 16 | 260 | Single | Glyphosate | 52 | 87 | 248 |
| 17 | 260 | Dual | Glyphosate + Focus | 52 | 87 | 268 |
| 18 | 260 | Dual | Glyphosate | 52 | 86 | 242 |
| LSD (0.05) | | | | 0.7 | NS | 24 |
| CV | | | | 0.9 | 0.7 | 8.7 |

NS = Not significant

Table 4: Impact of Treatments on Lentil and Weed Biomass and Weed Populations, 2019.

| Trt | Seed Rate (seed/m$^2$) | Fungicide Application | Pre-seed Herbicide Application | Lentil Biomass (kg/ha) | Disease Rating* | Total Plot Weed May 13 | Total Plot Weed June 12 |
|---|---|---|---|---|---|---|---|
| 1 | 130 | None | Glyphosate + Focus | 15634 | 2.5 | 44 | 36 |
| 2 | 130 | None | Glyphosate | 14654 | 3.6 | 42 | 66 |
| 3 | 130 | Single | Glyphosate + Focus | 18789 | 2.8 | 46 | 20 |
| 4 | 130 | Single | Glyphosate | 15945 | 2.8 | 45 | 77 |
| 5 | 130 | Dual | Glyphosate + Focus | 18579 | 2.0 | 45 | 44 |
| 6 | 130 | Dual | Glyphosate | 17482 | 2.6 | 39 | 52 |
| 7 | 190 | None | Glyphosate + Focus | 16012 | 3.3 | 40 | 25 |
| 8 | 190 | None | Glyphosate | 13329 | 4.3 | 50 | 75 |
| 9 | 190 | Single | Glyphosate + Focus | 17299 | 3.3 | 49 | 33 |
| 10 | 190 | Single | Glyphosate | 17228 | 3.6 | 41 | 70 |
| 11 | 190 | Dual | Glyphosate + Focus | 17924 | 2.9 | 44 | 27 |
| 12 | 190 | Dual | Glyphosate | 15376 | 3.9 | 43 | 40 |
| 13 | 260 | None | Glyphosate + Focus | 17371 | 4.6 | 48 | 39 |
| 14 | 260 | None | Glyphosate | 14237 | 5.9 | 54 | 51 |
| 15 | 260 | Single | Glyphosate + Focus | 15590 | 3.6 | 36 | 22 |
| 16 | 260 | Single | Glyphosate | 15368 | 4.8 | 55 | 45 |
| 17 | 260 | Dual | Glyphosate + Focus | 17289 | 3.0 | 41 | 23 |
| 18 | 260 | Dual | Glyphosate | 16176 | 4.1 | 37 | 77 |
| LSD (0.05) | | | | NS | 0.9 | NS | 36 |
| CV | | | | 15.7 | 18.5 | 24.1 | 56.0 |

Disease Rating: 0 = absent; 10 = very severe NS = not significant

Table 5. Factorial Analysis of Seeding Rate, Herbicide and Fungicide Application on Seed Quality & Agronomics of Lentil, 2019.

| Treatment | Yield (kg/ha) | Test weight (kg/hl) | 1K Seed weight (gm) | Days to Flower | Days to Mature | Plant Stand (plant/$m^2$) |
|---|---|---|---|---|---|---|
| **Seeding Rate (seeds/$m^2$)** | | | | | | |
| 130 | 1878 | 80.6 | 33.4 | 51 | 87 | 136 |
| 190 | 1596 | 80.6 | 33.5 | 52 | 87 | 191 |
| 260 | 1298 | 80.6 | 32.7 | 52 | 87 | 254 |
| LSD (0.05) | 159 | NS | NS | 0.2 | NS | 10 |
| **Pre-Seed Herbicide Application** | | | | | | |
| Glyphosate | 1820 | 80.7 | 33.0 | 51 | 87 | 196 |
| Glyphosate + Focus | 1361 | 80.6 | 33.5 | 52 | 87 | 191 |
| LSD (0.05) | 130 | NS | NS | 0.2 | NS | NS |
| **Fungicide Application** | | | | | | |
| None | 1479 | 80.7 | 33.7 | 51 | 86 | 193 |
| Priaxor | 1640 | 80.6 | 33.6 | 52 | 87 | 194 |
| Priaxor + Lance WDG | 1652 | 80.5 | 32.5 | 52 | 87 | 194 |
| LSD (0.05) | NS* | NS* | NS | NS* | NS* | NS |
| CV (%) | 17.2 | 0.4 | 7.4 | 0.9 | 0.7 | 8.7 |

NS = not significant

NS* = not significant at P<0.05 but significant at P<0.10

Table 6. Factorial Analysis of Seeding Rate, Herbicide and Fungicide Application on Lentil and Weed Biomass & Weed Populations, 2019.

| Treatment | Lentil Biomass (kg/ha) | Disease Rating 0 = absent 10 = severe | Total Plot Weed May 13 | Total Plot Weed June 12 |
|---|---|---|---|---|
| **Seeding Rate (seeds/$m^2$)** | | | | |
| 130 | 16847 | 2.7 | 44 | 49 |
| 190 | 16195 | 3.5 | 45 | 45 |
| 260 | 16005 | 4.3 | 45 | 43 |
| LSD (0.05) | NS | 0.4 | NS | NS |
| **Pre-Seed Herbicide Application** | | | | |
| Glyphosate | 17165 | 3.1 | 44 | 30 |
| Glyphosate + Focus | 15533 | 3.9 | 45 | 61 |
| LSD (0.05) | 1214 | 0.3 | NS | 15 |
| **Fungicide Application** | | | | |
| None | 15206 | 4.0 | 46 | 49 |
| Priaxor | 16703 | 3.5 | 45 | 44 |
| Priaxor + Lance WDG | 17138 | 3.1 | 42 | 44 |
| LSD (0.05) | 1486 | 0.4 | NS | NS |
| CV (%) | 15.7 | 18.5 | 24.1 | 56.0 |

NS = not significant

# Production Management Strategies to Improve Pea Root Health in Aphanomyces Contaminated Soils

## Funding

Funded by the Saskatchewan Pulse Growers Applied Research and Demonstration Program (ARD)

## Project Lead

- Project P.I: Jessica Weber (WARC)
- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Western Applied Research Corporation (WARC)
- North East Research Foundation (NARF)
- Wheatland Conservation Association (WCA)

## Objectives

To demonstrate multiple management strategies to reduce the effect of aphanomyces on field pea root health through root health assessments and overall yield production.

## Research Plan

Note that this trial was also conducted at each of the additional Agri-ARM sites listed above.

The ICDC trial was established at CSIDC in the spring of 2019 on Field #12 (NW quadrant). The trial was established in a factorial RBDC design replicated four times. Due to nature of the study plots were seeded twice the normal width to better facilitate disease ratings. CDC Inca Yellow Class field pea was seeded into wheat stubble on May 9, planting depth was approximately 6.25 cm (2.5"). Seed was planted to establish a final plant population of 85 plants/m2 (seed rate adjusted to adjust for % germination, seed weight and 90% seedling survival). The factors evaluated included fertility, herbicide, seed treatment, and foliar nutrients. Treatments are shown in Table 1. Pre-seed glyphosate (Glyphosate 540 @ 1L/ac) and trifluralin (Trifluralin 480 EC @ 0.65 L/ac) were applied May 6 according to recommended practices. Seed treatments, where applied, included Vibrance Maxx RFC (fludioxonil and metalaxyl-M @ 100 ml/100 kg seed) and Intego Solo (ethaboxam @ 19.6 ml/100 kg seed). Fertilizer in the "Low" P treatments was straight monoammonium nitrate (11-51-0), the "High" fertility treatments were a blend of monoammonium nitrate (11-51-0) plus potassium chloride (0-0-60) and ammonium sulphate (21-0-0-24). The foliar application was of Rogue II, a chelated solution of Zn, Mn and B from the RackTM, applied at the time of in-crop herbicide applications, June 10. In-crop herbicides were Viper ADV (imazamox and bentazon @ 400 ml/ac) plus UAN (@0.81 L/ac). A blanket fungicide application of Priaxor (fluxapyroxad and pyraclostrobin @ 180 ml/ac) was applied July 18. The entire trial was desiccated with Reglone (diquat @ 0.83 L/ac) on August 15. The trial was direct harvested with a small plot combine August 21, 2019. Plot yield samples were cleaned and yields adjusted to 16% moisture.

Prior to trial establishment a composite sample of soil was collected and sent to Discovery Seed Labs for testing for the presence aphanomyces, the test result was positive. Soil sampling was also conducted in the spring for nutrient analyses; results revealed the following available nutrients: N = 24 kg/ha (0-60cm), $P_2O_5$ = 11 kg/ha (0-15cm), $K_2O$ = 177 kg/ha (0-15cm) and $SO_4$-S = 61 kg/ha (0-30cm).

**Treatment List:**

Table 1. Production management strategies to improve field pea root health in aphanomyces contaminated soils treatment list.

| TRT | Pre-Seed Herbicide | Fertilizer | Seed Treatment | Foliar Nutrient |
|---|---|---|---|---|
| 1 | Glyphosate | 20 P only MAP "Low" | No Seed Treatment | N/A |
| 2 | Glyphosate | 20 P only MAP | Vibrance Maxx + Intego | N/A |
| 3 | Glyphosate + Trifluralin | 20 P only MAP | Vibrance Maxx | N/A |
| 4 | Glyphosate + Trifluralin | 20 P only MAP | Vibrance Maxx + Intego | N/A |
| 5 | Glyphosate + Trifluralin | 20 P only MAP | Vibrance Maxx + Intego | Rogue II |
| 6 | Glyphosate | 50 P, 20 K, 10 S "High" | No Seed Treatment | N/A |
| 7 | Glyphosate | 50 P, 20 K, 10 S | Vibrance Maxx + Intego | N/A |
| 8 | Glyphosate + Trifluralin | 50 P, 20 K, 10 S | Vibrance Maxx | N/A |
| 9 | Glyphosate + Trifluralin | 50 P, 20 K, 10 S | Vibrance Maxx + Intego | N/A |
| 10 | Glyphosate + Trifluralin | 50 P, 20 K, 10 S | Vibrance Maxx + Intego | Rogue II |

**Data Collection:**

Plant densities were determined by counting numbers of emerged plants on 2 x 1 meter row lengths from both front and back portions of each plot approximately four weeks after crop emergence. Disease root rating assessments occurred three and eight weeks after planting on five plants per plot. Timing of ratings depended on soil moisture levels at each location. At seven weeks after seeding the crop stage of the peas was approaching mid-flowering. A root disease scale from 0 – 5 was used where;

0 = no symptoms
1= some clear symptoms observed
2= symptoms without rot spread more than half of the root
3= root rot observed on half the root
4= root rot spread on more than half the root
5= root rot spread to the whole root.

Nodule scores where determined by a numerically additive scale of using the following criteria;

1. Plant Growth

5 = Plants green and vigorous
3 = Plants green and relatively small
2 = Plants slightly chlorotic
1 = Plants slightly chlorotic

2. Nodule Colour/Number

5 = Greater than 5 clusters/groups of pink pigmented nodules
3 = 3-5 clusters/groups of predominately pink nodules
1 = < 3 groups of nodules or nodules whitish/greenish in colour
0 = No nodules or nodules white or green in colour

3. Nodule Position

3 = Crown or lateral root nodulation
2 = Generally crown nodulation
1 = Generally lateral root nodulation

Total Score

11 – 13 = Effective nodulation, good N-fixation potential
7 – 10 = Nodulation less effective, N-fixation potential reduced
1 – 6 = Generally unsatisfactory nodulation

**Growing Conditions:**

Mean monthly temperatures and precipitation amounts are listed in Table 2 and 3. The 2019 season was cooler than the long-term averages. Rainfall was below average. Plant development and growth was slow, particularly in the first full month of growth. The irrigation applied to the site was 8 mm in May, 62.5 mm in June, 45.5 mm in July and 12.5 mm in August.

Table 2. Mean monthly temperature from April to September 2019 at Saskatchewan Trial Locations.

| Location | Year | May | June | July | August | September | Average |
|---|---|---|---|---|---|---|---|
| | | ----------------------------*Mean Temperature (°C)* ------------------- | | | | | |
| Outlook | 2019 | 9.9 | 16.0 | 18.0 | 16.2 | NA | 15.0 |
| | ***Long-term*** | ***11.5*** | ***16.1*** | ***18.9*** | ***18.0*** | **NA** | **16.1** |

Table 3. Precipitation amounts vs long-term (30 year) means for the 2019 growing seasons.

| Location | Year | May | June | July | August | September | Sum Total |
|---|---|---|---|---|---|---|---|
| | | ----------------------------*Precipitation (mm)* ------------------- | | | | | |
| Outlook | 2019 | 13.2 | 90.2 | 43.8 | 39.6 | NA | 186.6 |
| | ***Long-term*** | ***42.6*** | ***63.9*** | ***56.1*** | ***42.8*** | **NA** | **205.4** |

## Results

The influence of the various input product combinations on yield, seed & plant characteristics, and nodule and disease evaluations are shown in Tables 4 – 6.

Statistically, yield was not influenced by any additive inputs above the "base" treatment of glyphosate pre-seed and 20 $P_2O_5$/ha. Numerical yield gains were achieved with additional crop inputs but we cannot conclude, with any certainty, that these gains were actually due to inputs applied or simply to random variation within the experimental design. Some trends do occur and can be summed as follows;

- Yields appear elevated averaging comparable "Low" to "High" fertility treatments: Low = 4419 kg/ha (65.7 bu/ac) compared to High = 4543 kg/ha (67.6 bu/ac). This response, if real, is suspected to be due to elevated P application as available soil P was low while K and S were adequate.
- Yields appear elevated when applying Trifluralin versus comparable treatments without: Without Trifluralin = 4383 kg/ha (65.2 bu/ac) compared to with Trifluralin = 4448 kg/ha (66.1

bu/ac). Though weed pressure was not evaluated there may have been slightly less weeds with the Trifluralin application.

- Yields appear elevated when applying Rogue II versus comparable treatments without: Without Rogue II = 4448 kg/ha (66.1 bu/ac) compared with Rogue II = 4517 kg/ha (67.2 bu/ac)
- Seed treatments had no influence on seed yield.

Any of the above yield gains are very modest and the cost of the inputs not recouped by the yields obtained from their application.

In general, yield was reasonably high with an average across all treatments of 4481 kg/ha (66.6 bu/ac). It is apparent that disease pressure from aphanomyces was not sufficient to severely limit yield in 2019. Disease evaluations at 8 weeks after planting is shown in Table 6. Data for the 3 week after planting is not presented as no presence of aphanomyces was detected at this time point. Up to 3 weeks after planting conditions were very dry which would not have been favourable for the development of root rot. However, by 8 weeks both rainfall and irrigation had been applied such that the roots exhibited symptoms of infection but plant growth and development appeared to be vigorous such that disease pressure did not appear to be yield limiting. No strong treatment responses were apparent with respect to plant root rot disease.

Inputs applied within this study had no, or little impact, on any of the other observations listed in Tables 4 through 6.

This study has been submitted for an additional year of funding from the Ministry of Agricultures ADOPT funding program. A summary of the combined site results will be prepared by Jessica Weber and a report submitted to the Saskatchewan Pulse Growers.

**Acknowledgements**
Financial support was provided by the Saskatchewan Pulse Growers. All funding is gratefully acknowledged.

Table 4. Influence of Treatments on Field Pea Yield and Seed Characteristics.

| Trt | Pre-herbicide | Fertilizer | | | | Seed Treatment | Yield (kg/ha) | Protein (%) | Test weight (kg/hl) | 1K Seed weight (gm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | P | K | S | Micro's Rogue II | | | | | |
| 1 | glyphosate | 20 | | | | None | 4324 | 21.6 | 82.8 | 232 |
| 2 | glyphosate | 20 | | | | Vibrance Maxx + Intego | 4306 | 21.7 | 82.7 | 226 |
| 3 | glyphosate + trifluralin | 20 | | | | | 4615 | 21.6 | 83.1 | 231 |
| 4 | glyphosate + trifluralin | 20 | | | | Vibrance Maxx + Intego | 4361 | 21.5 | 83.0 | 232 |
| 5 | glyphosate + trifluralin | 20 | | | yes | Vibrance Maxx + Intego | 4490 | 21.8 | 82.9 | 226 |
| 6 | glyphosate | 50 | 20 | 10 | | None | 4785 | 21.8 | 82.5 | 223 |
| 7 | glyphosate | 50 | 20 | 10 | | Vibrance Maxx + Intego | 4460 | 21.9 | 82.6 | 220 |
| 8 | glyphosate + trifluralin | 50 | 20 | 10 | | | 4390 | 21.7 | 82.5 | 225 |
| 9 | glyphosate + trifluralin | 50 | 20 | 10 | | Vibrance Maxx + Intego | 4536 | 21.8 | 82.6 | 222 |
| 10 | glyphosate + trifluralin | 50 | 20 | 10 | yes | Vibrance Maxx + Intego | 4544 | 22.3 | 82.8 | 223 |
| | | | | | | LSD (0.05) | NS | NS | NS | 6.6 |
| | | | | | | CV (%) | 5.8 | 2.1 | 0.8 | 2.0 |

Table 5. Influence of Treatments on Field Pea Plant Characteristics.

| Trt | Pre-herbicide | Fertilizer P | K | S | Micro's Rogue II | Seed Treatment | Flower (days) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | glyphosate | 20 | | | | None | 56 | 95 | 99 | 4.3 |
| 2 | glyphosate | 20 | | | | Vibrance Maxx + Intego | 58 | 96 | 102 | 6.0 |
| 3 | glyphosate + trifluralin | 20 | | | | | 58 | 96 | 105 | 5.0 |
| 4 | glyphosate + trifluralin | 20 | | | | Vibrance Maxx + Intego | 58 | 96 | 99 | 5.3 |
| 5 | glyphosate + trifluralin | 20 | | | yes | Vibrance Maxx + Intego | 58 | 96 | 102 | 4.5 |
| 6 | glyphosate | 50 | 20 | 10 | | None | 57 | 96 | 104 | 5.5 |
| 7 | glyphosate | 50 | 20 | 10 | | Vibrance Maxx + Intego | 58 | 96 | 109 | 6.0 |
| 8 | glyphosate + trifluralin | 50 | 20 | 10 | | | 58 | 96 | 106 | 5.3 |
| 9 | glyphosate + trifluralin | 50 | 20 | 10 | | Vibrance Maxx + Intego | 58 | 96 | 106 | 5.0 |
| 10 | glyphosate + trifluralin | 50 | 20 | 10 | yes | Vibrance Maxx + Intego | 58 | 96 | 108 | 6.5 |
| | | | | | | LSD (0.05) | 0.7 | NS | NS* | NS |
| | | | | | | CV (%) | 0.8 | 0.5 | 4.7 | 23.9 |

NS = not significant

NS* = not significant at P<0.05 but significant at P<0.10

Table 6. Influence of Treatments on Field Pea Plant Population & Nodule/Disease Index.

| Trt | Pre-herbicide | Fertilizer P | K | S | Micro's Rogue II | Seed Treatment | Plants ($m^2$) | Nod Score 3 wks | Nod Score Flower | Disease Score |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | glyphosate | 20 | | | | None | 88 | 11 | 10.7 | 4.3 |
| 2 | glyphosate | 20 | | | | Vibrance Maxx + Intego | 81 | 11 | 10.5 | 4.1 |
| 3 | glyphosate + trifluralin | 20 | | | | | 80 | 11 | 9.9 | 4.2 |
| 4 | glyphosate + trifluralin | 20 | | | | Vibrance Maxx + Intego | 90 | 11 | 10.5 | 4.1 |
| 5 | glyphosate + trifluralin | 20 | | | yes | Vibrance Maxx + Intego | 80 | 11 | 10.1 | 4.4 |
| 6 | glyphosate | 50 | 20 | 10 | | None | 96 | 11 | 10.1 | 4.2 |
| 7 | glyphosate | 50 | 20 | 10 | | Vibrance Maxx + Intego | 82 | 11 | 10.8 | 4.4 |
| 8 | glyphosate + trifluralin | 50 | 20 | 10 | | | 76 | 11 | 10.7 | 4.4 |
| 9 | glyphosate + trifluralin | 50 | 20 | 10 | | Vibrance Maxx + Intego | 71 | 11 | 10.7 | 4.5 |
| 10 | glyphosate + trifluralin | 50 | 20 | 10 | yes | Vibrance Maxx + Intego | 86 | 11 | 11.1 | 4.3 |
| | | | | | | LSD (0.05) | NS | NS | NS | NS |
| | | | | | | CV (%) | 15.7 | 0 | 6.0 | 7.6 |

# Enhanced Fertilizer Management for Optimizing Yield and Protein in Field Pea

## Funding

Funded by the Saskatchewan Pulse Growers Applied Research and Demonstration Program (ARD)

## Project Lead

- Project P.I: Chris Holzapfel (IHARF)
- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Indian Head Applied Research Foundation (IHARF)
- East Central Research Foundation (ECRF)
- Western Applied Research Corporation (WARC)
- North East Research Foundation (NARF)
- Wheatland Conservation Association (WCA)

## Objectives

The objective of the study is to evaluate field pea yield and protein response to various rates and combinations of nitrogen (N), phosphorus (P) and sulphur (S) fertilizer additions.

## Research Plan

Note that this trial was also conducted at each of the additional Agri-ARM sites listed above.

The ICDC trial was established at CSIDC in the spring of 2019 on Field #12 (NW quadrant). The trial was established in a factorial RBDC design replicated four times. Treatments are listed in Table 1. The treatments were designed to basically evaluate phosphorus (P) and sulphur (S) responses as well as several nitrogen (N) fertilization strategies on yield and protein. To capture the possible full response range an absolute control (unfertilized) and "High" fertility treatments were included. P and S sources used were monoammonium phosphate (11-52-0) and ammonium sulphate (21-0-0-24). The N source was urea (46-0-0) except for treatment 12 & 13 where polymer coated urea (ESN; 44-0-0) was used.

Table 1. Fertilizer Treatments of Field Pea, 2019

| Trt # | Fertilizer Applied kg N-P2O5-K2O-S/ha | Treatment Discription/Objective | |
|---|---|---|---|
| 1 | 0-0-0-0 | Absolute control – no fertilizer | |
| 2 | 17.2-0-0-10 | 0 P control | Phosphorus Response |
| 3 | 17.2-20-0-10 | 20 P | |
| 4 | 17.2-40-0-10 | 40 P | |
| 5 | 21.4-60-0-10 | 60 P | |
| 6 | 25.7-80-0-10 | 80 P | |
| 7 | 17.2-40-0-0 | 0 S | Sulphur Response |
| 8 | 17.2-40-0-5 | 5 S | |
| 9 | 21.6-40-0-15 | 15 S | |
| 10 | 40-40-0-10 | N Rates, Forms, and Timing/Placement for Yield and Protein | |
| 11 | 17.2-40-0-10 + 40 N in-crop broadcast Urea | | |
| 12 | 40-40-0-10* (40 N as MAP/AS/ESN) | | |
| 13 | 40-80-0-15* (ultrahigh fertility/ESN) | High Fertility | |

The trial area received a pre-seed herbicide application of glyphosate (890 gm/ha) on May 6. CDC Spectrum field pea was seeded May 9 at a rate of 100 viable seeds/$m^2$ (adjusted for % germination, seed size and 90% seedling survival). Seed was treated with Apron Maxx RTA (fludioxonil, metalaxyl-M and S-isomer, thiabendazole @ 3.25 ml/kg seed) and Stress Shield 600 (imidacloprid @ 1.04 ml/kg seed) for disease and insect protection. In crop application of Viper ADV (imazamox and bentazon @ 400 ml/ac) plus UAN (@0.81 L/ac) was applied June 6 for weed control. The in-crop broadcast application of N occurred on June 27. Normalized difference vegetative index (NDVI) remote sensing measurements were conducted using a hand held instrument swept along the length of each plot at the same height, on June 7 when pea plants were in the 5-node stage and again June 17 when in the 8-node stage. A fungicide application of Priaxor (fluxapyroxad and pyraclostrobin @ 180 ml/ac) was applied July 18. The entire trial was desiccated with Reglone (diquat @ 0.83 L/ac) on August 20. The trial was direct harvested with a small plot combine August 22, 2019. Plot yield samples were cleaned and yields adjusted to 16% moisture.

Mean monthly temperatures and precipitation amounts are listed in Table 2 and 3. The 2019 season was cooler than the long-term averages. Rainfall was below average. Plant development and growth was slow, particularly in the first full month of growth. The irrigation applied to the site was 8 mm in May, 62.5 mm in June, 45.5 mm in July and 12.5 mm in August.

Table 2. Mean monthly temperature from April to September 2019 at Saskatchewan Trial Locations.

| Location | Year | May | June | July | August | September | Average |
|---|---|---|---|---|---|---|---|
| | | -----------------------------*Mean Temperature (°C)* ------------------- | | | | | |
| Outlook | 2019 | 9.9 | 16.0 | 18.0 | 16.2 | NA | 15.0 |
| | ***Long-term*** | ***11.5*** | ***16.1*** | ***18.9*** | ***18.0*** | **NA** | **16.1** |

Table 3. Precipitation amounts vs long-term (30 year) means for the 2019 growing seasons.

| Location | Year | May | June | July | August | September | Sum Total |
|---|---|---|---|---|---|---|---|
| | | ----------------------------*Precipitation (mm)* ------------------- | | | | | |
| Outlook | 2019 | 13.2 | 90.2 | 43.8 | 39.6 | NA | 186.6 |
| | ***Long-term*** | ***42.6*** | ***63.9*** | ***56.1*** | ***42.8*** | **NA** | **205.4** |

Soil test results from soils within the trial area and collected on April 16, 2019 are shown in Table 4.
Table 4. Soil Test Analyses Results.

| $NO_3$-N kg/ha (0-60cm) | Olsen-P ppm (0-15cm) | K ppm (0-15cm) | S kg/ha (0-30cm) | Soil Organic Matter (%) | Soil pH (0-15cm) | Soil pH (15-60cm) | Sol. Salts mmho/cm (0-15cm) | Sol. Salts mmho/cm (15-30cm) |
|---|---|---|---|---|---|---|---|---|
| 24 | 5 | 158 | 61 | 2.3 | 8.1 | 8.3 | 0.3 | 0.34 |

## Results

Results obtained are outlined in Tables 5 through 7.

In general, pea yields where good, despite the slow growth and vigor exhibited in the early seedling stage of development. Median seed yield of all treatments was 4980 kg/ha (74 bu/ac). The unfertilized control (trt #1) was the lowest yielding, 792 kg/ha (11.6 bu/ac) lower yielding than the 2$^{nd}$ lowest yielding treatment of 0 P (trt #2). Statistical analysis indicates significant yields differences between treatments occur, but in general these occurred between the unfertilized vs fertilized treatments, it is difficult to attribute yield responses to any particular nutrient (N, P, S) within fertilized treatments. The "base" level of starter N (17.2 kg N/ha) applied appears to have a singular benefit to seed yield response for all treatments. To facilitate the discussion of the results the individual nutrient responses to their respective treatments, as outlined in Table 1, will be discussed separately.

<u>P Response Discussion</u>

Yields tended to numerically increase as P rates increased (trts #2-6), as illustrated in Figure 1. On the basis of the soil test information, a response to this nutrient would be the one most likely to occur as soil P levels were deemed low. Yield increased greatly to the first 20 kg $P_2O_5$/ha applied and then leveled. Yield responses to P rates beyond this level would not likely provide an economic return to the fertilizer. Protein did not generally appear to be influenced by P applications. However, the very high P rate of 80 kg $P_2O_5$/ha in treatment #6 did results in the highest protein level obtained in the study. This is possibly within experimental variation as the "ultrahigh" treatment #12 also had 80 kg $P_2O_5$/ha applied and did not achieve the same level of protein. Seed test weight and thousand kernel weight was not influenced by P application. NDVI values did tend to increase, part of this at the higher P rates of 60 and 80 kg $P_2O_5$/ha could be attributed to the extra N applied with these treatments in the 11-52-0 applied. NDVI values did tend to rise with each P rate so it is intriguing to consider if the P additions were possibly enhancing biological N-fixation within the pea plants. Days to flower and days to maturity appeared to be delayed at elevated P rates although the days delayed would not be considered to be agronomically detrimental. Plant heights were higher with P application and lodging did increase as P rates increased. The degree of lodging at the highest P rates used would not seriously impede harvest management.

S Response Discussion

Sulphur applications for comparison purposes are treatments 4, 7, 8 & 9. Yield was not influenced by S fertilizer applications, nor was seed protein. This was also the case, in general, for all other agronomic measurements acquired. Where treatment differences occurred there was no obvious trend associated with increasing S fertilization. Intuitively, these results are not surprizing or unexpected. This site, and irrigated fields in general throughout the region, tend to have high soil test available S due to the S content provided in irrigation water (approximately 3-5 lbs S/ac for each inch irrigation water applied).

N Response Discussion

Treatments for comparison are treatments #4 & #10 – 13. Yields varied within the N treatments with no clear trends, and likely simply experimental variation. Yields obtained between treatments were not statistically differing. As previously discussed the base level of 17.2 kg N/ha applied to most treatments seems to have provided the most consistent response. The ultrahigh application did result in the highest yields of the trial, exceeding that obtained by the unfertilized treatment by 1973 kg/ha ((29.1 bu/ac). Other field pea characteristics were generally unaffected by these treatments.

This study may be repeated in 2020.

## Acknowledgements

Financial support was provided by the Saskatchewan Pulse Growers. All funding is gratefully acknowledged.

Table 5. Pea Yield and % Protein as Influenced by Fertilizer Applications.

| Trt # | Fertilizer Applied kg N-$P_2O_5$-$K_2O$-S/ha | Yield (kg/ha) | Yield (bu/ac) | Protein (%) |
|---|---|---|---|---|
| 1 | 0-0-0-0 (no fertilizer) | 3585 | 53.5 | 19.7 |
| 2 | 17.2-0-0-10 (0 P) | 4377 | 65.1 | 19.7 |
| 3 | 17.2-20-0-10 (20 P) | 4912 | 73.0 | 19.5 |
| 4 | 17.2-40-0-10 (40 P) | 4897 | 72.8 | 19.3 |
| 5 | 21.4-60-0-10 (60 P) | 5004 | 74.4 | 19.9 |
| 6 | 25.7-80-0-10 (80 P) | 5054 | 75.1 | 22.1 |
| 7 | 17.2-40-0-0 (0 S) | 5472 | 81.4 | 20.1 |
| 8 | 17.2-40-0-5 (5 S) | 4782 | 71.1 | 20.9 |
| 9 | 21.6-40-0-15 (15 S) | 5218 | 77.6 | 19.5 |
| 10 | 40-40-0-10 (40 N as MAP/AS/Urea) | 5366 | 79.8 | 18.8 |
| 11 | 17.2-40-0-10 + 40 N in-crop broadcast Urea | 5067 | 75.3 | 20.5 |
| 12 | 40-10-0-10* (40 N as MAP/AS/ESN) | 4628 | 68.8 | 18.7 |
| 13 | 40-80-0-15* (ultrahigh fertility/ESN) | 5558 | 82.6 | 19.6 |
| | LSD (0.05) | 787 | 11.7 | 1.8 |
| | CV (%) | 11.2 | 11.2 | 6.2 |

*Supplemental N provided as ESN in treatments 12 & 13

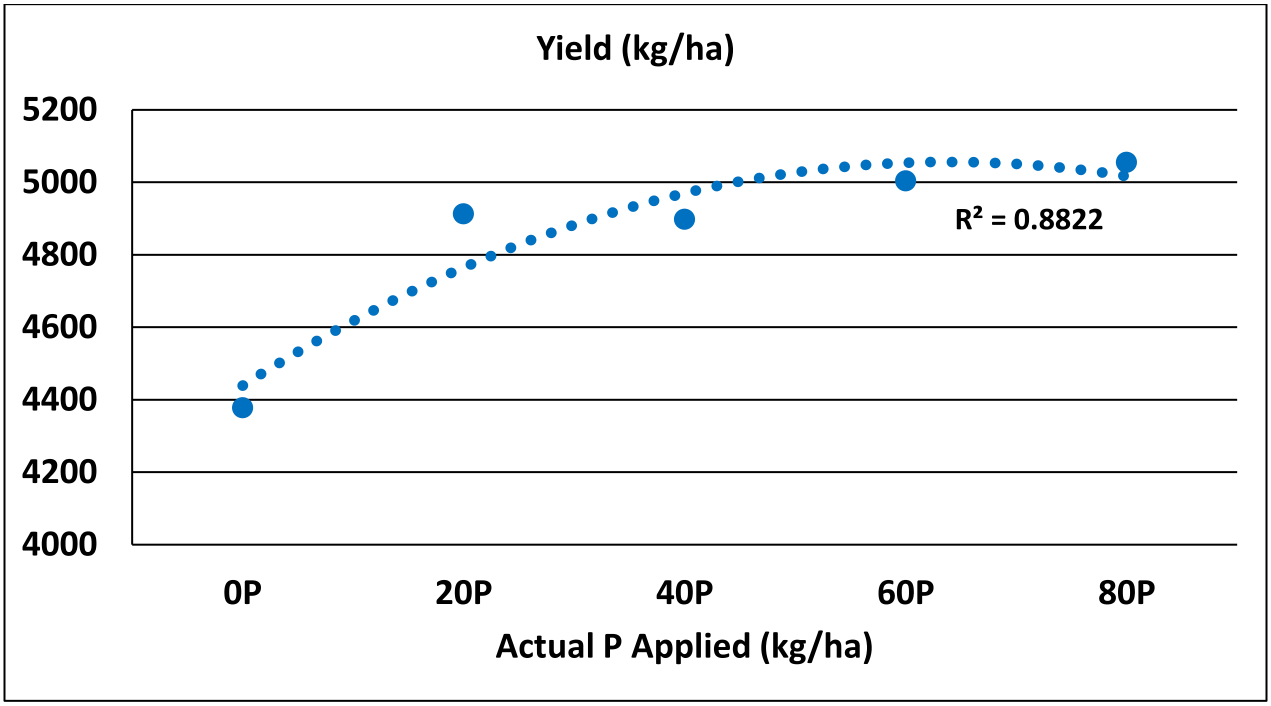
Table 6. Pea Seed Characteristics & NDVI Measurements as Influenced by Fertilizer Applications.

| Trt # | Fertilizer Applied kg N-$P_2O_5$-$K_2O$-S/ha | Test Weight (kg/hl) | 1K Seed Weight (gm) | NDVI 5 node | NDVI 8 node |
|---|---|---|---|---|---|
| 1 | 0-0-0-0 (no fertilizer) | 81.7 | 224 | 0.28 | 0.34 |
| 2 | 17.2-0-0-10 (0 P) | 82.1 | 278 | 0.29 | 0.37 |
| 3 | 17.2-20-0-10 (20 P) | 81.7 | 236 | 0.31 | 0.43 |
| 4 | 17.2-40-0-10 (40 P) | 81.5 | 229 | 0.32 | 0.43 |
| 5 | 21.4-60-0-10 (60 P) | 81.4 | 229 | 0.34 | 0.46 |
| 6 | 25.7-80-0-10 (80 P) | 80.7 | 226 | 0.37 | 0.53 |
| 7 | 17.2-40-0-0 (0 S) | 82.0 | 275 | 0.34 | 0.46 |
| 8 | 17.2-40-0-5 (5 S) | 81.6 | 231 | 0.39 | 0.51 |
| 9 | 21.6-40-0-15 (15 S) | 81.7 | 230 | 0.35 | 0.49 |
| 10 | 40-40-0-10 (40 N as MAP/AS/Urea) | 82.1 | 265 | 0.35 | 0.47 |
| 11 | 17.2-40-0-10 + 40 N in-crop broadcast Urea | 81.9 | 235 | 0.34 | 0.45 |
| 12 | 40-10-0-10* (40 N as MAP/AS/ESN) | 81.6 | 226 | 0.34 | 0.47 |
| 13 | 40-80-0-15* (ultrahigh fertility/ESN) | 81.0 | 243 | 0.36 | 0.50 |
| | LSD (0.05) | NS | NS | 0.04 | 0.05 |
| | CV (%) | 0.9 | 11.2 | 7.7 | 8.3 |

Table 7. Plant Growth Characteristics as Influenced by Fertilizer Applications.

| Trt # | Fertilizer Applied kg N-$P_2O_5$-$K_2O$-S/ha | Days to 10% Flower | Days to Mature | Plant Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|
| 1 | 0-0-0-0 (no fertilizer) | 54 | 92 | 79 | 1.8 |
| 2 | 17.2-0-0-10 (0 P) | 55 | 93 | 83 | 2.0 |
| 3 | 17.2-20-0-10 (20 P) | 56 | 96 | 101 | 3.3 |
| 4 | 17.2-40-0-10 (40 P) | 56 | 96 | 100 | 3.5 |
| 5 | 21.4-60-0-10 (60 P) | 57 | 95 | 102 | 3.8 |
| 6 | 25.7-80-0-10 (80 P) | 57 | 97 | 111 | 4.5 |
| 7 | 17.2-40-0-0 (0 S) | 57 | 96 | 101 | 3.5 |
| 8 | 17.2-40-0-5 (5 S) | 56 | 97 | 104 | 5.8 |
| 9 | 21.6-40-0-15 (15 S) | 57 | 97 | 102 | 3.0 |
| 10 | 40-40-0-10 (40 N as MAP/AS/Urea) | 57 | 96 | 101 | 2.0 |
| 11 | 17.2-40-0-10 + 40 N in-crop broadcast Urea | 57 | 97 | 104 | 4.0 |
| 12 | 40-10-0-10* (40 N as MAP/AS/ESN) | 57 | 95 | 101 | 1.3 |
| 13 | 40-80-0-15* (ultrahigh fertility/ESN) | 57 | 97 | 105 | 1.8 |
| | LSD (0.05) | 1.4 | 2.3 | 8.9 | 2.0 |
| | CV (%) | 1.7 | 1.7 | 6.2 | 45.3 |

Figure 1. Seed Yield Response to P Rates.



# Pea Oat Intercropping Demonstration

## Funding

Funded by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) and the Saskatchewan Oat Development Commission and General Mills.

## Project Lead

- Project P.I: Lana Shaw (SERF)
- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- East Central Research Foundation (ECRF)
- Indian Head Applied Research Foundation (IHARF)
- North East Research Foundation (NARF)
- Conservation Learning Center (CLC)
- Wheatland Conservation Association (WCA)

## Objectives

An oat-pea intercrop may be planted as a grain crop and local evaluation of seeding rates is needed to assess crop value, agronomic characteristics, and flexibility for end use. A combination of pea and oat may have higher LER and crop value than either monocrop on their own. Also, grain intercrops may improve agronomic characteristics of pea by reducing or mitigating lodging, disease, and insect damage. This project investigated the effect of varying the oat seeding rate as a companion crop with pea to determine whether there is a consistent optimum balance of the two crops.

The objective of this project is to:

- Demonstrate how to grow oat and pea together as a grain crop.
- Demonstrate how to separate grain components using slotted screens.
- Demonstrate the effect of varying oat seeding rate in intercrop with pea on yield and agronomic parameters.

## Research Plan

This trial was established at the ICDC off-station Rudy Agro location. The trial was established in a RCBD design replicated four times. Marrowfat pea was seeded, where required, at a uniform rate to target 100 plants/$m^2$. Pea seeding rates were adjusted for % germination, seed weight and assuming seedling mortality of 10%. Oat seeding rate varied but appropriate rates were also adjusted for % germination and seed weight and 1% seedling mortality. Treatments in the study are shown in Table 1. The trial was seeded on May 21. Plot size consisted of 6 rows spaced 25 cm apart (10"), plot length was 10 m. Both oat and pea, where intercropped, were mixed within the same rows, pre-weighed seed was distributed through dual cone systems on the seeder used. Treatments with peas received an in-furrow application of Nodulator Duo SCG granular inoculant at seeding at an application rate of 3.7 kg/ha. All plots received a side-banded application of 30 kg $P_2O_5$/ha as 11-52-0 at seeding. The trial was seeded on potato stubble that contained residual soil test N levels of 150 kg N/ha, so no additional nitrogen fertilizer was applied. Midori marrowfat pea and CS Camden oats were used in the trial. Weeds were controlled by an in-crop herbicide application of MCPA Ester 600 (phenoxy) on June 19. A fungicide application of Priaxor was applied July 18. All plots were desiccated with an application of Reglone on September 18. Both crop species were direct harvested with a small plot combine on October 7.

Table 1. Pea Oat Intercrop Treatment List

| Trt # | Crop Mix | Oat Seed Rate (plants/m$^2$) | Oat Seed Rate (approx. lbs/ac) | Pea Seed Rate (plants/m$^2$) |
|---|---|---|---|---|
| 1 | Pea Oat Intercrop | 25 | 10 | 100 |
| 2 | Pea Oat Intercrop | 50 | 21 | 100 |
| 3 | Pea Oat Intercrop | 75 | 31 | 100 |
| 4 | Pea Oat Intercrop | 100 | 41 | 100 |
| 5 | Pea Oat Intercrop | 125 | 51 | 100 |
| 6 | Oat Monocrop | 200 | 82 | |
| 7 | Pea Monocrop - weed free | | | 100 |
| 8 | Pea Monocrop - weedy | | | 100 |

## Results

In-season data collection of plant emergence; oat, pea & weed plant biomass, plant height, yield and seed quality was determined. However, no results from this trial will be reported. Plant emergence of marrowfat pea was approximately 33% of target plant population in all plots. Dry soil conditions severely limited optimal germination and plant emergence. As the season progressed and irrigation was applied the oat within intercrop plots quickly out competed and choked the marrowfat peas that did emerge. By harvest monocrop plots were virtually oat only.

Therefore, this demonstration suggests that marrowfat pea are poor competitors and not conducive to intercropping with oat.

## Acknowledgements

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# Dry Bean Inoculant and Fertilizer Strategies for Solid Seeded Production

## Funding

Funded by Agriculture Demonstration of Practices and Technologies (ADOPT)

## Project Lead

- Garry Hnatowich, ICDC

## Organizations

- Irrigation Crop Diversification Corporation (ICDC) – Outlook, SK
- Western Applied Research Corporation (WARC) – Scott, SK
- South East Research Farm (SERF) – Redvers, SK
- East Central Research Foundation (ECRF) – Yorkton, SK
- Indian Head Applied Research Foundation (IHARF) – Indian Head, SK

## Objectives

The objective of this study is:

(1) To demonstrate the efficacy of commercial dry bean inoculant formulations alone or in conjunction with fertilizer nitrogen and

(2) To evaluate the potential for solid seeded dry bean production under dry land conditions in the non-irrigated areas of Saskatchewan.

## Research Plan

Trials were established five Agri-ARM facilities in Saskatchewan – ICDC (Outlook), WARC (Scott), SERF (Redvers), ECRF (Yorkton) and IHARF (Indian Head). Each trial was established in a factorial RCBD design with four replications. The factors evaluated were inoculation and N fertilization. Dry Bean inoculant formulations were obtained from Verdisian Life Sciences based in Cary, North Carolina. They included a peat formulation (N Charge, intended for on-seed applications) and a granular formulation (PRIMO GX2, applied in-furrow at seeding). All inoculant treatments were applied without fertilizer N additions or with fertilizer N additions such that total N (soil test N + fertilizer N applications) equaled 80 lbs N/ac. Trail treatments are shown in Table 1. All inoculants were applied at the manufactures recommended rates. The N Charge peat had a guaranteed titre of 2 x 10e8 cfu/gm and applied for all on-seed treatments at 3.1 gm/kg of seed. The peat formulation contained a self-sticking agent but a damp application method of inoculation was used such that 2 ml of water was applied to each kg seed to assist adhesion. With the molasses application a dilute solution of 60 ml molasses mixed with 240 ml water and then 2 ml of solution was used in substitution for the 2 ml water for damp application. Seed applied inoculant treatments, applied on-site, were treated immediately prior to seeding, allowing sufficient time to dry in order to prevent seed bridging while planting. The polymer was applied with the N Charge utilizing a commercial applicator, application occurred on May 10. The granular inoculant PRIMO GX2 had a guaranteed titre of 1 x 10e8 cfu/gm and was applied at either 4.8 kg/ha (25 cm or 10" row spacing) or 4.0 kg/ha (30 cm or 12" row spacing). Granular treatments were applied with the seed in-furrow.

Times of the various field operations and crop assist products used at each trial location are shown in Table 2. CDC Blackstrap, a Black market class dry bean, was used at all trial locations. A target plant population of 35 plants/m$^2$ was attempted, with seeding rate adjusted to account for 99% seed germination, seed size and an assumed 90% emergence. Soil test N results from each site are shown in Table 3. Fertilizer N applied at each trial location was determined on the basis of the soil test N results.

Plant population (where obtained) was determined after such a time that no further plants were observed emerging. Maturity was deemed at 90% pod colour change. *Sclerotinia* (white mold) was evaluated at maturity using the following rating;

0 – no symptoms apparent
1 – 1-3 small independent lesions on leaf or stems
2 – At least 1 coalescence of lesions with moderate mycelial growth
3 – Mycelial development or wilt involving up to 25% of foliage
4 – Extensive mycelial growth or wilt involving up to 50% of foliage
5 – Plant death

At all locations dry bean plants were directly harvested with small plot combines. Plot grain samples were cleaned and yields adjusted to 16% moisture.

Growing Season Weather

Mean monthly temperatures and precipitation amounts for trial locations are listed in Table 4 and 5. The 2019 season was cooler than the long-term average at all sites. Rainfall was below average for all sites except Scott. Irrigation applied to the Outlook site included 8 mm in May, 27.5 mm in June, 45.5 mm in July and 12.5 mm in August.

Table 1. Inoculant and fertilizer treatments.

| Trt # | Inoculant | Formulation | Total N (soil + fertilizer) |
|---|---|---|---|
| **1** | Control | n/a | 0 lbs N/ac |
| **2** | N Charge | Peat on-seed | 0 lbs N/ac |
| **3** | N Charge | Peat on-seed + molasses | 0 lbs N/ac |
| **4** | N Charge | Pretreated Polymer Peat on-seed | 0 lbs N/ac |
| **5** | PRIMO GX2 | Granular | 0 lbs N/ac |
| **6** | N Charge + PRIMO GX2 | Peat on-seed + Granular | 0 lbs N/ac |
| **7** | Control | n/a | 80 lbs N/ac |
| **8** | N Charge | Peat on-seed | 80 lbs N/ac |
| **9** | N Charge | Peat on-seed + molasses | 80 lbs N/ac |
| **10** | N Charge | Pretreated Polymer Peat on-seed | 80 lbs N/ac |
| **11** | PRIMO GX2 | Granular | 80 lbs N/ac |
| **12** | N Charge + PRIMO GX2 | Peat on-seed + Granular | 80 lbs N/ac |

Table 2. Times of operations and crop input products utilized by location.

| Activity | Location | | | | |
|---|---|---|---|---|---|
| | Outlook | Scott | Redvers | Yorkton | Indian Head |
| Pre-seed Herbicide Application | NA | May 19 Glyphosate 540 (0.7 L/ac) + AIM (35 ml/ac) | May 23 Glyphosate 540 (1 L/ac) + AIM (35 ml/ac) | NA | May 27 Roundup Weathermax 540 (0.67 L/ac) |
| Seeding | May 23 | May 24 | May 27 | May 23 | May 17 |
| Row Spacing | 25 cm (10”) | 25 cm (10”) | 30 cm (12”) | 30 cm (12”) | 30 cm (12”) |
| Emergence Counts | June 11 | June 5 | NC | June 14 | July 4 |
| In-crop Herbicide Application | June 26 Viper ADV (400 ml/ac) + Basagran Forte (145 ml/ac) + UAN | June 26 Viper ADV (400 ml/ac) + Basagran Forte (145 ml/ac) + UAN | June 6 Centurion (75 ml/ac) + Amigo (200 ml/ac) July 1 Viper ADV (400 ml/ac) | May 24 Roundup Transorb (0.5L/ac) June 26 Centurion (150 ml/ac) + Amigo July 2 Viper ADV (400 ml/ac) + Basagran Forte (145 ml/ac) + UAN | July 12 Viper ADV (400 ml/ac) + Basagran Forte (145 ml/ac) + UAN + Equinox (100 ml/ac + Merge) |
| In-crop Fungicide Application | July 27 Priaxor (180 ml/ac) | NA | NA | July 22 Acapela (350 ml/ac) | NA |
| Harvest | Sept 20 | Oct 7 | Sept 17 | Oct 7 | Oct 12 |

NA = not applied
NC = observation not captured

Table 3. Soil test results from each trial location.

| Nitrate Levels (lbs $NO_3$-N/ac) | Outlook | Scott | Redvers | Yorkton | Indian Head |
|---|---|---|---|---|---|
| 0-15cm (0-6in) | 10 lb/ac | 12 lb/ac | 20 lb/ac | 14 lb/ac | 12 lb/ac |
| 15-30cm (6-12in) | 7 lb/ac | | | | |
| 15-60cm (6-24in) | 12 lb/ac | 30 lb/ac | 24 lb/ac | 15 lb/ac | 15 lb/ac |
| **Total** 0-60cm (0-24in) | 29 lb/ac | 42 lb/ac | 44 lb/ac | 29 lb/ac | 27 lb/ac |

Table 4. Mean monthly temperatures vs long-term (30 year) means for the 2019 growing seasons at Saskatchewan Trial Locations.

| **Location** | **Year** | **May** | **June** | **July** | **August** | **Avg. / Total** |
|---|---|---|---|---|---|---|
| | | ***-----------------------------Mean Temperature (°C) -------------------*** | | | | |
| Outlook | 2019 | 9.9 | 16.0 | 18.0 | 16.2 | 15.0 |
| | ***Long-term*** | ***11.5*** | ***16.1*** | ***18.9*** | ***18.0*** | ***16.1*** |
| Scott | 2019 | *9.1* | *14.9* | *16.1* | *14.4* | *13.6* |
| | ***Long-term*** | ***10.8*** | ***14.8*** | ***17.3*** | ***16.3*** | ***14.8*** |
| Redvers | 2019 | 9.5 | 16.3 | 18.5 | 16.6 | 15.2 |
| | ***Long-term*** | ***12*** | ***16*** | ***19*** | ***18*** | ***16.3*** |
| Yorkton | 2019 | 8.6 | 16 | 18.3 | 16.1 | 14.8 |
| | ***Long-term*** | ***10.4*** | ***15.5*** | ***17.9*** | ***17.1*** | ***15.2*** |
| Indian Head | 2019 | 8.9 | 15.7 | 17.4 | 15.8 | 14.4 |
| | ***Long-term*** | ***10.8*** | ***15.8*** | ***18.2*** | ***17.4*** | ***15.6*** |

Table 5. Precipitation amounts vs long-term (30 year means for the 2019 growing seasons at Saskatchewan Trial Locations.

| **Location** | **Year** | **May** | **June** | **July** | **August** | **Avg. / Total** |
|---|---|---|---|---|---|---|
| | | ***------------------------------- Precipitation (mm) ---------------------*** | | | | |
| Outlook | 2019 | 13.2 | 90.2 | 43.8 | 39.6 | 186.8 |
| | ***Long-term*** | ***42.6*** | ***63.9*** | ***56.1*** | ***42.8*** | ***205.4*** |
| Scott | 2019 | 12.7 | 97.7 | 107.8 | 18 | 236.2 |
| | ***Long -term*** | ***38.9*** | ***69.7*** | ***69.4*** | ***48.7*** | ***226.7*** |
| Redvers | 2019 | 18.0 | 79.0 | 54.0 | 88.0 | 239 |
| | ***Long-term*** | ***60*** | ***91*** | ***78*** | ***64*** | ***293*** |
| Yorkton | 2019 | 11.1 | 81.6 | 49.1 | 32.2 | 174 |
| | ***Long-term*** | ***51*** | ***80*** | ***78*** | ***62*** | ***272*** |
| Indian Head | 2019 | 13.3 | 50.4 | 53.1 | 96.0 | 212.8 |
| | ***Long-term*** | ***51.7*** | ***77.4*** | ***63.8*** | ***51.2*** | ***241.4*** |

## Results

Individual site treatment agronomic results and associated statistics for each treatment are shown in the Appendix. For clarity of data interpretation, results of factorial analyses for each trial location are presented in Tables 6 through 10.

Treatment of dry bean seed with *rhizobium* inoculant generally failed to provide a yield response at any trial location excepting Indian Head (Table 10). At Indian Head some treatments appeared to be influencing yield, with or without fertilizer N additions. However no clear explanation of response is apparent. The N Charge peat is statistically higher yielding than the control but N Charge + molasses and N Charge polymer treatments are not. It is not thought that the addition of a sugar source or the commonly adopted polymer technology should adversely affect the *rhizobium* inoculant. The granular and dual inoculant treatments also appear to positively influence yield. Treatment effects on yield for Indian Head are illustrated in Figure 1. It is apparent that the yields obtained at Indian Head were very low and statistical analyses indicated a high coefficient of variation (CV). A higher CV in dry bean trials in Saskatchewan, compared to other pulse, cereals or oilseed crops, is not unusual. These results exhibit a variability between inoculant treatments and their variation may be a result of the very low yields obtained. Yield obtained may also be a reflection of differing plant populations between treatments. Indian Head results have not been rejected, as a consequence of its higher CV, based on personal experience in dry bean trials and because of the strong significant influence of fertilizer N additions. This site location exhibits the same N fertilizer response as all other locations and Figure 1 clearly illustrates that fertilizer N applications increase and influence yield to a far greater extent than did inoculation.

Inoculation of dry bean failed to positively influence dry bean yield at any remaining trial location. The reason for the inability of the inoculant to influence dry bean yield cannot be definitively answered within the limited observations/measurements undertaken within the scope of this trial. Given the inherent soil N fertility as revealed by soil testing procedures it is not thought that the N levels at any site would be sufficiently high to inhibit *rhizobia* infection and possible N-fixation. However, the author suggests that the following are possible reasons;

1. *Rhiobia* strain specificity is known to occur within dry bean. Meaning that it is possible that the strain of *rhizobium leguminosarum bv. Phaseoli* simply failed to form a symbiotic relationship with CDC Blackstrap dry bean. While developing commercial inoculant formulations the author did experience this phenomena. A specific *rhizobium* strain might generally work in one market class type of dry bean but not in others. Further, specificity was also found within market classes such that the strain might result in acceptable N-fixation in one variety but not others.

2. The *rhizobium* within the inoculants may not have been adaptable to Saskatchewan soil conditions. This regional adaptability is also known and is the reason inoculant companies often screen soils for effective indigenous *rhizobium* strains to be used within their sales market region and where production of the pulse commodity is highest.

Inoculation may have failed to influence dry bean yield in 2019 but the application of fertilizer N certainly did. All trial locations obtained significant yield responses to the addition of fertilizer N. This response highlights the inefficiency of the inoculant formulations evaluated. With respect to seed yield, results from all sites indicate that supplemental fertilizer N is required to optimize dry bean yield. At Outlook, the trial was irrigated and yields obtained at this location generally doubled those obtained at the remaining dry land locations. The Outlook location has a long-term history of dry bean production with the field on which the trial was conducted having had dry beans produced numerable times. Though not part of the trial protocol, plant roots were exhumed from all unfertilized and fertilized control treatments and nodules were found on all. Moreover, the red colour exhibited upon cutting nodules suggest they were performing active biological N-fixation. These bacteria were from indigenous populations likely built up from previous dry bean production and likely contributed to the high unfertilized yield obtained at Outlook. However, even these indigenous populations did not suffice to provide maximum yields and a fertilizer N response occurred.

In general, inoculation did not directly influence any other agronomic measurement, at any trial location. Nitrogen fertilizer additions tended to decrease individual seed weight and increased plant height. *Sclerotinia* (white mold) was not an issue at any site in 2019

The result of inoculation and N fertilizer additions on dry bean yield averaged across all 5 trial locations is shown in Figure 2.

A summary of the combined all site analyses, and for the 4 dry land trials alone, for CDC Blackstrap seed yield is presented in Table 11. Yield results indicate that, for all sites, the average yield response to N fertilizer was 521 kg/ha (464 lb/ac). However, an objective of this project was to demonstrate dry bean production away from the traditional irrigated production and into dry land production. Therefore if we exclude the Outlook site the average yield response to N fertilizer increases to 690 kg/ha (614 lb/ac). Presently, Black dry beans are being purchased at $0.75/kg ($0.34/lb) so the gross return of the fertilizer additions is approximately $518/ha or $209/ac, easily an economic return for the fertilizer investment.

The result of inoculation and N fertilizer additions on dry bean yield averaged across only the 4 dry land trial locations is shown in Figure 3.

Some general observations and thoughts regarding the dry land production trials can be made;

- All sites were solid seeded and direct combined. While harvest loss assessment was beyond the scope of the study (given the finances), all sites report that harvest losses were deemed minimal.

- Direct combining of dry beans is likely only possible at this time with the Black market class variety CDC Blackstrap which is a Type II plant structure with pods that may initiate high enough on the plant stem to facilitate direct combining or swathing.

- Seed weights obtained at WARC (Scott) were very low and might limit market acceptance, additional work should be conducted in this region in order to ascertain if this is a function of the trialing season or potentially problematic to the region.

    - It is reasonable to believe rolling of the dry beans after seeding will assist harvest management by facilitating pod clearance. On heavy textured, such as at Indian Head, rolling can be a challenge for dry bean. Seed bed conditions need be ideal and packing pressure be light enough to minimize possible compaction issues.

Table 6. ICDC (Outlook) Dry Bean Yield & Agronomic Observations as Influenced by N Fertilizer and Inoculant.

| Treatment | ICDC | | | | | | |
|---|---|---|---|---|---|---|---|
| | Yield | | Seed weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants /m$^2$) |
| | kg/ha | lb/ac | | | | | |
| **Nitrogen Fertilizer Application (lbs N/ac)** | | | | | | | |
| 0 | 2651 | 2365 | 225 | 105 | 0 | 37 | 29 |
| 80 | 3142 | 2802 | 225 | 107 | 0 | 39 | 31 |
| Fertilizer LSD (0.05) | 247 | 220 | NS | 0.4 | NS | 1.7 | NS |
| CV (%) | 14.5 | 14.5 | 2.0 | 0.6 | 0 | 7.4 | 22.1 |
| **Inoculant** | | | | | | | |
| Control | 2829 | 2523 | 225 | 106 | 0 | 38 | 30 |
| N Charge peat | 3008 | 2683 | 225 | 106 | 0 | 39 | 29 |
| N Charge peat + molasses | 3046 | 2717 | 225 | 106 | 0 | 38 | 31 |
| N Charge polymer | 2868 | 2558 | 226 | 106 | 0 | 39 | 29 |
| PRIMO GX2 granular | 2782 | 2481 | 224 | 106 | 0 | 37 | 29 |
| N Charge + PRIMO GX2 | 2846 | 2538 | 228 | 106 | 0 | 38 | 31 |
| Inoculant LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |
| **Nitrogen Fertilizer x Inoculation** | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |

NS = not significant

Table 7. WARC (Scott) Dry Bean Yield & Agronomic Observations as Influenced by N Fertilizer and Inoculant.

| Treatment | WARC | | | | | | |
|---|---|---|---|---|---|---|---|
| | Yield | | Seed weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants /m$^2$) |
| | kg/ha | lb/ac | | | | | |
| **Nitrogen Fertilizer Application (lbs N/ac)** | | | | | | | |
| 0 | 1324 | 1181 | 169 | 103 | 0.04 | 27 | 18 |
| 80 | 1983 | 1768 | 161 | 99 | 0.25 | 34 | 14 |
| Fertilizer LSD (0.05) | 112 | 100 | 2.7 | 1.0 | 0.2 | 2.0 | 2.8 |
| CV (%) | 11.5 | 11.5 | 2.8 | 1.7 | 229 | 11.1 | 30.6 |
| **Inoculant** | | | | | | | |
| Control | 1666 | 1486 | 168 | 102 | 0.25 | 29 | 18 |
| N Charge peat | 1617 | 1442 | 165 | 101 | 0.13 | 31 | 15 |
| N Charge peat + molasses | 1663 | 1483 | 164 | 101 | 0.13 | 30 | 15 |
| N Charge polymer | 1686 | 1503 | 164 | 101 | 0.13 | 34 | 17 |
| PRIMO GX2 granular | 1674 | 1493 | 165 | 102 | 0.25 | 30 | 13 |
| N Charge + PRIMO GX2 | 1613 | 1439 | 165 | 101 | 0 | 30 | 17 |
| Inoculant LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |

| Nitrogen Fertilizer x Inoculation | | | | | | | |
|---|---|---|---|---|---|---|---|
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |

NS = Not Significant

Table 8. SERF (Redvers) Dry Bean Yield & Agronomic Observations as Influenced by N Fertilizer and Inoculant.

| Treatment | SERF | | | | | | |
|---|---|---|---|---|---|---|---|
| | Yield | | Seed weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants /m$^2$) |
| | kg/ha | lb/ac | | | | | |
| **Nitrogen Fertilizer Application (lbs N/ac)** | | | | | | | |
| 0 | 1381 | 1229 | 198 | 97 | 0 | 28 | 25 |
| 80 | 1746 | 1554 | 191 | 96 | 0 | 31 | 28 |
| Fertilizer LSD (0.05) | 121 | 108 | 5.2 | NS | NS | 1.2 | NS |
| CV (%) | 13.2 | 13.2 | 4.6 | 1.4 | 0 | 7.1 | 24.7 |
| **Inoculant** | | | | | | | |
| Control | 1695 | 1509 | 197 | 97 | 0 | 30 | 29 |
| N Charge peat | 1570 | 1397 | 199 | 96 | 0 | 29 | 25 |
| N Charge peat + molasses | 1558 | 1386 | 196 | 96 | 0 | 29 | 29 |
| N Charge polymer | 1593 | 1418 | 195 | 97 | 0 | 29 | 24 |
| PRIMO GX2 granular | 1450 | 1290 | 189 | 95 | 0 | 30 | 23 |
| N Charge + PRIMO GX2 | 1514 | 1348 | 193 | 97 | 0 | 29 | 27 |
| Inoculant LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |
| **Nitrogen Fertilizer x Inoculation** | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |

NS = Not Significant
NC = Observation Not Captured

Table 9. ECRF (Yorkton) Dry Bean Yield & Agronomic Observations as Influenced by N Fertilizer and Inoculant.

| Treatment | ECRF | | | | | | |
|---|---|---|---|---|---|---|---|
| | Yield | | Seed weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants /m$^2$) |
| | kg/ha | lb/ac | | | | | |
| **Nitrogen Fertilizer Application (lbs N/ac)** | | | | | | | |
| 0 | 973 | 866 | 200 | 105 | 0 | 41 | 32 |
| 80 | 1885 | 1677 | 210 | 105 | 0 | 46 | 39 |
| Fertilizer LSD (0.05) | 166 | 148 | 3.6 | NS | NS | 2.3 | 4.5 |
| CV (%) | 19.8 | 19.8 | 3.0 | 1.5 | 0 | 8.9 | 21.4 |
| **Inoculant** | | | | | | | |
| Control | 1372 | 1221 | 203 | 105 | 0 | 44 | 35 |
| N Charge peat | 1447 | 1288 | 207 | 105 | 0 | 44 | 30 |
| N Charge peat + molasses | 1266 | 1127 | 206 | 104 | 0 | 41 | 34 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| N Charge polymer | 1341 | 1194 | 204 | 104 | 0 | 43 | 39 |
| PRIMO GX2 granular | 1454 | 1294 | 205 | 105 | 0 | 43 | 40 |
| N Charge + PRIMO GX2 | 1694 | 1508 | 206 | 105 | 0 | 48 | 39 |
| Inoculant LSD (0.05) | NS | NS | NS | NS | NS | 3.9 | NS |
| **Nitrogen Fertilizer x Inoculation** | | | | | | | |
| LSD (0.05) | NS | NS | NS | NS | NS | NS | NS |

S = Significant
NS = Not Significant

Table 10. IHARF (Indian Head) Dry Bean Yield & Agronomic Observations as Influenced by N Fertilizer and Inoculant.

| **Treatment** | **IHARF** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Yield** | | **Seed weight (gm/1000)** | **Maturity (days)** | **White Mold (0 – 5)** | **Height (cm)** | **Plant Stand (plants /m$^2$)** |
| | **kg/ha** | **lb/ac** | | | | | |
| **Nitrogen Fertilizer Application (lbs N/ac)** | | | | | | | |
| 0 | 174 | 155 | 220 | 110 | 0 | 22 | 22 |
| 80 | 998 | 890 | 224 | 113 | 0 | 30 | 23 |
| Fertilizer LSD (0.05) | 70 | 62 | NS | 0.2 | NS | 1.0 | NS |
| CV (%) | 20.3 | 20.3 | 12.9 | 0.4 | 0 | 6.3 | 19.9 |
| **Inoculant** | | | | | | | |
| Control | 484 | 432 | 228 | 110 | 0 | 25 | 20 |
| N Charge peat | 620 | 553 | 214 | 111 | 0 | 26 | 26 |
| N Charge peat + molasses | 533 | 475 | 211 | 111 | 0 | 26 | 23 |
| N Charge polymer | 526 | 469 | 227 | 112 | 0 | 27 | 18 |
| PRIMO GX2 granular | 641 | 572 | 215 | 112 | 0 | 27 | 21 |
| N Charge + PRIMO GX2 | 712 | 635 | 239 | 112 | 0 | 25 | 27 |
| Inoculant LSD (0.05) | 121 | 108 | NS | 0.4 | NS | NS | 4.5 |
| **Nitrogen Fertilizer x Inoculation** | | | | | | | |
| LSD (0.05) | S | S | NS | NS | NS | NS | NS |

S = Significant
NS = Not Significant

Table 11. Dry Bean Combined Site Yields: Effect of Inoculation and N Fertilization, 2019.

| **Location/Treatment** | **All 5 Sites** | | **4 Dry Land Sites Only** | |
|---|---|---|---|---|
| | **Yield** | | **Yield** | |
| **Trial Site** | **kg/ha** | **lb/ac** | **kg/ha** | **lb/ac** |
| ICDC – Outlook | 2896 | 2583 | - | - |
| WARC – Scott | 1653 | 1475 | 1653 | 1475 |
| SERF – Redvers | 1563 | 1391 | 1563 | 1391 |
| ECRF – Yorkton | 1429 | 1272 | 1429 | 1272 |
| IHARF – Indian Head | 586 | 523 | 586 | 523 |
| Location LSD (0.05) | 113 | 101 | 92 | 144 |

| | | | | |
|---|---|---|---|---|
| CV (%) | 17.4 | 17.4 | 15.5 | 15.5 |
| **Nitrogen Fertilizer Application (lbs N/ac)** | | | | |
| 0 | 1365 | 1217 | 963 | 858 |
| 80 | 1886 | 1681 | 1653 | 1472 |
| Fertilizer LSD (0.05) | 72 | 64 | 81 | 72 |
| **Inoculant** | | | | |
| Control | 1589 | 1416 | 1305 | 1162 |
| N Charge peat | 1620 | 1444 | 1314 | 1170 |
| N Charge peat + molasses | 1616 | 1440 | 1255 | 1118 |
| N Charge polymer | 1568 | 1398 | 1286 | 1146 |
| PRIMO GX2 granular | 1675 | 1493 | 1305 | 1162 |
| N Charge + PRIMO GX2 | 1686 | 1502 | 1383 | 1232 |
| Inoculant LSD (0.05) | NS | NS | NS | NS |
| **Location x Nitrogen Fertilizer Application Interaction** | | | | |
| LSD (0.05) | S | S | S | S |
| **Location x Inoculant Interaction** | | | | |
| LSD (0.05) | NS | NS | NS | NS |
| **Nitrogen Fertilizer Application x Inoculant Interaction** | | | | |
| LSD (0.05) | NS | NS | NS | NS |
| **Location x Nitrogen Fertilizer Application x Inoculant Interaction** | | | | |
| LSD (0.05) | NS | NS | NS | NS |

S = Significant
NS = Not Significant

Figure 1. Dry Bean Yield Response to Inoculation & N Fertilization – Indian Head, 2019

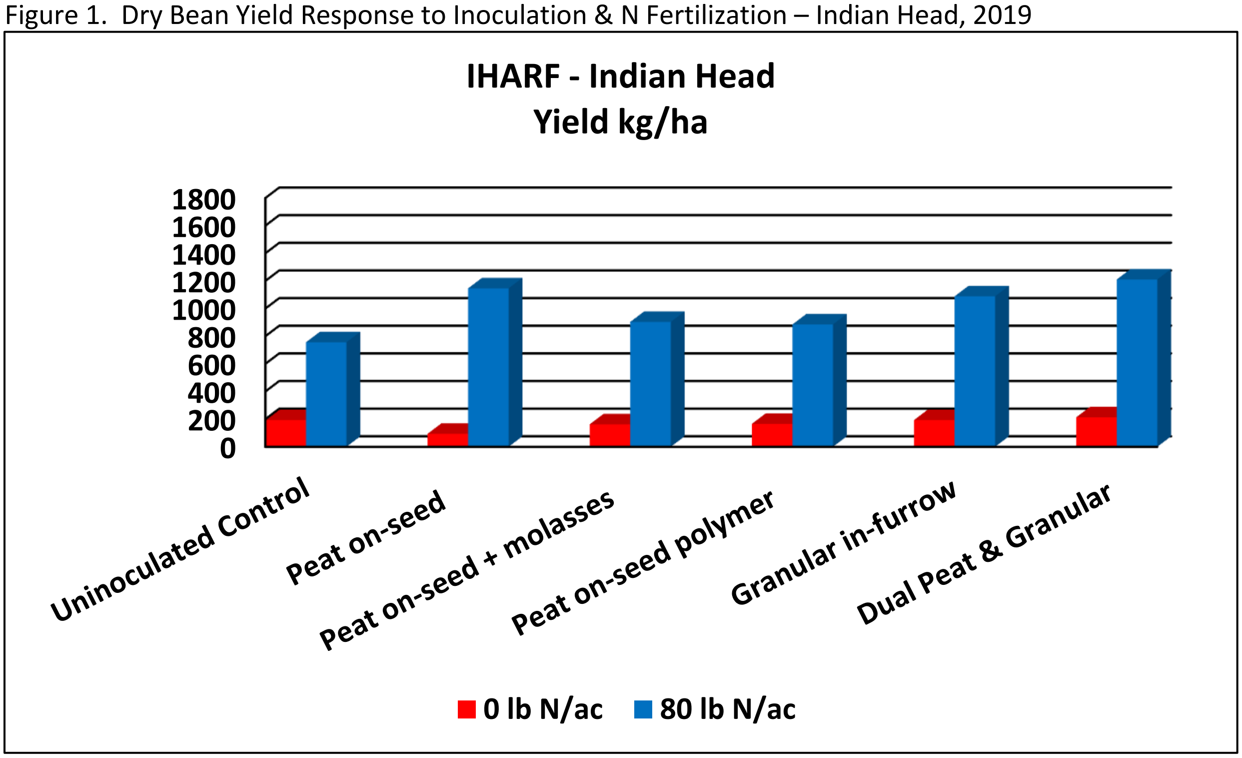


Figure 2. Combined 5 Site Dry Bean Yield, Effect of Inoculation and N Fertilization, 2019.

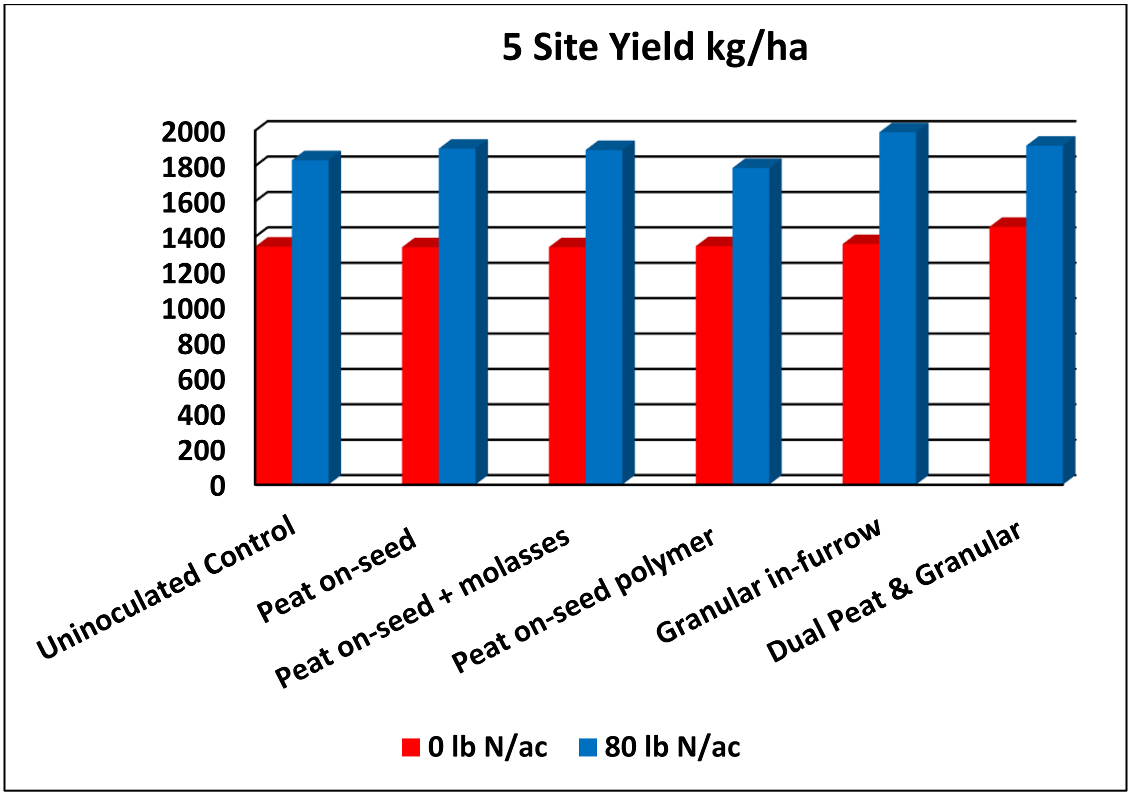
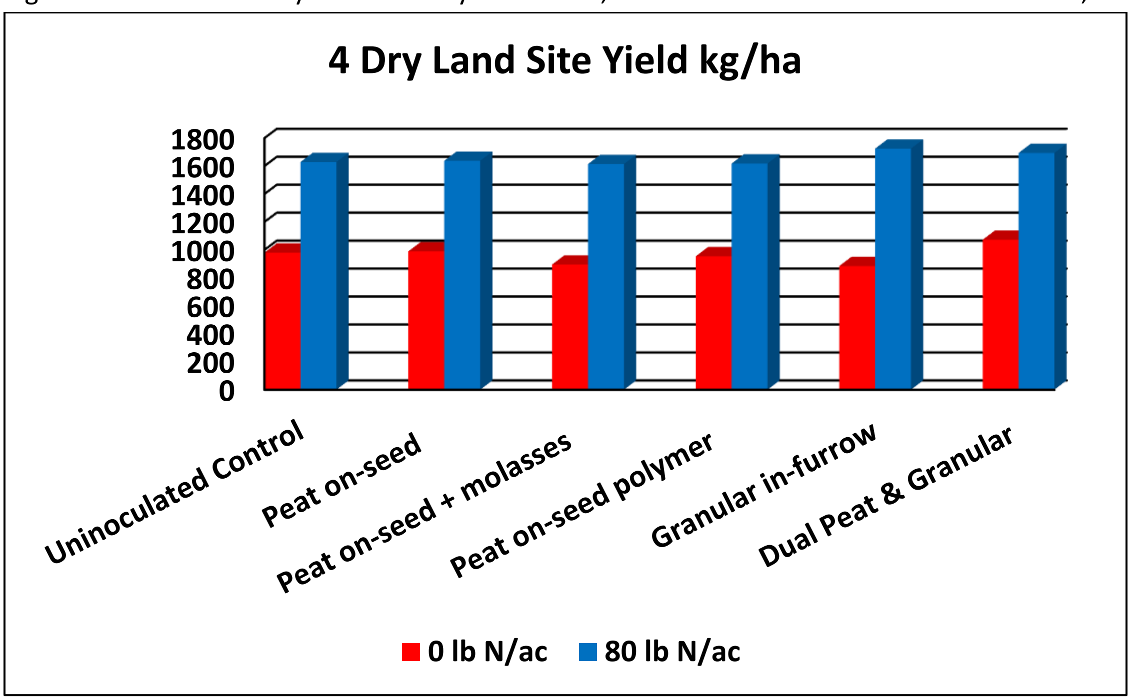



Figure 3. Combined 4 Dry Land Site Dry Bean Yield, Effect of Inoculation and N Fertilization, 2019.



Extension Activities

*ICDC – Outlook*

This trial was mentioned but not viewed during the CSIDC/ICDC Annual Field Day on July 11 and attended by approximately 200 producers, agrologists and company or governmental represetatives. The trial was clearly posted with ADOPT signage. Further, an in-season video outlining the background and objectives of this project was created and can be viewed at ICDC's you tube video page located at https://irrigationsaskatchewan.com/icdc/icdc-research-and-development-program/ A supplimental video highlighting the results of this study will be developed and added to this introductory video during the winter. At present the video has been viewed 42 times. The results were also presented at the 2020 Agri-ARM Update during the Crop Production Show on Jan. 18, 2020, with approximately 30 attendees. The presentation was entitled *"Dry Bean Production: To Inoculate or Fertilize"* and will be posted to the Agri-ARM website. The trial will be discussed at the ICDC Annual Agronomy Update to be held March 5, 2020 in Outlook with expected attendance of approximately 40. Results will also be made available in the 2019 ICDC Field Crops Annual Report and the 2019 CSIDC Annual Report. Trial results will also be made available on the ICDC website http://irrigationsaskatchewan.com/icdc/ Results may also be presented in extension activities when requested.

*WARC – Scott*

The trial was viewed and discussed during the WARC Annual Field Day held July 10, 2019 and viewed by approximately 150 participants.

*SERF – Redvers*

The trial was viewed and discussed during the SERF Annual Field Day held July 18, 2019 and viewed by approximately 30 participants.

*ECRF – Yorkton*

The trial was viewed and discussed on two separate Field Days. The first was the Annual ECRF Field Day held on July 23, 2019 and viewed by approximately 100 participants. The second, an Agratactics Field event took place on August 8, 2019 with approximately 40 participants. ECRF is also intending to produce a video on the project that when completed will be found on their website located at http://www.ecrf.ca/

*IHARF – Indian Head*

Due to distance this trial was not viewed during the Annual IHARF Field Day, however, it was toured by 35 – 40 Federated Co-Operatives Limited agronomists on July 12, 2019 and then by a small contingent of SPG staff on July 18, 2019. Key results of the study will also be presented at an ICAN (Independent Consulting Agronomist Network) meeting in Regina on February 4, 2020 and during the IHARF Annual Winter Meeting & AGM in Balgonie, February 5, 2020. Expected combined attendance is estimated at 180 – 225 participants.

## Conclusions

Inoculation failed to provide yield or agronomic benefits to dry beans in this trial. It is suspected that the strain of *rhizobium leguminosarum bv. Phaseoli* provided in the inoculant formulations used in the study were either inefficient in forming an effective symbiotic relationship with the CDC Blackstrap variety used in the study or the strain was unable to thrive and multiply under Saskatchewan soil/climatic conditions. Application of fertilizer N, such that the combination of soil available N (0-60cm depth) plus fertilizer N (nutrient) equaled 80 lb N/ac significantly increased grain yield and tended to produce taller plants which may facilitate harvest management. It is recommended that producers view

N fertilizer as their primary nutrient source for dry bean production. An inoculant, if available, can be used as an insurance but is unlikely to provide optimal N-fixation to optimize yield goals.

This study demonstrated the feasibility of producing CDC Blackstrap dry bean under dry land conditions utilizing a solid seeded production system. Should further investigations also demonstrate this potential then dry bean production could expand considerably beyond the present acreage. This pulse could be an alternative for the moister regions of the province where root diseases have impacted other pulse crops.

Additional research projects such as the following are suggested;

- Further N fertilizer studies are warranted, rates should continue beyond those used in this study. Within these studies *sclerotinia* should be closely assessed, as well as pod clearance.
- Seeding rate trials would have merit and value.
- Seeding date trials should be geographically evaluated with attention to soil temperatures, plant populations and pod clearance.
- Further regional adaptability trials should be considered, certainly the entire black soil zone of Saskatchewan should be assessed.
- As dry beans are poor competitors until canopy closure, weed control options under solid seeded production should be assessed.
- Within all trials where dry bean is either direct combined or swathed, harvest losses and seed quality should be assessed.
- Should dry bean inoculants be made available then;
    - Producers should view such products sceptically unless regional independent third-party efficacy results are provided. Regardless, N fertilizer supplementation will be required.
    - Consideration should be given to secure funding for organizations such as Agri-ARM facilities to maintain an annual pulse inoculant trials for suitable pulses within their local whereby all commercial and pre-commercial inoculant products can be compared for efficacy.
- An economic investigation either by the Ministry of Agriculture or the University of Saskatchewan Ag, Econ., should be undertaken to investigate such aspects as crop insurance/risk management options, lack or perceived lack, of buyer interest within Saskatchewan, production contracts and marketing agreements presently available, market barriers to possible low quality dry bean, accessibility and availability of CDC varieties (closed loop systems?), etc.

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. Inoculant products were provided in-kind by Verdesian Life Sciences. The Saskatchewan Ministry of Agriculture will be acknowlodged in any written or oral presentations which may arise regarding this study.

## Appendix

Individual trial location agronomic responses and associated statistical results for individual treatments are shown in Tables 12 through 16.

Table 12. ICDC (Outlook) Dry Bean Yield & Agronomic Observations, RCBD Analyses, 2020.

| Trt | Description | Yield kg/ha | Yield lbs/ac | Seed Weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants/m2) |
|---|---|---|---|---|---|---|---|---|
| 1 | Uninoculated – 0 N/ac | 2601 | 2320 | 224 | 106 | 0 | 37 | 29 |
| 2 | N Charge peat – 0 N/ac | 2947 | 2629 | 224 | 105 | 0 | 36 | 27 |
| 3 | N Charge peat + molasses – 0 N/ac | 2769 | 2470 | 227 | 105 | 0 | 38 | 28 |
| 4 | N Charge polymer – 0 N/ac | 2531 | 2258 | 227 | 105 | 0 | 38 | 28 |
| 5 | PRIMO GX2 granular – 0 N/ac | 2480 | 2212 | 223 | 105 | 0 | 36 | 30 |
| 6 | N Charge + PRIMO GX2 – 0 N/ac | 2579 | 2300 | 227 | 105 | 0 | 38 | 32 |
| 7 | Uninoculated – 80 N/ac | 3056 | 2726 | 226 | 107 | 0 | 38 | 32 |
| 8 | N Charge peat – 80 N/ac | 3069 | 2737 | 226 | 107 | 0 | 42 | 31 |
| 9 | N Charge peat + molasses – 80 N/ac | 3323 | 2964 | 222 | 107 | 0 | 39 | 35 |
| 10 | N Charge polymer – 80 N/ac | 3205 | 2859 | 224 | 107 | 0 | 40 | 30 |
| 11 | PRIMO GX2 granular – 80 N/ac | 3083 | 2750 | 226 | 107 | 0 | 39 | 28 |
| 12 | N Charge + PRIMO GX2 – 80 N/ac | 3112 | 2776 | 228 | 107 | 0 | 38 | 30 |
| | LSD (0.05) | NS* | NS* | NS | 0.0001 | | NS | NS |
| | CV (%) | 14.5 | 14.5 | 2.0 | 0.6 | | 7.4 | 22.1 |

NS = not significant
NS* = not significant at P<0.05 but significant at P<0.10

Table 13. WARC (Scott) Dry Bean Yield & Agronomic Observations, RCBD Analyses, 2020.

| Trt | Description | Yield kg/ha | Yield lbs/ac | Seed Weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants/m2) |
|---|---|---|---|---|---|---|---|---|
| 1 | Uninoculated – 0 N/ac | 1334 | 1190 | 171 | 103 | 0 | 26 | 18 |
| 2 | N Charge peat – 0 N/ac | 1298 | 1157 | 170 | 104 | 0 | 28 | 19 |
| 3 | N Charge peat + molasses – 0 N/ac | 1243 | 1109 | 169 | 104 | 0 | 26 | 15 |
| 4 | N Charge polymer – 0 N/ac | 1352 | 1206 | 167 | 104 | 0.3 | 32 | 20 |
| 5 | PRIMO GX2 granular – 0 N/ac | 1325 | 1182 | 171 | 104 | 0 | 27 | 13 |
| 6 | N Charge + PRIMO GX2 – 0 N/ac | 1391 | 1241 | 165 | 102 | 0 | 27 | 20 |
| 7 | Uninoculated – 80 N/ac | 1999 | 1783 | 164 | 100 | 0.5 | 32 | 18 |
| 8 | N Charge peat – 80 N/ac | 1937 | 1728 | 160 | 98 | 0.3 | 35 | 12 |
| 9 | N Charge peat + molasses – 80 N/ac | 2083 | 1858 | 160 | 98 | 0.3 | 35 | 15 |
| 10 | N Charge polymer – 80 N/ac | 2020 | 1801 | 161 | 99 | 0 | 35 | 15 |
| 11 | PRIMO GX2 granular – 80 N/ac | 2023 | 1804 | 159 | 99 | 0.5 | 34 | 13 |
| 12 | N Charge + PRIMO GX2 – 80 N/ac | 1835 | 1637 | 165 | 100 | 0 | 34 | 13 |
| | LSD (0.05) | 273 | 244 | 6.7 | 2.5 | NS | 4.9 | NS |
| | CV (%) | 11.5 | 11.5 | 2.8 | 1.7 | 229 | 11.1 | 30.6 |

NS = not significant

Table 14. SERF (Redvers) Dry Bean Yield & Agronomic Observations, RCBD Analyses, 2020.

| Trt | Description | Yield kg/ha | Yield lbs/ac | Seed Weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants/m2) |
|---|---|---|---|---|---|---|---|---|
| 1 | Uninoculated – 0 N/ac | 1525 | 1357 | 197 | 97 | 0 | 28 | 30 |
| 2 | N Charge peat – 0 N/ac | 1371 | 1221 | 209 | 97 | 0 | 28 | 21 |
| 3 | N Charge peat + molasses – 0 N/ac | 1403 | 1248 | 199 | 97 | 0 | 29 | 27 |
| 4 | N Charge polymer – 0 N/ac | 1376 | 1224 | 197 | 96 | 0 | 28 | 23 |
| 5 | PRIMO GX2 granular – 0 N/ac | 1197 | 1065 | 189 | 96 | 0 | 28 | 22 |
| 6 | N Charge + PRIMO GX2 – 0 N/ac | 1415 | 1260 | 199 | 98 | 0 | 27 | 27 |
| 7 | Uninoculated – 80 N/ac | 1866 | 1661 | 196 | 98 | 0 | 32 | 29 |
| 8 | N Charge peat – 80 N/ac | 1769 | 1574 | 190 | 96 | 0 | 31 | 30 |
| 9 | N Charge peat + molasses – 80 N/ac | 1713 | 1524 | 193 | 96 | 0 | 30 | 31 |
| 10 | N Charge polymer – 80 N/ac | 1811 | 1612 | 193 | 98 | 0 | 31 | 26 |
| 11 | PRIMO GX2 granular – 80 N/ac | 1703 | 1515 | 189 | 95 | 0 | 31 | 25 |
| 12 | N Charge + PRIMO GX2 – 80 N/ac | 1613 | 1436 | 186 | 96 | 0 | 31 | 28 |
| | LSD (0.05) | 296 | 264 | NS* | NS | | 3.0 | NS |
| | CV (%) | 13.2 | 13.2 | 4.6 | 1.4 | | 7.1 | 24.7 |

NS = not significant

NS* = not significant at P<0.05 but significant at P<0.10

NC = observation not captured

Table 15. ECRF (Yorkton) Dry Bean Yield & Agronomic Observations, RCBD Analyses, 2020.

| Trt | Description | Yield kg/ha | Yield lbs/ac | Seed Weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants/m2) |
|---|---|---|---|---|---|---|---|---|
| 1 | Uninoculated – 0 N/ac | 851 | 757 | 197 | 104 | 0 | 39 | 32 |
| 2 | N Charge peat – 0 N/ac | 1195 | 1064 | 206 | 106 | 0 | 43 | 23 |
| 3 | N Charge peat + molasses – 0 N/ac | 773 | 688 | 204 | 104 | 0 | 38 | 32 |
| 4 | N Charge polymer – 0 N/ac | 925 | 823 | 195 | 104 | 0 | 41 | 39 |
| 5 | PRIMO GX2 granular – 0 N/ac | 824 | 733 | 198 | 105 | 0 | 39 | 37 |
| 6 | N Charge + PRIMO GX2 – 0 N/ac | 1272 | 1132 | 199 | 104 | 0 | 46 | 32 |
| 7 | Uninoculated – 80 N/ac | 1894 | 1686 | 210 | 105 | 0 | 48 | 37 |
| 8 | N Charge peat – 80 N/ac | 1698 | 1511 | 208 | 105 | 0 | 45 | 37 |
| 9 | N Charge peat + molasses – 80 N/ac | 1759 | 1566 | 207 | 104 | 0 | 43 | 37 |
| 10 | N Charge polymer – 80 N/ac | 1757 | 1564 | 212 | 103 | 0 | 45 | 39 |
| 11 | PRIMO GX2 granular – 80 N/ac | 2084 | 1855 | 211 | 105 | 0 | 48 | 43 |
| 12 | N Charge + PRIMO GX2 – 80 N/ac | 2116 | 1883 | 213 | 106 | 0 | 50 | 39 |
| | LSD (0.05) | 408 | 363 | 8.7 | NS | | 5.6 | NS* |
| | CV (%) | 19.8 | 19.8 | 3.0 | 1.5 | | 8.9 | 21.4 |

NS = not significant

NS* = not significant at P<0.05 but significant at P<0.10

Table 16. IHARF (Indian Head) Dry Bean Yield & Agronomic Observations, RCBD Analyses, 2020.

| Trt | Description | Yield kg/ha | Yield lbs/ac | Seed Weight (gm/1000) | Maturity (days) | White Mold (0 – 5) | Height (cm) | Plant Stand (plants/m2) |
|---|---|---|---|---|---|---|---|---|
| 1 | Uninoculated – 0 N/ac | 212 | 189 | 215 | 110 | 0 | 21 | 20 |
| 2 | N Charge peat – 0 N/ac | 94 | 84 | 217 | 110 | 0 | 21 | 23 |
| 3 | N Charge peat + molasses – 0 N/ac | 163 | 145 | 221 | 110 | 0 | 21 | 24 |
| 4 | N Charge polymer – 0 N/ac | 166 | 148 | 236 | 110 | 0 | 23 | 19 |
| 5 | PRIMO GX2 granular – 0 N/ac | 194 | 173 | 213 | 110 | 0 | 23 | 22 |
| 6 | N Charge + PRIMO GX2 – 0 N/ac | 213 | 190 | 222 | 110 | 0 | 20 | 28 |
| 7 | Uninoculated – 80 N/ac | 756 | 674 | 242 | 111 | 0 | 30 | 18 |
| 8 | N Charge peat – 80 N/ac | 1146 | 1023 | 210 | 113 | 0 | 30 | 29 |
| 9 | N Charge peat + molasses – 80 N/ac | 903 | 806 | 200 | 113 | 0 | 31 | 22 |
| 10 | N Charge polymer – 80 N/ac | 885 | 790 | 219 | 113 | 0 | 30 | 18 |
| 11 | PRIMO GX2 granular – 80 N/ac | 1089 | 971 | 216 | 113 | 0 | 31 | 20 |
| 12 | N Charge + PRIMO GX2 – 80 N/ac | 1211 | 1080 | 257 | 113 | 0 | 30 | 26 |
| | LSD (0.05) | 171 | 153 | NS | 0.6 | | 2.3 | 6.4 |
| | CV (%) | 20.3 | 20.3 | 12.9 | 0.4 | | 6.3 | 19.9 |

NS = not significant

NS* = not significant at P<0.05 but significant at P<0.10

# Nitrogen Fertilization of Irrigated Dry Bean

## Funding

Funded by the Agricultural Development Fund

## Project Lead


- Project P.I: Garry Hnatowich


## Organizations


- Irrigation Crop Diversification Corporation (ICDC)


## Objectives

The objectives of this project are:

(1) To determine the nitrogen fertilizer rate yield response for Pinto market class wide-row dry bean production.
(2) To determine whether ESN nitrogen fertilizer is beneficial compared to urea as a fertilizer nitrogen source for irrigated dry bean production.

## Research Plan

In May 2019 three individual research trials were established within the South Saskatchewan River Irrigation District. CDC WM-2 variety of the Pinto Market Class dry bean was seeded at a rate of 30 seeds m2, after adjusting for % germination and seed weight. Three rows of dry beans were planted at 50 cm row spacings, plots seeded length was 10 m, plots were later trimmed back to 8 m lengths. All trials were established in a randomized complete block design with four replications. Two nitrogen fertilizer sources were used – conventional urea (46-0-0) and ESN (44-0-0). All trial locations were soil tested in the spring of 2019. Soil test N results are shown in Table 1. Fertilizer additions were adjusted to account for the available soil test N in the 0-30 cm depth of the soil profile. Therefore, actual fertilizer applied was either 30 60, 90, 120 or 150 kg N/ha (total soil plus fertilizer N). Fertilizer rates and sources were side banded, at seeding, 2.5 cm to the side and approximately 5.0 cm below the seed. All plots received 25 kg/ha seed placed $P_2O_5$ at seeding. Weed control involved a spring pre-seed application of granular incorporated Edge (ethalfluralin) at 6.9 kg/ac and in-season tank mix application of Viper ADV (imazamox & bentazon) at 400 ml/ac plus Basagran Forte (bentaon) at 145 ml/ac plus UAN at 800ml/ac. Plots were periodically hand weeded as required. An application of Priaxor (fluxapyroxad & pyraclostrobin) was applied at flowering for disease control or suppression. At the R2 growth stage (early pod initiation) plants were harvested from two 0.5 m lengths of the center row of each treatment. For each plot 0.5 m lengths were harvested from both the front and back portions of the plot, starting from 1 m into the plot. Plants collected from each sample length of plot were combined and weighed for both fresh and dried biomass weights. Dried material was ground through a stainless steel Wiley mill to pass through a 2.0 mm sieve and submitted to Agvise Laboratories for N tissue analysis determinations. At physiological maturity two rows of each plot were undercut with a small plot research undercutter and the plants windrowed and allowed to dry prior to combining. Prior to undercutting all plots were assessed for *sclerotinia* (white mold) disease incidence. Combining was conducted with a Wintersteiger small plot combine. Seed was cleaned and yields adjusted to 16% moisture.

Table 1. Soil Test N Results and dates of operation at each trial.

| Location | Soil Test N kg/ha (0-30 cm) | Soil Test N kg/ha (0-60 cm) | Seeding Date | Undercut Date | Harvest Date |
|---|---|---|---|---|---|
| CSIDC | 19 | 33 | May 23 | August 30 | Sept 19 |
| Knapik | 34 | 74 | May 30 | August 30 | Sept 19 |
| Sommerfeld | 20 | 29 | May 24 | August 30 | Sept 19 |

Table 2. Seasonal vs Long-Term Precipitation, CSIDC Outlook Weather Station.

| | Year | | |
|---|---|---|---|
| **Month** | **2019 mm (inches)** | **30 Year Average mm (inches)** | **% of Long-Term** |
| May | 13.2 (0.5) | 46.0 (1.8) | 29 |
| June | 90.2 (3.6) | 67.0 (2.6) | 135 |
| July | 43.8 (1.7) | 57.0 (2.2) | 77 |
| August | 39.2 (1.5) | 46.0 (1.8) | 85 |
| September | 38.2 (1.5) | 33.0 (1.3) | 116 |
| **Total** | 224.6 (8.8) | 249.0 (9.8) | **90** |

Table 3. Cumulative Growing Degree Days (Base 10°C) vs Long-Term Average, CSIDC Outlook Weather Station.

| | Year | | |
|---|---|---|---|
| **Month** | **2019** | **30 Year Average** | **% of Long-Term** |
| May | 52 | 60 | 87 |
| June | 231 | 242 | 95 |
| July | 479 | 510 | 94 |
| August | 671 | 754 | 89 |
| September | 737 | 821 | 90 |

## Results

General observations of the 2019 growing season are warranted. The 2019 growing season began dry in terms of precipitation (Table 2), however, this was not overly a concern as all three trials were irrigated. However, the daily temperatures were believed an issue. The values shown in Table 3 are cumulative growing degrees throughout the season based on 10° C, as dry bean do not develop and grow at temperatures less than 10° C. The optimal growing degree days was well below optimal for dry bean development. Added influence was that average night time temperatures were below normal throughout the entire growing season. Consequently, agronomic dry bean growth, at all three sites, was less than normally experienced within the region. Plant canopies did not close at two of the three trials, and only at the high N rates at the CSIDC test trial.

Agronomic data or observations collected are shown in Tables 4 through 9 for the CSIDC, Knapik and Sommerfeld trial locations respectively. A brief overview of location differences will be discussed but summary of results will mainly focus on combined site analyses as presented in Tables 10 & 11.

The Coefficient of Variation (%CV) obtained for seed yield at all sites were higher than the generally assumed standard of 15% for agronomic research. However, dry bean tends to be a crop that exhibits greater variation both due to its phenotypic response to environment and wide-row production system. Although caution should be used when assessing yield, the results are believed to reflect those obtained commercially in 2019, and are deemed acceptable. Dry bean yield obtained at CSIDC was approximately double that obtained at other trial locations. A partial explanation is that this trial was protected by shelterbelts to both the west and north of the trial. A micro-climate develops in the protected areas of this field, and this phenomena has historically lead to higher yields as compared to all other areas of the AAFC Research Station. The other two trials were located in un-protected, open areas of fields. Yields obtained at CSIDC are similar to historic wide-row dry bean production obtained in ICDC varietal trials (see ICDC "*Crop Varieties For Irrigation*" https://irrigationsaskatchewan.com/icdc/publications/crop-varieties-for-irrigation/ ), yields from the Knapik and Sommerfeld locations much lower than typically obtained. Plant biomass production was similar to seed yield in that biomass yields followed CSIDC > Sommerfeld > Knapik.

Treatment influence on dry bean growth and development is shown in a factorial manner for combined site analysis in Tables 10 and 11. Data is assessed using factorial analysis (common control treatment used for each N source). Not overly surprisingly the three trials did differ with respect to all agronomic measurements. Sites did differ in geographic location and influencing factors such as soil texture, precipitation, irrigation additions and scheduling, etc. Combined analysis indicates that N fertilizer rates did not, overall, influence seed yield. This was found individually at both the CSIDC and Sommerfeld locations, but N fertilization did increase up to the 120 kg N/ha rate at Knapik. A partial explanation for this might result in the prior history of dry bean production at these locations. Previous frequency of dry bean production at the Sommerfeld location is not fully known, however, it is very possible that this field has had a history of dry bean production. With respect to the AAFC owned locations of CSIDC and Knapik, both have had a prior history, with the CSIDC location having a far greater intensity of dry bean within the rotation. Though not part of the trial protocol, plant roots were exhumed from unfertilized and fertilized treatments randomly at all sites. Nodules were observed with higher numbers on unfertilized plots at CSIDC and Sommerfeld than at Knapik. Indigenous *rhizobium leguminosarum bv. Phaseoli*, possibly added and elevated by prior inoculated dry bean production, may have minimized N fertilizer response at these two locations as compared to the Knapik location with its limited dry bean production history. Further, at the Knapik location, ESN did provide higher yields than did urea. At CSIDC and Sommerfeld yield differences between fertilizer sources did not occur. CSIDC and Sommerfeld locations were loam textured soils, the Knapik was a sandy loam, it was apparent in plant growth and development that the ESN was having a greater influence than urea and this expressed itself in both seed yield and plant biomass. It is possible that irrigation additions on this sandy loam textured soil leached N from the urea fertilizer source below the root zone of the dry bean, particularly given the very slow growth and development of dry bean during 2019. The influence of mean N fertilizer additions for each location is illustrated in Figure 1, the mean effect of urea compared to ESN shown in Figure 2.

Combined site analysis indicated that N rates had little statistical influence on biomass production until the very highest N rates of 120 and 150 kg/ha total N were applied. Of interest, the data summary suggests that N fertilizer source did influence biomass yield, this is illustrated for dry matter biomass production in Figure 3. Results suggest that the ESN N source was advantageous in providing higher biomass yields compared to urea. Tissue %N was not influenced by N fertilizer at either CSIDC or Sommerfeld, but was increased when fertilizer rates of 60 kg N/ha, or greater, were applied at Knapik. Total N uptake, averaged across all sites, did increase as fertilizer N rates increased and total N removed was greater for ESN than urea. Results are intriguing, suggesting that the slow release nature of ESN may be beneficial. However, results are from a single year of trials (and a year deemed abnormal) and no definitive conclusions can be made at this stage.

Higher N rates did delay maturity, and ESN delayed maturity statistically, more than the urea treatments, although the delay had no practical impact on harvestability. At only the highest N rate was there a negative influence on plant lodging, and in this case, its magnitude had no detrimental impact on harvest management. Pod clearance (% pods not adversely affected should a direct cut or swathing harvest system be considered) was not influenced by either N fertilizer rate or source. *Sclerotinia,* or white mold, did increase as N rates exceeded 60 kg N/ha. As biomass production did increase at higher rates of N fertilizer applications, the possibility of white mold incidence to be present is of agronomic concern. The % incidence observed occurred only at the CSIDC site where the highest biomass production was obtained. Plant height was increased by higher N rates and by ESN applications. Plant establishment was not impacted by either N fertilizer rate or N fertilizer source, indicating the fertilizer additions where sufficiently removed from the germinating seed and developing seedling as to not cause any toxicity.
This is the first year of an intended three-year study, it will be repeated in 2020.

## Acknowledgements

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Table 4. CSIDC Trial (1) – Dry Bean Agronomic Observations 2019.

| Treatment Kg N/ha N Source | Yield (kg/ha) | Yield (lbs/ac) | Protein % | Test weight (kg/hl) | Seed weight (g/1000) | Biomass Fresh Wt. (gm/m2) | Biomass Dry Wt. (gm/m2) | %N Dry Wt | N Uptake (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|
| Control | 3930 | 3506 | 22.4 | 84.0 | 365 | 4031 | 457 | 2.68 | 122 |
| 30 kg N Urea | 4484 | 3991 | 23.0 | 84.3 | 350 | 4131 | 410 | 2.73 | 112 |
| 60 kg N Urea | 4102 | 3658 | 23.1 | 83.6 | 368 | 4080 | 452 | 2.65 | 120 |
| 90 kg N Urea | 4251 | 3791 | 23.0 | 83.2 | 356 | 2945 | 360 | 2.73 | 98 |
| 120 kg N Urea | 3532 | 3150 | 23.6 | 83.4 | 353 | 4311 | 455 | 2.65 | 119 |
| 150 kg N Urea | 3820 | 3407 | 23.2 | 83.4 | 373 | 4107 | 472 | 2.80 | 131 |
| 30 kg N ESN | 4782 | 4266 | 22.5 | 83.9 | 371 | 4109 | 413 | 2.75 | 113 |
| 60 kg N ESN | 3623 | 3232 | 21.9 | 84.1 | 368 | 3688 | 399 | 2.68 | 106 |
| 90 kg N ESN | 3140 | 2801 | 24.0 | 82.6 | 346 | 3791 | 443 | 2.73 | 120 |
| 120 kg N ESN | 4105 | 3661 | 24.0 | 83.9 | 347 | 3878 | 433 | 2.73 | 117 |
| 150 kg N ESN | 3612 | 3221 | 23.5 | 83.1 | 356 | 4572 | 499 | 2.80 | 140 |
| LSD (0.05) | NS | NS | 1.3 | NS | NS | NS | NS | NS | NS |
| CV (%) | 16.6 | 16.6 | 3.8 | 0.9 | 3.9 | 17.6 | 19.2 | 4.8 | 18.7 |

Table 5. CSIDC Trial (2) – Dry Bean Agronomic Observations 2019.

| Treatment Kg N/ha N Source | Maturity (days) | Lodge 1=erect 5=flat | Pod Clearance (%) | White Mold (% plot) | Plant Height (cm) | Plant Population (plant/m2) |
|---|---|---|---|---|---|---|
| Control | 93 | 2.0 | 60 | 0 | 42 | 23 |
| 30 kg N Urea | 93 | 2.0 | 60 | 0 | 38 | 24 |
| 60 kg N Urea | 95 | 2.0 | 60 | 0 | 41 | 20 |
| 90 kg N Urea | 96 | 2.0 | 60 | 5.0 | 37 | 24 |
| 120 kg N Urea | 97 | 2.0 | 60 | 6.3 | 40 | 25 |
| 150 kg N Urea | 98 | 2.3 | 60 | 8.8 | 43 | 23 |
| 30 kg N ESN | 93 | 2.0 | 60 | 0 | 42 | 20 |
| 60 kg N ESN | 95 | 2.0 | 60 | 0 | 42 | 24 |
| 90 kg N ESN | 97 | 2.0 | 60 | 5.0 | 45 | 24 |
| 120 kg N ESN | 97 | 2.0 | 60 | 7.5 | 42 | 24 |
| 150 kg N ESN | 99 | 2.5 | 60 | 11.3 | 45 | 24 |
| LSD (0.05) | 0.8 | NS | NS | 5.3 | NS | NS |
| CV (%) | 0.6 | 10.8 | 60.0 | 93.1 | 11.5 | 14.8 |

Table 6. Knapik Trial (1) – Dry Bean Agronomic Observations 2019.

| Treatment Kg N/ha N Source | Yield (kg/ha) | Yield (lbs/ac) | Protein % | Test weight (kg/hl) | Seed weight (TKW) | Biomass Fresh Wt. (gm/m2) | Biomass Dry Wt. (gm/m2) | %N Dry Wt | N Uptake (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|
| Control | 1630 | 1454 | 22.1 | 82.0 | 371 | 1153 | 200 | 2.51 | 50 |
| 30 kg N Urea | 1667 | 1487 | 22.1 | 81.8 | 379 | 969 | 176 | 2.67 | 47 |
| 60 kg N Urea | 1912 | 1705 | 22.4 | 81.9 | 357 | 1207 | 215 | 2.63 | 56 |
| 90 kg N Urea | 1777 | 1585 | 22.3 | 82.1 | 363 | 1224 | 226 | 2.70 | 61 |
| 120 kg N Urea | 1969 | 1756 | 22.4 | 82.2 | 376 | 1473 | 263 | 2.71 | 71 |
| 150 kg N Urea | 1792 | 1599 | 22.6 | 81.7 | 352 | 1391 | 248 | 2.73 | 68 |
| 30 kg N ESN | 1642 | 1465 | 22.4 | 81.9 | 373 | 1125 | 211 | 2.53 | 54 |
| 60 kg N ESN | 2231 | 1990 | 22.4 | 81.8 | 367 | 1728 | 307 | 2.59 | 79 |
| 90 kg N ESN | 2601 | 2320 | 22.3 | 81.2 | 364 | 1835 | 342 | 2.71 | 92 |
| 120 kg N ESN | 3114 | 2778 | 22.4 | 81.9 | 366 | 2170 | 395 | 2.67 | 106 |
| 150 kg N ESN | 2745 | 2449 | 23.4 | 81.9 | 385 | 1941 | 356 | 2.98 | 106 |
| LSD (0.05) | 589 | 525 | NS | NS | NS | 326 | 63 | 0.14 | 16 |
| CV (%) | 19.4 | 19.4 | 3.9 | 0.8 | 4.0 | 15.3 | 16.4 | 3.6 | 15.9 |

Table 7. Knapik Trial (2) – Dry Bean Agronomic Observations 2019.

| Treatment Kg N/ha N Source | Maturity (days) | Lodge 1=erect 5=flat | Pod Clearance (%) | White Mold (% plot) | Plant Height (cm) | Plant Population (plant/m2) |
|---|---|---|---|---|---|---|
| Control | 90 | 1.0 | 65 | 0 | 37 | 19 |
| 30 kg N Urea | 90 | 1.0 | 65 | 0 | 40 | 18 |
| 60 kg N Urea | 90 | 1.0 | 60 | 0 | 39 | 19 |
| 90 kg N Urea | 91 | 1.0 | 60 | 0 | 39 | 19 |
| 120 kg N Urea | 92 | 1.0 | 63 | 0 | 42 | 19 |
| 150 kg N Urea | 93 | 1.0 | 68 | 0 | 44 | 20 |
| 30 kg N ESN | 90 | 1.0 | 65 | 0 | 39 | 19 |
| 60 kg N ESN | 91 | 1.0 | 65 | 0 | 42 | 19 |
| 90 kg N ESN | 91 | 1.0 | 60 | 0 | 44 | 19 |
| 120 kg N ESN | 94 | 1.0 | 60 | 0 | 45 | 19 |
| 150 kg N ESN | 93 | 1.0 | 63 | 0 | 41 | 17 |
| LSD (0.05) | 0.7 | 1.0 | NS | NS | NS | NS |
| CV (%) | 0.6 | 1.0 | 9.7 | 0 | 9.4 | 13.2 |

Table 8. Sommerfeld Trial (1) – Dry Bean Agronomic Observations 2019.

| Treatment Kg N/ha N Source | Yield (kg/ha) | Yield (lbs/ac) | Protein % | Test weight (kg/hl) | Seed weight (TKW) | Biomass Fresh Wt. (gm/m2) | Biomass Dry Wt. (gm/m2) | %N Dry Wt | N Uptake (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|
| Control | 2250 | 2007 | 24.1 | 82.8 | 366 | 1877 | 287 | 3.05 | 88 |
| 30 kg N Urea | 2452 | 2188 | 24.1 | 82.6 | 360 | 1910 | 290 | 3.02 | 88 |
| 60 kg N Urea | 2157 | 1924 | 23.8 | 82.7 | 363 | 1855 | 277 | 2.96 | 82 |
| 90 kg N Urea | 2351 | 2097 | 23.9 | 82.4 | 353 | 2244 | 342 | 2.99 | 102 |
| 120 kg N Urea | 2211 | 1972 | 24.6 | 82.3 | 357 | 2044 | 337 | 3.09 | 104 |
| 150 kg N Urea | 2459 | 2194 | 24.3 | 82.6 | 357 | 1821 | 284 | 3.08 | 88 |
| 30 kg N ESN | 2507 | 2236 | 23.3 | 82.7 | 356 | 1976 | 305 | 2.95 | 89 |
| 60 kg N ESN | 2597 | 2316 | 24.4 | 82.0 | 351 | 2195 | 341 | 2.92 | 99 |
| 90 kg N ESN | 2632 | 2348 | 23.9 | 82.8 | 356 | 2067 | 333 | 3.04 | 101 |
| 120 kg N ESN | 2917 | 2602 | 24.4 | 82.4 | 358 | 2424 | 398 | 2.96 | 118 |
| 150 kg N ESN | 2482 | 2214 | 25.0 | 82.2 | 361 | 2347 | 370 | 2.87 | 106 |
| LSD (0.05) | NS | NS | 0.7 | NS | NS | NS | NS | NS | NS |
| CV (%) | 21.4 | 21.4 | 2.0 | 0.6 | 2.9 | 15.8 | 16.7 | 5.6 | 17.6 |

Table 9. Sommerfeld Trial (2) – Dry Bean Agronomic Observations 2019.

| Treatment Kg N/ha N Source | Maturity (days) | Lodge 1=erect 5=flat | Pod Clearance (%) | White Mold (% plot) | Plant Height (cm) | Plant Population (plant/m2) |
|---|---|---|---|---|---|---|
| Control | 93 | 1.0 | 65 | 0 | 33 | 24 |
| 30 kg N Urea | 92 | 1.0 | 68 | 0 | 39 | 28 |
| 60 kg N Urea | 92 | 1.0 | 70 | 0 | 41 | 25 |
| 90 kg N Urea | 93 | 1.0 | 70 | 0 | 39 | 28 |
| 120 kg N Urea | 93 | 1.0 | 69 | 0 | 42 | 29 |
| 150 kg N Urea | 94 | 1.0 | 69 | 0 | 39 | 25 |
| 30 kg N ESN | 91 | 1.0 | 70 | 0 | 38 | 27 |
| 60 kg N ESN | 92 | 1.0 | 70 | 0 | 41 | 26 |
| 90 kg N ESN | 93 | 1.0 | 70 | 0 | 43 | 25 |
| 120 kg N ESN | 93 | 1.0 | 68 | 0 | 42 | 26 |
| 150 kg N ESN | 94 | 1.0 | 70 | 0 | 41 | 24 |
| LSD (0.05) | 1.3 | NS | NS | NS | NS | NS |
| CV (%) | 1.0 | 1.0 | 5.6 | 0 | 11.8 | 12.8 |

Table 10. Combined Site Analyses – Factorial for Trial Location, N Fertilizer Rate and N Fertilizer Source.

| Location Kg N/ha N Source | Yield (kg/ha) | Yield (lbs/ac) | Protein % | Test weight (kg/hl) | Seed weight (TKW) | Biomass Fresh Wt. (gm/m2) | Biomass Dry Wt. (gm/m2) | %N Dry Wt | N Uptake (kg/ha) |
|---|---|---|---|---|---|---|---|---|---|
| **Location** | | | | | | | | | |
| CSIDC | 3943 | 3517 | 23.0 | 83.6 | 360 | 3973 | 437 | 2.71 | 118 |
| Knapik | 2059 | 1837 | 22.4 | 81.9 | 369 | 1448 | 262 | 2.66 | 70 |
| Sommerfeld | 2439 | 2175 | 24.1 | 82.5 | 359 | 2053 | 321 | 3.00 | 96 |
| LSD (0.05) | 218 | 194 | 0.3 | 0.3 | 5 | 196 | 26 | 0.06 | 7.0 |
| CV (%) | 19.1 | 19.1 | 3.5 | 0.7 | 3.5 | 19.5 | 18.9 | 5.2 | 18.4 |
| **N Rate** | | | | | | | | | |
| Control | 2604 | 2322 | 22.9 | 82.9 | 367 | 2354 | 315 | 2.75 | 86 |
| 30 kg N | 2922 | 2607 | 22.9 | 82.9 | 365 | 2370 | 301 | 2.77 | 84 |
| 60 kg N | 2770 | 2471 | 23.0 | 82.7 | 363 | 2459 | 332 | 2.74 | 90 |
| 90 kg N | 2792 | 2490 | 23.2 | 82.4 | 356 | 2351 | 341 | 2.81 | 96 |
| 120 kg N | 2975 | 2653 | 23.6 | 82.7 | 360 | 2717 | 380 | 2.80 | 106 |
| 150 kg N | 2818 | 2514 | 23.6 | 82.5 | 364 | 2697 | 371 | 2.87 | 106 |
| LSD (0.05) | NS | NS | 0.5 | 0.4 | NS | 278 | 37 | 0.08 | 10.0 |
| **N Source** | | | | | | | | | |
| Urea | 2708 | 2415 | 23.1 | 82.7 | 362 | 2376 | 319 | 2.80 | 89 |
| ESN | 2919 | 2604 | 23.2 | 82.6 | 363 | 2606 | 360 | 2.78 | 100 |
| LSD (0.05) | 178 | 159 | NS | NS | NS | 160 | 21 | NS | 6.0 |
| **Location x N Rate Interaction** | | | | | | | | | |
| | S | S | NS | NS | NS | S | NS | S | S |
| **Location x N Source Interaction** | | | | | | | | | |
| | S | S | NS | NS | NS | NS | S | NS | S |
| **N Rate x N Source Interaction** | | | | | | | | | |
| | NS | NS | NS | NS | NS | NS | NS | NS | NS |

| Location x N Rate x N Source Interaction | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Table 11. Combined Site Analyses – Factorial for Trial Location, N Fertilizer Rate and N Fertilizer Source.

| **Location<br>Kg N/ha<br>N Source** | **Maturity (days)** | **Lodge 1=erect 5=flat** | **Pod Clearance (%)** | **White Mold (% plot)** | **Plant Height (cm)** | **Plant Population (plant/m2)** |
|---|---|---|---|---|---|---|
| **Location** | | | | | | |
| CSIDC | 95 | 2.1 | 60 | 3.6 | 41 | 23 |
| Knapik | 91 | 1.0 | 63 | 0 | 41 | 19 |
| Sommerfeld | 93 | 1.0 | 69 | 0 | 39 | 26 |
| LSD (0.05) | 0.3 | 0.1 | 2.0 | 0.9 | NS | 1.4 |
| CV (%) | 0.7 | 9.3 | 7.8 | 185 | 11.5 | 14.9 |
| **N Rate** | | | | | | |
| Control | 92 | 1.3 | 63 | 0 | 37 | 22 |
| 30 kg N | 92 | 1.3 | 65 | 0 | 39 | 23 |
| 60 kg N | 92 | 1.3 | 64 | 0 | 41 | 22 |
| 90 kg N | 93 | 1.3 | 63 | 1.7 | 41 | 23 |
| 120 kg N | 94 | 1.3 | 63 | 2.3 | 42 | 24 |
| 150 kg N | 95 | 1.5 | 65 | 3.3 | 42 | 22 |
| LSD (0.05) | 0.4 | 0.1 | NS | 1.3 | 2.7 | NS |
| **N Source** | | | | | | |
| Urea | 93.0 | 1.3 | 64 | 1.1 | 39 | 23 |
| ESN | 93.3 | 1.4 | 64 | 1.3 | 42 | 22 |
| LSD (0.05) | 0.2 | NS | NS | NS | 1.5 | NS |
| **Location x N Rate Interaction** | | | | | | |
| | S | S | NS | S | NS | NS |
| **Location x N Source Interaction** | | | | | | |
| | NS | NS | NS | NS | NS | NS |
| **N Rate x N Source Interaction** | | | | | | |
| | NS | NS | NS | NS | NS | NS |
| **Location x N Rate x N Source Interaction** | | | | | | |
| | NS | NS | NS | NS | NS | NS |

Figure 1. Mean Influence of N Fertilizer on Dry Bean Yield, 2019

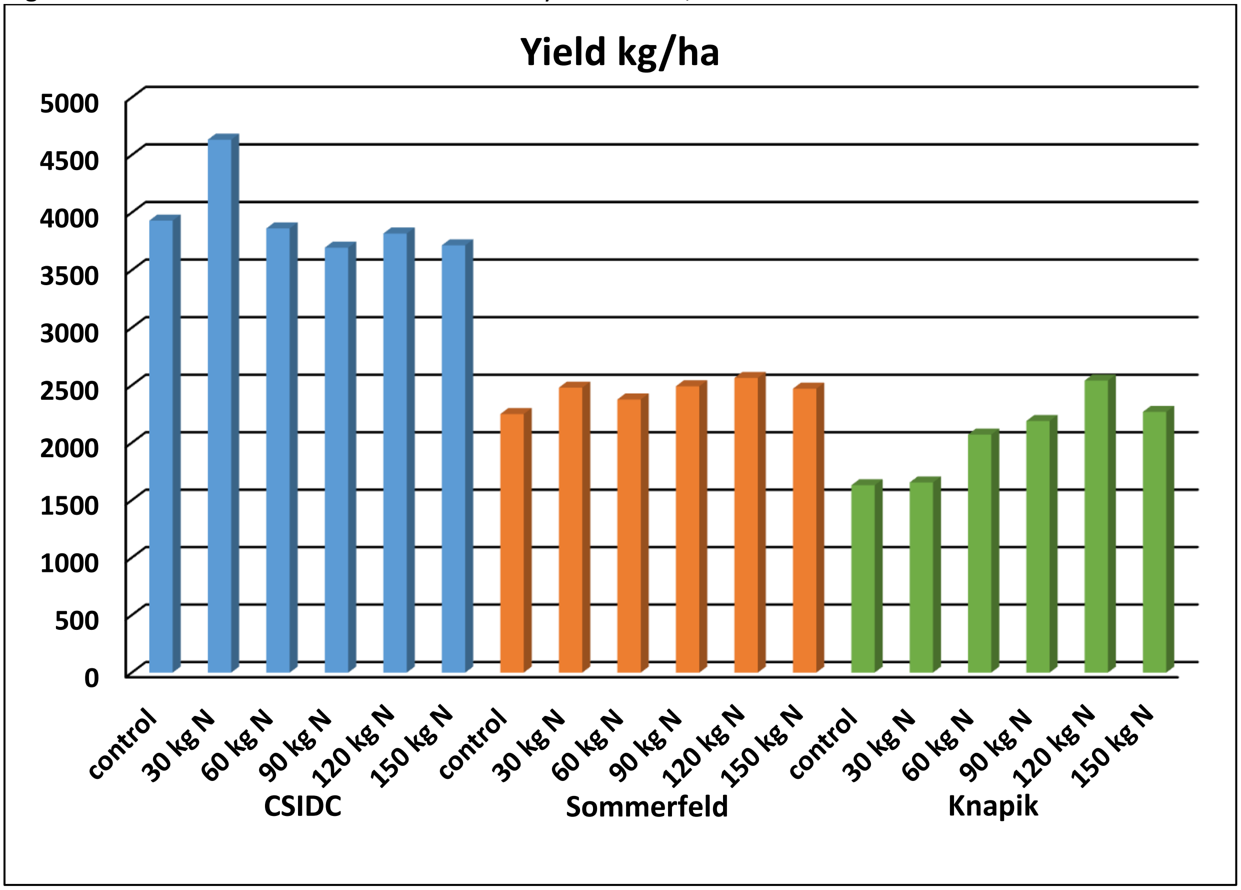



Figure 2. Mean Influence of N Source on Dry Bean Yield, 2019

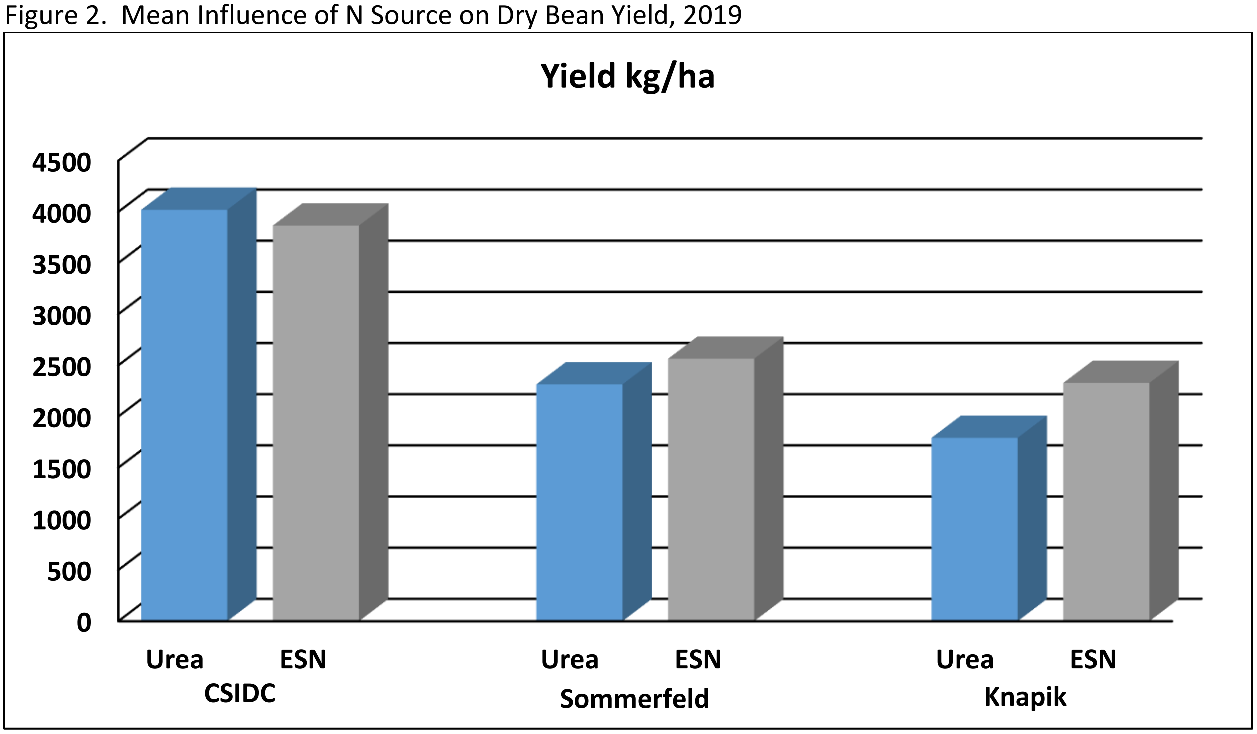
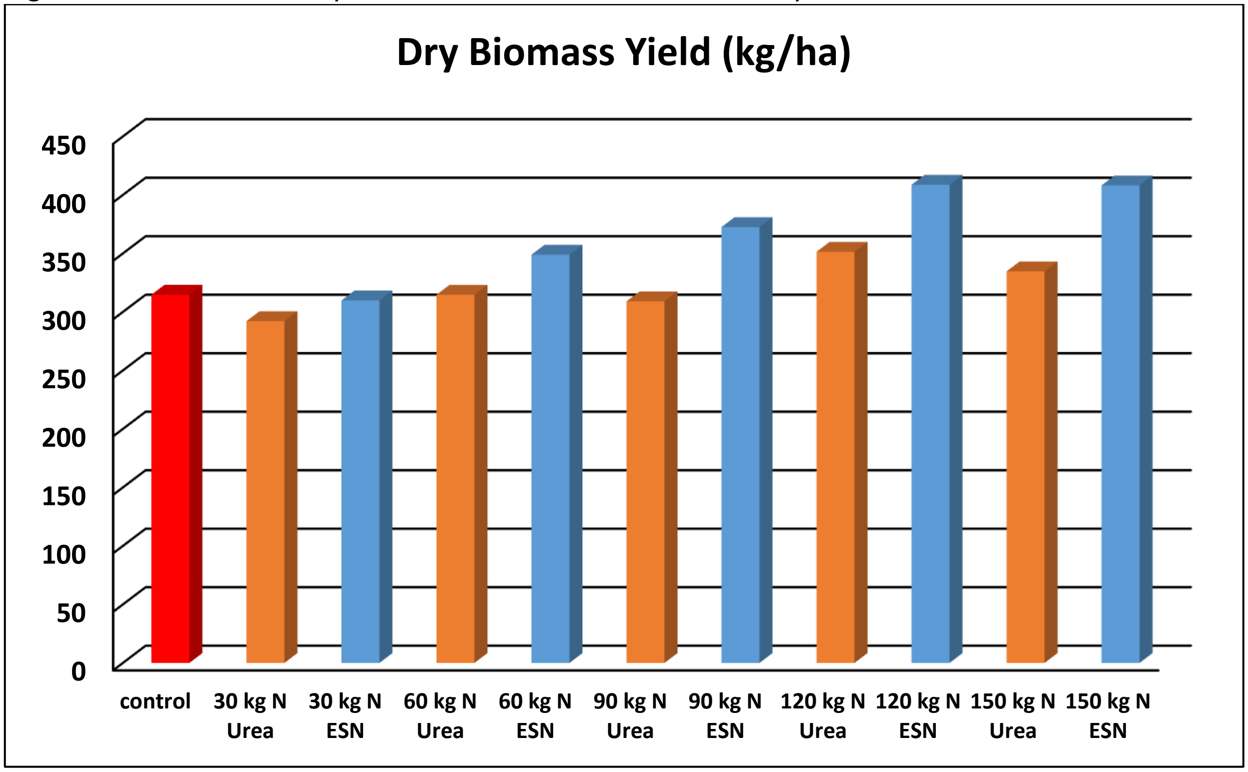


Figure 3. Combined Site Dry Matter Biomass Yield as Influenced by N Rate and Source.



# Expanding the Label Recommendations of Edge (ethalfluralin) in Dry Bean

## Funding

Funded by Gowan Canada

## Project Lead


- Project P.I: Garry Hnatowich
- Co-investigators: Mike Grenier and Erin Matlock, Gowan Canada


## Organizations


- Irrigation Crop Diversification Corporation (ICDC)
- Gowan Canada


## Objectives

Dry beans are the major pulse crop grown under irrigation in Saskatchewan, exceeding the acreage of other pulses combined by approximately two fold. Due to their inability to compete with weed pressure until mid-season when canopy closure occurs early season weed control is imperative to maximize yields. Presently Gowan Canada has ethalfluralin registered for use in navy and kidney market class dry beans in western Canada. However, these two market classes are rarely grown in Saskatchewan where pinto and black dry bean market classes are preferred. Therefore this study was established to evaluate the effectiveness of ethalfluralin, alone or in combination with additional herbicides, on;

(1) the growth and development of pinto and black dry beans and,
(2) the effectiveness of weed control under wide-row irrigated dry bean production.

## Research Plan

A research project was designed through mutual discussions between Gowan Canada and ICDC, Gowan Canada self-funded the trial. A research trial was established in the spring of 2019 at an ICDC off-station land base approximately 10 km north of Broderick, Saskatchewan (SW27-30-07 W3). Two dry bean varieties, CDC WM2 a pinto market class and CDC Blackstrap a black market class, were established in separate studies. Each trial was established in a RCBD design with four replicates. Each plot consisted of 4 rows of dry bean at 60 cm row spacings, each plot was 8 m in length giving a total plot area of 19.2 m2. Seed was treated with Apron Maxx RTA (fludioxonil and metalaxyl-M and S-isomer) for various seed rots, damping off and seedling blights and with and Stress Shield 600 (imidacloprid) for wireworm control. The trials were seeded May 28. For both trials phosphorus fertilizer was side-banded at a rate of 25 kg $P_2O_5$/ha during the seeding operation. *Rhizobial* inoculant were commercially unavailable in 2019 so the trial was established on potato stubble with residual soil test N levels, determined by soil test proceedures, of 150 kg N/ha to meet N plant demand. At no time during dry bean growth did plants exhibit symptoms of nitrogen deficiencies.

Weed control treatments consisted of the following treatments;

1. Unsprayed control
2. Ethalfluralin liquid EC (1100 g ai/ha)
3. Ethalfluralin liquid EC (1100g ai/ha) + Permit (35 g ai/ha)
4. Ethalfluralin liquid EC (1100g ai/ha) + Viper ADV (445g ai/ha) + Basagran Forte (175g ai/ha) + UAN (2l/ha)
5. Ethalfluralin liquid EC (1100g ai/ha) + Permit (35 g ai/ha) + Viper ADV (445g ai/ha) + Basagran Forte (175g ai/ha) + UAN (2l/ha)

Ethalfluralin was applied and incorporated on May 27, Permit on May 31, 2019. Post-emergent herbicide treatments were applied June 19, 2019. No fungicidal applications were applied in 2019.

Plant health and vigor were evaluated prior to post emergent herbicide treatment applications on June 18 when plants were in the 1-2 trifoliate leaf stage and again after in-season herbicide treatment applications June 26 at the 2-3 trifoliate leaf stage. Crop phytotoxicity was assessed on a visual scale of 0 (no damage) to 10 (severe, death), vigor on a visual scale of 1 (poor) to 5 (vigorous). Weed biomass was assessed by hand clipping all weeds from two separate 0.25 $m^2$ areas of each plot and recording fresh weights. Weed biomass sampling occurred on July 26. Plant establishment consisting of all plants within the center two harvest rows was conducted twice, the count was repeated as dry beans slowly continued to emerge and some minor cutworm activity was thought to be present.

No additional chemical or mechanical weed control other than the products outlined in the treatments listed were used in this study.

Dry bean maturity was abnormally late, not obtaining physiological maturity (90% pod colour change) until the end of August however plant dry down was also very slow. All plots were desiccated with an application of Reglone (diquat) on September 18 to facilitate dry down of both dry bean and the high weed growth in plots. Snow events delayed harvest further and significant seed deterioration was observed. Plots were finally undercut October 7 and combined October 17.

## Results & Discussion

The 2019 growing season was not overly favourable to dry bean growth and development. Monthly minimum and maximum temperatures by month are illustrated in Figure 1. Growing degree days for May through September are shown in Figure 2. Minimum temperatures remained below historic values for the first half of the season, maximum daily temperatures remained below historic values for the last half of the growing season. Plant growth and development was however slow and remained that way throughout the season. These trials were irrigated so soil moisture was not limiting. A total of 203 mm (8”) of rainfall was recorded at this site and it received an additional 229 mm of irrigation.

Seed yield was very low and exhibited extremely high variability when imposed to statistical analysis procedures. Yield was low for two reasons. The first was that dry bean seed deterioration reduced yield due to late season disease *sclerotinia* induced by excessive fall precipitation. The second was due to high weed density in most plots. No additional weed control other than treatments were utilized. In hind-site, possibly inter-row cultivation should have been utilized to control later flushes of weeds in all treatments. Beans are not competitive with weeds and yields reflect this. Consequently, no conclusions can be established with respect to herbicide treatments with respect to yield, statistically. It can be observed though that the control treatment was numerically lower yielding than all treatments for both the Pinto and the Black dry bean varieties. Seed size was significantly lower in the control treatment of both dry bean varieties compared to chemical herbicide treatments.

Agronomic data and observations conducted on the CDC WM2 Pinto market class dry bean is shown in Tables 1, 2 & 3. Results from the CDC Blackstrap Black market class dry bean are presented in Tables 4, 5 & 6.

Figure 1. Growing Season Temperature (average daily minimum & maximum, by month)

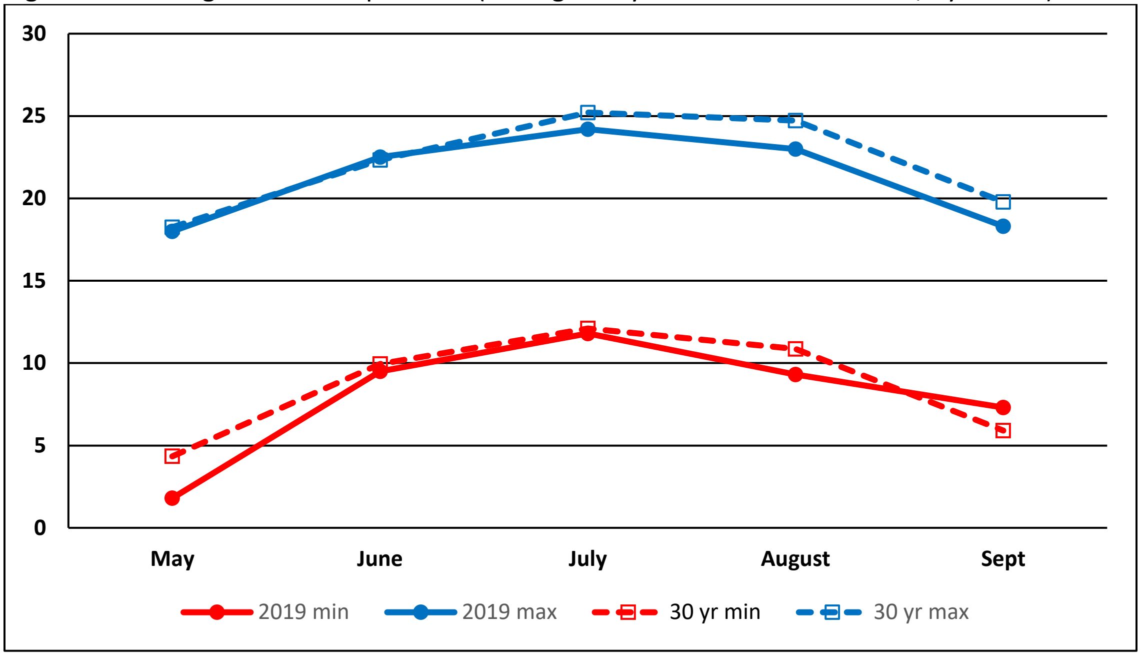
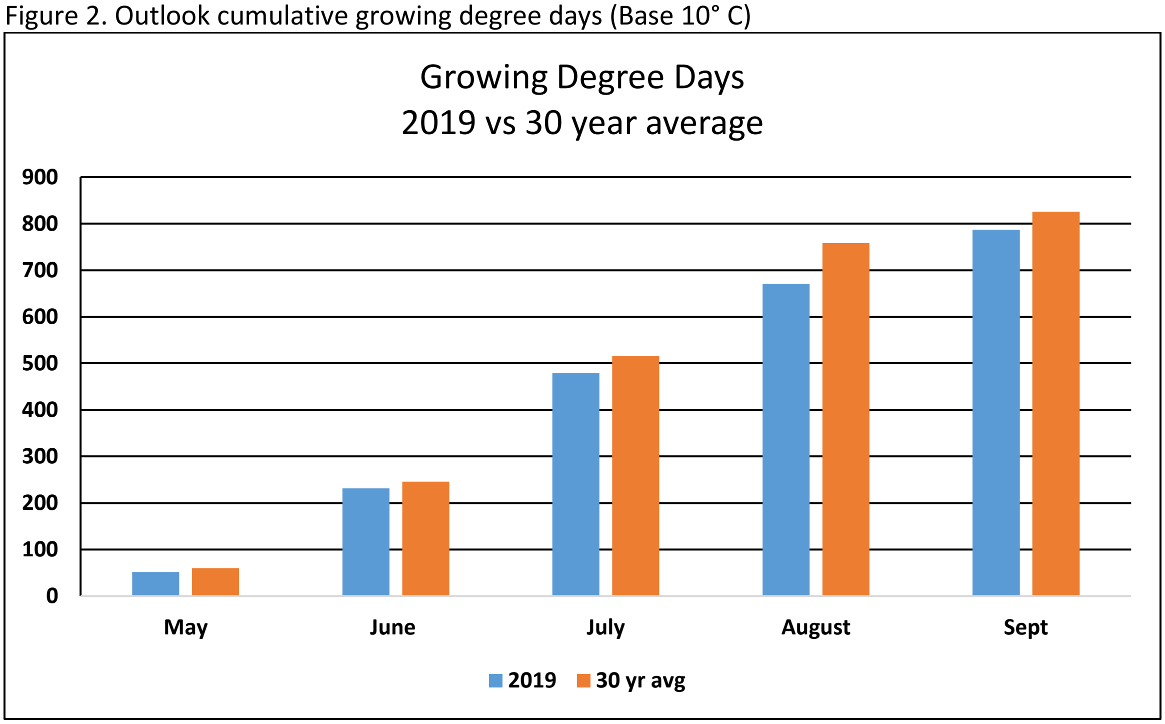



Figure 2. Outlook cumulative growing degree days (Base 10° C)



**CDC WM2**

Table 1. CDC WM2 Yield and seed characteristics as influenced by herbicide applications, 2019.

| Treatment | Yield (kg/ha) | 1K Seed Weight (gm) |
|---|---|---|
| Unsprayed control | 172 | 307 |
| Ethalfluralin | 273 | 330 |
| Ethalfluralin + Permit | 384 | 334 |
| Ethalfluralin + Viper ADV + Basagran Forte + UAN | 322 | 329 |
| Ethalfluralin + Permit + Viper ADV + Basagran Forte + UAN | 406 | 339 |
| LSD (0.05) | NS | 18 |
| CV (%) | 49.0 | 3.6 |

Table 2. CDC WM2 Phytotoxicity & Vigour Assessments, 2019.

| Treatment | Phytotoxicity (0–10) | | Vigor (1-5) | |
|---|---|---|---|---|
| | June 18 | June 26 | June 18 | June 26 |
| Unsprayed control | 0 | 0 | 2.8 | 3.0 |
| Ethalfluralin | 0 | 0 | 3.0 | 2.8 |
| Ethalfluralin + Permit | 0 | 0 | 2.3 | 2.8 |
| Ethalfluralin + Viper ADV + Basagran Forte + UAN | 0 | 0.8 | 2.8 | 2.8 |
| Ethalfluralin + Permit + Viper ADV + Basagran Forte + UAN | 0 | 0.8 | 2.8 | 2.8 |
| LSD (0.05) | NS | NS | NS | NS |
| CV (%) | -- | 110 | 15.1 | 16.6 |

NS = not significant

Table 3. CDC WM2 Weed Biomass Yields & Dry Bean Plant Growth Parameters, 2019.

| Treatment | Plant Stand June 18 (plants/m²) | Plant Stand June 25 (plants/m²) | Weed Biomass (g/m²) | Days to 10% Flower | Days to Mature | Height (cm) |
|---|---|---|---|---|---|---|
| Unsprayed control | 11.5 | 10.9 | 1863 | 50 | 91 | 30 |
| Ethalfluralin | 12.4 | 11.2 | 483 | 54 | 91 | 37 |
| Ethalfluralin + Permit | 12.9 | 12.8 | 77 | 54 | 94 | 34 |
| Ethalfluralin + Viper ADV + Basagran Forte + UAN | 12.3 | 11.5 | 25 | 56 | 95 | 31 |
| Ethalfluralin + Permit + Viper ADV + Basagran Forte + UAN | 14.0 | 13.3 | 14 | 56 | 95 | 32 |
| LSD (0.05) | NS | NS | 392 | 1.4 | 1.6 | NS |
| CV (%) | 13.0 | 14.0 | 51.7 | 1.7 | 1.1 | 14.3 |

NS = not significant

No visual phytotoxicity was observed with either pre-emergent applications of Ethalfluralin Liquid EC or Permit at any time through the growing season. Post emergent in-season herbicide applications caused some minor leaf scorching but these were not statistically significant. Plant vigor did not differ between treatments, in general plant growth was less than desired. Plant stands were not influenced by herbicide applications at either time of assessment. The unsprayed control had statistically significantly more weed growth and competition as reflected in weed biomass fresh weights as compared to all other treatments. The application of Ethalfluralin Liquid EC alone had statistically higher weed biomass than when Permit was also applied or with the addition of post emergent herbicides. In general, herbicide applications tended to increase both the time to flower and mature for CDC WM2 pinto beans.

**CDC Blackstrap**

Table 4. CDC Blackstrap Yield and seed characteristics as influenced by herbicide applications, 2019.

| Treatment | Yield (kg/ha) | 1K Seed Weight (gm) |
|---|---|---|
| Unsprayed control | 88 | 176 |
| Ethalfluralin | 304 | 193 |
| Ethalfluralin + Permit | 572 | 200 |
| Ethalfluralin + Viper ADV + Basagran Forte + UAN | 617 | 205 |
| Ethalfluralin + Permit + Viper ADV + Basagran Forte + UAN | 313 | 208 |
| LSD (0.05) | NS | 16.8 |
| CV (%) | 52.1 | 5.6 |

Table 5. CDC Blackstrap Phytotoxicity & Vigour Assessments, 2019.

| Treatment | Phytotoxicity (0–10) | | Vigor (1-5) | |
|---|---|---|---|---|
| | June 18 | June 26 | June 18 | June 26 |
| Unsprayed control | 0 | 0 | 3.3 | 3.3 |
| Ethalfluralin | 0 | 0 | 3.5 | 3.5 |
| Ethalfluralin + Permit | 0 | 0 | 3.8 | 3.5 |
| Ethalfluralin + Viper ADV + Basagran Forte + UAN | 0 | 0.3 | 3.8 | 3.5 |
| Ethalfluralin + Permit + Viper ADV + Basagran Forte + UAN | 0 | 0.5 | 3.5 | 3.5 |
| LSD (0.05) | NS | NS | NS | NS |
| CV (%) | -- | 243 | 13.9 | 17.2 |

NS = not significant

Table 6. CDC Blackstrap Weed Biomass Yields & Dry Bean Plant Growth Parameters, 2019.

| Treatment | Plant Stand June 18 (plants/m$^2$) | Plant Stand June 25 (plants/m$^2$) | Weed Biomass (g/m$^2$) | Days to 10% Flower | Days to Mature | Height (cm) |
|---|---|---|---|---|---|---|
| Unsprayed control | 13.6 | 13.2 | 1073 | 51 | 88 | 30 |
| Ethalfluralin | 12.2 | 12.9 | 953 | 52 | 88 | 31 |
| Ethalfluralin + Permit | 14.3 | 14.7 | 116 | 55 | 93 | 31 |
| Ethalfluralin + Viper ADV + Basagran Forte + UAN | 15.2 | 15.2 | 89 | 55 | 93 | 33 |
| Ethalfluralin + Permit + Viper ADV + Basagran Forte + UAN | 13.9 | 14.3 | 16 | 56 | 93 | 29 |
| LSD (0.05) | NS | NS | 620 | 1.6 | 1.3 | NS |
| CV (%) | 10.8 | 10.6 | 89.5 | 2.0 | 0.9 | 11.7 |

NS = not significant

No visual phytotoxicity was observed with either pre-emergent applications of Ethalfluralin Liquid EC or Permit at any time through the growing season. Post emergent in-season herbicide applications caused some minor leaf scorching but these were not statistically significant. Plant vigor did not differ between treatments, in general plant growth was less than desired. Plant stands were not influenced by herbicide applications at either time of assessment. Weed biomass was statistically higher in both the control and the Ethalfluralin Liquid EC alone treatment. Early season weed control was observed with the Ethalfluralin Liquid EC alone treatment but with frequent irrigation applications weeds continued to emerge and the beans never completely achieved full closure and ground cover to offer competition. While not statistically significant the post emergent applications resulted in less weed growth in comparison to the Ethalfluralin + Permit treatment. Both the control and the Ethalfluralin Liquid EC treatments flowered and matured earlier than other treatments. This is likely a result of accelerated development due to weed pressure. Plant heights were not influenced by herbicide applications.

## Summary

No data collected, or observations of plant health and development, suggests that ethalfluralin applications in any manner adversely affected Pinto or Black market class dry beans.

## Acknowledgements

Financial support was provided by Gowan Canada. Funding is gratefully acknowledged.

# Oxidate for Control of White Mold in AC Island Dry Beans

## Funding
Funding by BioSafe Systems, Hartford, Connecticut.

## Project Lead

- Gary Kruger, PAg, Irrigation Agrologist, Saskatchewan Ministry of Agriculture
- Garry Hnatowich, Research Director, Irrigation Crop Diversification Corporation
- Joel Peru, PAg, Irrigation Agrologist, Saskatchewan Ministry of Agriculture


## Co-operator
- Jeff Ewen, Irrigator, Riverhurst Irrigation District
- Kurt Schwartau, Research Coordinator, BioSafe Systems, Colorado
- Josh Krautkramer, Agri-inject, Canada Sales Representative

## Organizations
- Irrigation Crop Diversification Corporation (ICDC)
- BioSafe Systems, Hartford, Connecticut.

## Objectives
Oxidate, a mixture of hydrogen peroxide and peroxycetic acid, is registered for ground and aerial application to dry bean in Canada. The disease control has been similar to other control strategies and the hope is that with application by chemigation, improved coverage of plant material will increase the level of disease control. The environmental risk with the application is virtually nil since the active ingredients degrade to water and oxygen. Application through an irrigation pivot is preferred to improve the coverage of the plant foliage to improve the disease control.

The project objective is to collect data for submission to the Pest Management Regulatory Agency for registration of Oxidate for application with an irrigation pivot to dry beans for control of white mold.

## Research Plan
The site is located on SW21-22-7-W3 in Riverhurst Irrigation District, part of Maple Bush Rural Municipality #224. The field is irrigated with a Zimmatic center pivot. The crop of AC Island dry beans was seeded May 27, 2019 on Fox Valley silty loam using a JD MaxEmerge 24 row Vacuplanter. The crop was managed by a custom farming operation which plants dry beans using row crop equipment on 22" centers. Their row cropping practice consists of 12 passes across the field during the growing season including two inter-row cultivations. The field operations are listed in Table 1.

Table 1: Field operations for row crop dry bean production.

| |
|---|
| 1) Spring or fall heavy tillage |
| 2) Spring or fall applied ethalfluralin incorporated with heavy harrow for trash management |
| 3) Fertilize by banding or broadcast application |
| 4) Preplant cultivation |
| 5) Sow with planter on 22" centers |
| 6) Weed kill with interrow cultivation |
| 7) Apply herbicide |
| 8) Weed kill with interrow tillage (ripping) |
| 9) And 10) Two fungicide applications |
| 10) Undercutting and windrowing |
| 11) Harvest with Pickett bean combine |

Other potential alternatives
Windrow with a swather
Conventional combine with pickup header
Direct harvest with flex header draper (for black and navy beans)

Oxidate was applied using an Agri-Inject Mac-Roy G pump rated to deliver 55 gallon per hour injected into the supply water stream. The pump setting for the two rates was 41.6% for 2 gallon per acre and 31.2% for 1.5 gallon per acre.

Four applications of the fungicide were applied during the growing season. The treatments were applied on the basis of crop staging and disease development without considering moisture conditions in the field or the presence of infection. The first application was applied at initial flowering on July 15 (rated July 22) followed by a second application July 25 (rated July 29). The dry bean plants were free of white mold until the discovery made on July 30. The third application was made on Aug 2 following discovery of visual sclerotinia symptoms on July 30. A final application was made on Aug 9. A rating of the percent of plant affected by disease was determined on August 14, 2019. The dry bean canopy on this field was more open than is usually found for irrigated dry bean production because of the unusually dry spring until mid-June. The absence of rainfall during spring together with relatively cool conditions and very open dry bean stand led to very low risk of sclerotinia infection even for the irrigated dry bean crop.

Harvest samples of the dry bean were collected on September 16, 2019. The sample size was 2 rows of dry beans (22 inch row spacing) x 2 m for a sample area of 2.24 $m^2$. Just prior to field harvest (undercutting), the dry bean plants from each plot area were pulled by hand, placed in a sample bag and dried in a greenhouse for three weeks before threshing with a stationary harvester. The samples were cleaned and ready for processing.

White mold disease ratings were collected over the growing season. Even though no white mold was observed in the production field prior to July 29, 2019, the site was rated for disease for the different treatment areas. White mold was found in the production field by the producer on July 30, 2019. Although two applications of Oxidate had already been applied to the field as a protective measure, the white mold infection levels were recorded July 30 in preparation for a followup Oxidate chemigation on August 2, 2019. The observations of disease incidence are summarized in Table 1 prior to the third

Oxidate application, Table 2 prior to the fourth Oxidate application and Table 3 following the fourth Oxidate application. A final disease rating was collected on August 21, 2019 by determining the percentage infection on each individual plant in the treated area (Table 5). Four replications were rated for each treatment. Table 4 lists the rating scale used for each rating conducted prior to the final individual plant ratings just prior to maturity.

Table 1: Disease Ratings July 30, 2019 prior to third Oxidate application on Aug 2, 2019

| Treatment | Stage | Plants | Rep 1 | Plants | Rep 2 | Plants | Rep 3 | Plants | Rep 4 |
|---|---|---|---|---|---|---|---|---|---|
| Control | R-3 | 24 | 4 Pods | 22 | 2 Pods | 23 | 11 Pods | 22 | 7 Pods |
| Oxidate 1:1000 High | R-3 | 21 | 8 Pods | 23 | 5 Pods | 23 | 4 Pods | 23 | 5 Pods |
| Oxidate 1:2000 Low | R-3 | 22 | 2 Pods | 22 | 8 Pods | 27 | 3 Pods 1 -3 rated | 23 | 2 Pods |

Table 2: Disease Ratings August 7, 2019 prior to fourth Oxidate application on August 9, 2019

| Treatment | Stage | Plants | Rep 1 | Plants | Rep 2 | Plants | Rep 3 | Plants | Rep 4 |
|---|---|---|---|---|---|---|---|---|---|
| Control | R-4 | 24 | 5 Pods 1-4 rated | 19 | 10 Pods No Dead | 23 | 7 Pods No Dead | 21 | 12 Pods No Dead |
| Oxidate 1:1000 High | R-4 | 19 1 Dead | 15 Pods | 19 | 10 Pods 1 Dead | 22 | 7 Pods No Dead | 22 | 12 Pods No Dead |
| Oxidate 1:2000 Low | R-4 | 23 | 8 Pods No Dead | 22 | 29 Pods No Dead | 22 | 8 Pods No Dead | 23 | 11 Pods No Dead |

Table 3: Disease Ratings August 14, 2019

| Treatment | Stage | Plants/2m | Rep 1 | Plants/2m | Rep 2 | Plants/2 m | Rep 3 | Plants/2m | Rep 4 |
|---|---|---|---|---|---|---|---|---|---|
| Control | R-6 | 21 | 6 Pods | 22 | 2 Pods 1 -2 rated | 22 | 4 Pods 8 – 3 rated 1 – 4 rated | 21 | 7 Pods 1-2 rated 1-3 rated 2-4 rated 1-5 rated |
| Oxidate 1:1000 High | R-6 | 21 | 8 Pods 2-2 rated 2-4 rated 1-5 rated | 24 | 6 Pods 5-2 rated 2-3 rated 1-4 rated | 21 | 5 Pods 6-2 rated | 20 | 5 Pods 4-2 rated |
| Oxidate 1:2000 Low | R-6 | 23 | 6 Pods 6-2 rated 1-5 rated | 23 | 10 Pods 1-2 rated 6-3 rated 1-4 rated | 20 | 4 Pods 3 – 2 rated 3 – 3 rated | 19 | 5 Pods 8-2 rated 2–3 rated |

Table 4: Rating scale used to describe disease in dry bean

| |
|---|
| 0 None |
| 1 1-3 small independent lesions on leaf or stems |
| 2 At least 1 coalescense of lesions with moderate mycelial growth |
| 3 Mycelial development or wilt involving up to 25% of foliage |
| 4 Extensive mycelial growth or wilt involving up to 50% of foliage |
| 5 Death, deceased |

Table 5: Disease rating of dry bean plants as plants started to dry down – Percent of plant affected by disease on August 21, 2019

| **Control** | Rep 1 | Rep 2 | Rep 3 | Rep 4 | **High Rate** | Rep 1 | Rep 2 | Rep 3 | Rep 4 |
|---|---|---|---|---|---|---|---|---|---|
| **Plant 1** | 30 | 100 | 0 | 10 | **Plant 1** | 0 | 0 | 0 | 10 |
| **Plant 2** | 0 | 0 | 0 | 0 | **Plant 2** | 0 | 20 | 0 | 0 |
| **Plant 3** | 10 | 0 | 0 | 0 | **Plant 3** | 0 | 0 | 20 | 10 |
| **Plant 4** | 0 | 0 | 5 | 20 | **Plant 4** | 0 | 0 | 0 | 0 |
| **Plant 5** | 10 | 0 | 20 | 0 | **Plant 5** | 0 | 0 | 0 | 0 |
| **Plant 6** | 0 | 0 | 10 | 0 | **Plant 6** | 30 | 20 | 0 | 0 |
| **Plant 7** | 0 | 0 | 0 | 0 | **Plant 7** | 20 | 0 | 0 | 0 |
| **Plant 8** | 20 | 100 | 0 | 0 | **Plant 8** | 0 | 0 | 0 | 0 |
| **Plant 9** | 10 | 0 | 5 | 0 | **Plant 9** | 0 | 0 | 10 | 0 |
| **Plant 10** | 10 | 100 | 0 | 0 | **Plant 10** | 0 | 0 | 0 | 0 |
| **Plant 11** | 40 | 0 | 0 | 10 | **Plant 11** | 10 | 0 | 0 | 0 |
| **Plant 12** | 50 | 0 | 0 | 0 | **Plant 12** | 20 | 0 | 0 | 10 |
| **Plant 13** | 20 | 0 | 0 | 0 | **Plant 13** | 40 | 10 | 0 | 0 |
| **Plant 14** | 0 | 0 | 0 | 0 | **Plant 14** | 0 | 10 | 0 | 0 |
| **Plant 15** | 0 | 0 | 30 | 10 | **Plant 15** | 0 | 0 | 20 | 0 |
| **Plant 16** | 10 | 0 | 0 | 0 | **Plant 16** | 0 | 0 | 0 | 0 |
| **Plant 17** | 25 | 100 | 0 | 0 | **Plant 17** | 0 | 0 | 0 | 0 |
| **Plant 18** | 25 | 0 | 40 | 0 | **Plant 18** | 10 | 0 | 0 | 0 |
| **Plant 19** | 20 | 0 | 10 | 0 | **Plant 19** | 0 | 0 | 0 | 0 |
| **Plant 20** | 0 | 0 | 10 | 0 | **Plant 20** | 0 | 20 | 20 | 0 |
| **Plant 21** | 0 | 0 | 0 | 0 | **Plant 21** | 0 | 0 | 0 | 0 |
| **Plant 22** | | 0 | | 0 | **Plant 22** | 0 | 0 | 0 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Plant 23** | | 0 | | | **Plant 23** | | 0 | 0 | |
| **Low Rate** | **Rep 1** | **Rep 2** | **Rep 3** | **Rep 4** | **Fungicide** | **Rep 1** | **Rep 2** | **Rep 3** | **Rep 4** |
| **Plant 1** | 0 | 30 | 20 | 30 | **Plant 1** | 40 | 20 | 0 | 0 |
| **Plant 2** | 0 | 0 | 20 | 0 | **Plant 2** | 30 | 0 | 60 | 60 |
| **Plant 3** | 0 | 0 | 0 | 0 | **Plant 3** | 30 | 0 | 0 | 0 |
| **Plant 4** | 0 | 0 | 0 | 10 | **Plant 4** | 30 | 0 | 20 | 60 |
| **Plant 5** | 20 | 30 | 0 | 20 | **Plant 5** | 0 | 20 | 60 | 0 |
| **Plant 6** | 80 | 0 | 0 | 0 | **Plant 6** | 80 | 0 | 0 | 0 |
| **Plant 7** | 0 | 0 | 0 | 10 | **Plant 7** | 0 | 40 | 0 | 60 |
| **Plant 8** | 0 | 80 | 80 | 0 | **Plant 8** | 0 | 10 | 60 | 0 |
| **Plant 9** | 0 | 0 | 0 | 0 | **Plant 9** | 0 | 10 | 0 | 0 |
| **Plant 10** | 60 | 0 | 0 | 0 | **Plant 10** | 0 | 0 | 60 | 0 |
| **Plant 11** | 0 | 80 | 10 | 0 | **Plant 11** | 10 | 80 | 0 | 60 |
| **Plant 12** | 0 | 25 | 0 | 30 | **Plant 12** | 20 | 0 | 0 | 40 |
| **Plant 13** | 0 | 10 | 40 | 80 | **Plant 13** | 10 | 0 | 20 | 0 |
| **Plant 14** | 20 | 0 | 30 | 10 | **Plant 14** | 0 | 0 | 0 | 0 |
| **Plant 15** | 0 | 10 | 0 | 0 | **Plant 15** | 20 | 10 | 60 | 0 |
| **Plant 16** | 20 | 0 | 0 | 0 | **Plant 16** | 0 | 0 | 0 | 0 |
| **Plant 17** | 5 | 20 | 0 | 0 | **Plant 17** | 80 | 0 | 60 | 40 |
| **Plant 18** | 80 | 10 | 0 | 0 | **Plant 18** | 0 | 20 | 0 | 60 |
| **Plant 19** | 0 | 90 | 20 | 10 | **Plant 19** | 0 | 0 | 0 | 0 |
| **Plant 20** | 0 | 0 | 0 | 30 | **Plant 20** | 0 | 0 | 0 | 100 |
| **Plant 21** | 20 | 30 | 0 | 0 | **Plant 21** | 10 | 0 | 0 | 0 |
| **Plant 22** | 0 | 0 | | 0 | **Plant 22** | 0 | 0 | 40 | 20 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Plant 23** | | | | | **Plant 23** | 0 | | 0 | 0 |
| | | | | | **Plant 24** | | | 0 | |

Harvest samples were collected September 16, 2019 from the sample areas marked in the dry bean field when the final disease assessments were determined. The sample area consisted of two rows of dry beans of 2 meter length with row spacing of 0.56 m. (2 rows x 0.56 row spacing x 2 meter = 2.24 $m^2$)

Table 6: Harvest dry bean samples for chemigation application of Oxidate

| Treatment | Seed moisture (%) | Test weight (kg/hl) | Thousand Kernel Weight (g/1000 seeds) | Yield (bu/ac) |
|---|---|---|---|---|
| Check | 7.8 | 80.1 | 244.9 | 56.2 |
| High rate | 7.7 | 80.5 | 289.2 | 61.3 |
| Low rate | 7.8 | 81.3 | 242.8 | 57.9 |
| Fungicide | 7.8 | 80.4 | 281.9 | 61.2 |

## Final Discussion

Oxidate was effective in reducing the white mold infection level of the AC Island dry beans at the high rate of Oxidate application through the irrigation pivot. The level of infection as measured by visual field disease inspections supported the control that was observed. A yield response of 5 bu/ac dry bean seed was observed in the field demonstration. The TKW for the dry beans was higher for the high rate of chemigation and the application of fungicide with a high clearance sprayer. The seed yield for the high rate of Oxidate application and fungicide application were equal. A concern for the use of Oxidate for dry bean disease management is the $72/ ac cost accumulated in the multiple applications conducted during the growing season. Likely, the first two applications were not needed and provided little benefit to the grower. Some adjustment of the application rate may be needed to encourage adoption by growers.

## Acknowledgements

Thanks to Jeff Ewen for providing the irrigated field to conduct the testing. The product applied through the center pivot chemigation was provided by BioSafe Systems, Hartford, Connecticut thanks to Kurt Schwartau. An injection pump matched to the requirements needed for injecting the required fungicide product into the water stream was provided by Agri-Inject based out of Yuma, Arizona thanks to Josh Krautkramer based out of Yuma, Colorado. Garry Hnatowich, ICDC Research Director, rated the disease infection on the dry beans after the first two applications of Oxidate. Rhett Carlson, ICDC summer technician, assisted with maintaining the project site and collecting the data. Gary Kruger conducted the final disease rating with the assistance of Rhett Carlson on August 21, 2019.

# Demonstrating 4R Nitrogen Management Principals for Canola

## Funding

Funded by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT).

## Project Lead

- ICDC Lead: Garry Hnatowich

## Organizations

Irrigation Crop Diversification Corporation (ICDC)

## Objectives

Nitrogen is the most commonly limiting nutrient in annual crop production and often accounts for one of the most expensive crop nutrients, particularly for crops with high N requirements like wheat and canola. Most inorganic N fertilizers contain NH4-N but some (i.e. UAN) also contain NO3-N. Since the advent of no-till and innovations in direct seeding equipment, side- or midrow-band applications and single pass seeding / fertilization quickly became the standard and most commonly recommended BMP for nitrogen. Side-or mid-row banding is effective with the major forms of N including anhydrous ammonia (82-0-0), urea (46-0-0) and urea ammonium-nitrate (28-0-0) and the combination of concentrating fertilizer (safely away from the seed row) and placing it beneath the soil surface dramatically reduced the potential for environmental losses while maintaining seed safety. Fall applications have always been popular, at least on a regional basis, in that fertilizer prices are usually lower and applying N in a separate pass can take logistic pressure off during seeding when labour and time are limited. It is primarily for these logistic reasons that many growers are again considering two pass seeding / fertilization strategies as a means of spreading out their workload and managing logistic challenges associated with handling large product volumes during the narrow seeding window. While the timing and/or placement associated with two pass systems are usually not ideal, enhanced efficiency formulations such as polymer coats (ESN®), volatilization inhibitors (i.e. Agrotain®) and volatilization / nitrification inhibitors (Super Urea®) can reduce the potential risks associated with applying N well ahead of peak crop uptake (i.e. fall applications) or sub-optimal placement methods (i.e. surface broadcast, which seems to be increasing in popularity for irrigated production). Enhanced efficiency N products are more expensive than their more traditional counterparts; however, this higher cost may be justified by the potential improvements in efficacy and logistic advantages of alternative fertilization practices.

This project is relevant to producers because, for many, there has been a movement back to two pass seeding fertilization systems for logistic reasons. The availability of high speed floater applicators is increasing within major irrigation districts. While we do not necessarily want to encourage growers to revert to two pass seeding / fertilization systems, it is important for them to have a certain amount of flexibility with respect to how they manage N on their farms. By demonstrating different N fertilization strategies according to the 4R principles and providing data on their efficacy relative to benchmark BMPs we can help them to make informed decisions while taking into consideration both the advantages and potential disadvantages of the various options. Canola is a good candidate for this project since it is highly responsive to N fertilizer applications.

Developing Best Management Practices (BMPs) for nutrient applications has long been focussed on the 4R principles which refer to using the: 1) right source, 2) right rate, 3) right time and 4) right placement.

These factors are not necessarily independent of each other. For example, depending on the source, application timings or placement options that would normally be considered high risk can become viable. The objective of this trial is to demonstrate canola response to varying rates of Nitrogen (N) along with different combinations of formulations, timing and placement options relative to side-banded, untreated urea as a benchmark. The proposed field trial design encompasses all four considerations (source, rate, time and placement) for 4R nutrient management.

## Research Plan

The trial was established at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC Field #12). The trial was established in a randomized complete block design (RCBD) with four replications. Fall fertilizer applications were conducted on October 24, 2018, broadcast applications were incorporated at the time of application. Spring fertilizer band applications and canola seeding occurred on May 16, canola was seeded into wheat stubble. The Liberty tolerant hybrid L252 was seeded at a rate of 6.0 kg/ha. Fertilizer treatments are shown in Table 1. Sources of nitrogen (N) used were "bare" urea (46-0-0), urea treated with Agrotain® (46-0-0: N-{n-buty} thiophosphoric triamide), urea treated with SuperU® (46-0-0: dicyandiamide + N-{n-buty} thiophosphoric triamide) and ESN® (44-0-0: polymer coated urea). Soil analyses, from fall 2018 sampling time, of the trial area is provided in Table 2. On the basis of soil test analyses the 1X rate of N fertilizer was identified as 130 kg N/ha. All treatments received 25 kg P2O5/ha seed placed monoammonium phosphate (11-51-0) at seeding. Weed control consisted of a pre-emergent application of Edge (ethalfluralin) and post-emergent tank-mix application of Muster Toss-N-Go (ethametsulfuron @ 12 gm/ac) on June 17, 2019, supplemented by periodic hand weeding. The trial received a foliar application of Priaxor (fluxapyroxad & pyraclostrobin) applied July 18 at the 50% bloom for disease control or suppression. Individual plots were mechanically separated on August 28, swathed on August 29, and harvested with a small plot combine September 16.
Total in-season rainfall from May through September was 225 mm (8.8"). Total in-season irrigation was 234 mm (9.2").

Table 1. 4R Nitrogen Canola Study Treatments, 2019

| Treatment | Fertilizer Rate, Placement & Source |
|---|---|
| 1 | Un-fertilized control |
| 2 | 0.5X spring side-band Urea |
| 3 | 1.0X spring side-band Urea |
| 4 | 1.5x spring side-band Urea |
| 5 | 1.0x spring side-band Agrotain |
| 6 | 1.0x spring side-band SuperU |
| 7 | 1.0x spring side-band ESN |
| 8 | 1.0x fall broadcast Urea |
| 9 | 1.0x fall broadcast Agrotain |
| 10 | 1.0x fall broadcast SuperU |
| 11 | 1.0x fall band Urea |
| 12 | 1.0x fall band Agrotain |
| 13 | 1.0x fall band SuperU |
| 14 | 1.0x fall band ESN |

1.0x rate = 130 kg/N/ha

Table 2. Soil Testing Report, Agvise Labs, Sampled fall 2018

| Depth (cm) | $NO_3$-N (lb/ac) | P (ppm) | K (ppm) | $SO_4$-S (lb/ac) |
|---|---|---|---|---|
| 0 - 15 | 7 | 2 | 159 | 114 |
| 15 - 30 | 5 | | | 126 |
| 30 - 60 | 13 | | | |
| Organic Matter | 2.3% | | | |
| pH (0 - 15 cm) | 7.9 | | | |
| pH (15 - 60 cm) | 8.5 | | | |
| Soluble Salts (0 - 15 cm) | 0.44 mmho/cm | | | |
| Soluble Salts (15 - 60 cm) | 0.54 mmho/cm | | | |

| Table 3. Seasonal vs Long-Term Precipitation, CSIDC Outlook Weather Station | | | |
|---|---|---|---|
| | Year | | |
| **Month** | **2019 mm (inches)** | **30 Year Average mm (inches)** | **% of Long-Term** |
| May | 13.2 (0.5) | 46.0 (1.8) | 29 |
| June | 90.2 (3.6) | 67.0 (2.6) | 135 |
| July | 43.8 (1.7) | 57.0 (2.2) | 77 |
| August | 39.2 (1.5) | 46.0 (1.8) | 85 |
| September | 38.2 (1.5) | 33.0 (1.3) | 116 |
| **Total** | 224.6 (8.8) | 249.0 (9.8) | **90** |

| Table 4. Cumulative Growing Degree Days (Base 0°C) vs Long-Term Average, CSIDC Outlook Weather Station | | | |
|---|---|---|---|
| | Year | | |
| **Month** | **2019** | **30 Year Average** | **% of Long-Term** |
| May | 211 | 224 | 94 |
| June | 691 | 708 | 98 |
| July | 1249 | 1290 | 97 |
| August | 1750 | 1844 | 94 |
| September | 2133 | 2058 | 104 |

## Results

Results obtained for the 4R Nitrogen Principals in Canola are shown in Table 5.

The unfertilized control was statistically lower yielding compared to all fertilized treatments (excepting the fall broadcast Agrotain treated urea application). Fall broadcast applications did elevate seed yield, the average of the three fall broadcast applications suggests that broadcast applications were effective in increasing canola yield by 636 kg/ha (11.4 bu/ac). The fall broadcast Agrotain treatment was not statistically higher than the control unfertilized yield, the fall broadcast urea and SuperU applications were, however, were not statistically significant from the broadcast Agrotain treatment. This is likely due to experimental variation. Regardless, fall broadcast applications were effective in increasing yield, but there was no benefit to the enhanced urea sources Agrotain or SuperU. Fall banded fertilizer applications were, generally, statistically higher yielding compared to fall broadcast fertilizer applications. On average fall band applications were 1019 kg/ha (18.1 bu/ac) higher in yield as compared to the average fall broadcast applications. Efficiency enhanced fertilizer sources (Agrotain, SupperU, ESN) offered no yield advantage as compared to bare urea fertilizer. The application of the 0.5x (65 kg N/ha) spring band urea was the lowest yielding spring application. Numerical yield gains were obtained by increasing the rate of N to the 1x (130 kg N/ha) rate, the additional N increase to the 1.5x (195 kg N/ha) rate provided no yield advantage over the 1.0x rate. Spring side band fertilizer applied at 1.0x N rate resulted in a yield advantage, compared to the same fall band applications, of 160 kg/ha (2.9 bu/ac). This difference was not statistically significant. Again, C Influence of fertilizer timing, placement and rate is illustrated in Figure 1.

Oil content of canola seed was greatest for the unfertilized and fall broadcast applications. Banded fertilizer (fall or spring applied) treatments oil content varied somewhat but were lower than the unfertilizer and broadcast N applications. Since a negative correlation exists between seed oil and protein, these results infer that the protein content was higher in the band applications as a result of enhanced seed N uptake. Test weight, seed weight and plant heights were not largely influenced by fertilizer time, placement or N source. Generally band N applications, regardless of N source, resulted in longer days to maturity compared to fall broadcast and the unfertilized control. Plant lodging was not significantly influenced by fertilizer N applications within this study.

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. All funding is gratefully acknowledged.

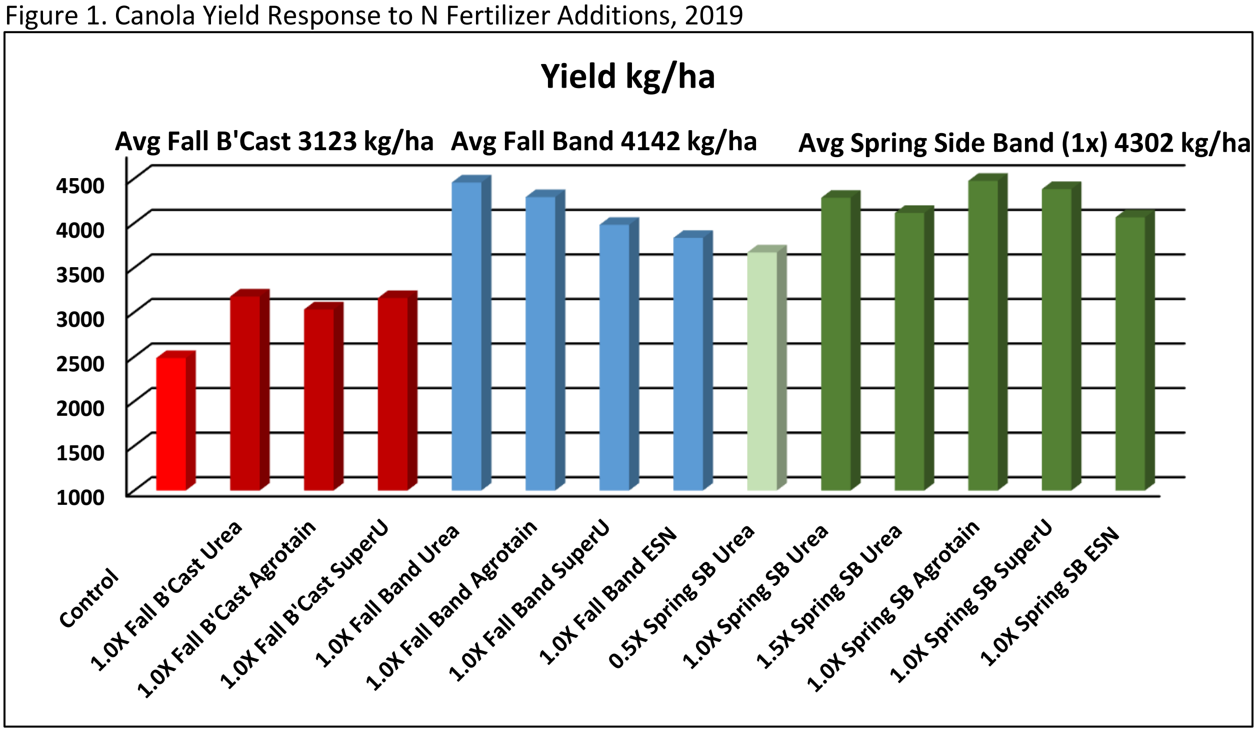
Table 5. Influence of Fertilizer N Applications on Canola Yield, Seed Quality and Plant Growth Charachteristics , 2019

| Treatment | Yield (kg/ha) | Yield (bu/ac) | Oil (%) | Test weight (kg/hl) | Seed weight (gm/1000) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|---|
| ***1. unfertilized check*** | ***2487*** | ***44.4*** | ***52.8*** | ***64.1*** | ***3.5*** | ***97*** | ***114*** | ***1.5*** |
| 2. 0.5X spring side-band Urea | 3672 | 65.5 | 52.1 | 63.8 | 3.5 | 99 | 117 | 1.5 |
| 3. 1.0X spring side-band Urea | 4285 | 76.5 | 51.6 | 64.8 | 3.4 | 101 | 124 | 1.5 |
| 4. 1.5x spring side-band Urea | 4115 | 73.4 | 51.1 | 64.7 | 3.5 | 102 | 120 | 1.5 |
| 5. 1.0x spring side-band Agrotain | 4476 | 79.8 | 51.1 | 65.1 | 3.5 | 101 | 125 | 1.8 |
| 6. 1.0x spring side-band SuperU | 4383 | 78.2 | 50.8 | 64.7 | 3.6 | 101 | 124 | 1.8 |
| 7. 1.0x spring side-band ESN | 4066 | 72.6 | 51.4 | 64.5 | 3.6 | 101 | 120 | 1.8 |
| 8. 1.0x fall broadcast Urea | 3178 | 56.7 | 52.8 | 64.1 | 3.5 | 98 | 114 | 1.3 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9. 1.0x fall broadcast Agrotain | 3032 | 54.1 | 52.6 | 64.0 | 3.4 | 99 | 117 | 1.5 |
| 10. 1.0x fall broadcast SuperU | 3161 | 56.4 | 53.2 | 64.2 | 3.5 | 99 | 118 | 1.3 |
| 11. 1.0x fall band Urea | 4457 | 79.5 | 50.7 | 65.1 | 3.4 | 101 | 121 | 1.8 |
| 12. 1.0x fall band Agrotain | 4293 | 76.6 | 51.4 | 65.0 | 3.4 | 100 | 113 | 1.8 |
| 13. 1.0x fall band SuperU | 3982 | 71.0 | 50.6 | 64.8 | 3.3 | 101 | 118 | 2.0 |
| 14. 1.0x fall band ESN | 3835 | 68.4 | 52.1 | 64.0 | 3.5 | 99 | 117 | 1.8 |
| LSD (0.05) | 668 | 11.9 | 1.3 | 0.8 | NS | 1.9 | NS | NS |
| CV (%) | 12.3 | 12.3 | 1.7 | 0.9 | 3.6 | 1.3 | 5.0 | 25.7 |

NS = not significant

Figure 1. Canola Yield Response to N Fertilizer Additions, 2019



# 4R Fall Nitrogen Application for Irrigated Canola

## Funding

Funded by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT).

## Project Lead

- ICDC Leads: Joel Peru & Gary Kruger, Irrigation Agrologists, SK Ministry of Agriculture

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)

## Objectives

Canola is a major irrigated crop in Saskatchewan, making up 25% of the irrigated acres in the Lake Diefenbaker Development Area. Irrigators have high target yields for canola compared to dryland producers, and can achieve yields greater than 70 bu/acre. There are very high nitrogen demands when growing canola for high yields, making proper fertilization necessary to achieve maximum returns.

4R Nutrient Stewardship (Right Source @ the Right Rate, Right Time, and Right Place) helps producers minimize environmental concerns related to agriculture while maximizing economic benefits. Growers are questioning whether the added cost of nitrogen efficiency products will deliver the efficiencies promised in the promotional materials. Demonstrating these products in a field setting will give the growers experience with the potential of this technology and inspire confidence in adoption. These new technologies are intended to help reduce N losses from volatilization and leaching and may help to reduce the amount of nitrous oxide emissions and/or denitrification losses when compared to traditional urea. Nitrogen efficiency enhanced products are a critical part of 4R nitrogen stewardship and increased adoption will help the province's goal of reducing man-made contributions to climate change.

Since these products reduce nitrogen loss, potentially less fertilizer is needed to provide for the needs of a crop. There is also less risk of loss when broadcasting these products before seeding which can help producers with time management. Producers are increasing the amount of nitrogen broadcast by a floater in order to save time during seeding. If this trend continues, using some of these new products can potentially help reduce the negative consequences associated with this practice.
This project was intended to demonstrate the use and benefit of specialty nitrogen fertilizer products applied with 4R principles for irrigated crop production.

## Research Plan

Fall applied treatments for this project (Table 1) were applied on November 20$^{th}$ 2018 with a pneumatic fertilizer floater in a co-operators field near Outlook, SK. Fertilizer rates were based off a 70 bu/acre canola yield target based upon soil test residual nitrogen. All fertilizer sources were broadcast and unincorporated. At the time of broadcast, there was about an inch of snow cover (Picture 1). The fertilizer products were able to melt through the snow after application. Products were applied at 125lb N/acre of actual N to the soil. Plots ran across the entire field and were marked with flags and GPS coordinates.

Proven® Seed PV540G Canola was seeded on May 18th on SW24-29-08 W3 with an air drill. This site is fine sand-loam Asquith soil. This quarter section is irrigated with a low pressure pivot system. The remainder of the field received urea via side banding with a rate of 125 lbs N/acre.

This field was swathed and plots were harvested on October 13th. Yield results were measured with a weigh wagon and plot size was measured using a GPS to determine distance. The header width was 24 feet.

**Picture 1: Fall Broadcast Products Melting Through Snow**

Table 1: Treatments

| | |
|---|---|
| **Treatment 1** | Fall applied bare urea |
| **Treatment 2** | Fall applied Agrotain® treated urea |
| **Treatment 3** | Fall applied Super U® |
| **Treatment 4** | Fall applied Amidas® |
| **Treatment 5** | Fall applied Agrotain® treated Amidas® |
| **Treatment 6** | Spring banded urea |

## Results

Due to harvest timing, the untreated spring banded urea (treatment 6) portion of the field was harvested a week earlier. Due to this area of the field being harvested and measure separately, it was not a proper comparison and will be omitted from the rest of the report.

The yield results of the remaining treatments are outlined in Table 2. The results indicate the Agrotain® treated Amidas® (treatment 5) and Super U® (treatment3) may have provided a small yield benefit. The field was affected by hail damage which promoted blackleg disease in the canola which could have impacted the results.

The economic return was negative for all of the treatments in this trial with the exception of Super U®

(treatment 3) when compared to fall broadcast bare urea (treatment 1). This table uses the yields from this trial, actual cost of products at the time of purchase and assumes the price of canola is $10.70/bu.

Table 2: Yield Results of the 2019 demonstration

| Trt # | Fertilizer N Time of Application & Source | Yield (bu/acre) |
|---|---|---|
| 1 | Fall Urea | 67 |
| 2 | Fall Agrotain® treated Urea | 67 |
| 3 | Fall Super U® | 70 |
| 4 | Fall Amidas® | 67 |
| 5 | Fall Agrotain® treated Amidas® | 71 |

Table 3: Economics of Treatments Using the Observed Results

| Trt # | Product | Cost of N ($/lb. actual N) | Total N cost ($/acre) | Gross Value of Crop ($/acre) | Loss/Gain per acre compared to Bare Urea ($/acre) | Value Less N cost ($/acre) |
|---|---|---|---|---|---|---|
| 1 | Fall Urea | 0.56 | 69.75 | 721 | 0 | 651.25 |
| 2 | Fall Agrotain® treated Urea | 0.64 | 79.75 | 722 | -9.75 | 641.75 |
| 3 | Fall Super U® | 0.68 | 84.92 | 753 | +16.86 | 668.04 |
| 4 | Fall Amidas® | 0.70 | 87.89 | 721 | -17.89 | 633.40 |
| 5 | Fall Agrotain® Treated Amidas® | 0.78 | 119.03 | 762 | -8.59 | 642.60 |

## Conclusions and Recommendations

The project demonstrated broadcast application of nitrogen using several different sources of nitrogen. The best performing source was Agrotain® treated Amidas® with Super U® close behind. The only product that provided an economic benefit in this trial was Super U®. The winter of 2018-19 was relatively dry which minimizes the risk for loss of nitrogen from the soil. Enhanced efficiency fertilizer products provide greater benefit when the risk for N losses are high. Using enhanced nitrogen efficacy products costs around 10% more than using bare urea alone. The observed increase in yield in this trial from using these products would not benefit the producer's net profit on this canola crop. On years where nitrogen losses are higher there could be an economic benefit in applying these products, along with the reduced nitrous oxide emissions from volatilization.

In Saskatchewan, there has been an increase in applying broadcast nitrogen in fall. This is not considered a 4R practise and can cause nutrient loss and have a negative impact the environment. If a producer chooses to follow this practise for time management purposes, using these enhanced nitrogen efficacy products could help reduce risk.

## Acknowledgements

Financial support was provided by the Agricultural Demonstration of Practices and Technologies Fund (ADOPT) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. All funding is gratefully acknowledged.

# Comparative efficacy of insecticidal seed treatments for flea beetle control in canola and evaluation of a novel mitigation strategy to reduce neonicotinoid use

## Funding

Funded by the Strategic Field Program (SFP).

## Project Lead

- Project P.I: Dr. James Tansey, Provincial Specialist, Insect/Pest Management, SK Ministry of Agriculture
- ICDC Lead: Garry Hnatowich

## Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- East Central Research Foundation (Yorkton)
- Western Applied Research Corporation (Scott)
- Agriculture and Agri-Food Canada, Saskatoon (Dr. Tyler Wyst)

## Objectives

Flea beetles in the genus *Phyllotreta* are the most important perennial threats to seedling canola on the Canadian Prairies. Most canola is prophylactically treated with insecticidal seed treatments in anticipation of heavy flea beetle pressure. There are currently two major modes of action associated with registered seed treatments: neonicotinoids (Class 4A) and diamides (Class 28). The former is represented by the thiamethoxam, clothianidin and imidacloprid, the latter by cyantraniliprole. Most seed is treated with thiamethoxam or clothianidin. Seed treatments incorporating sulfoxaflor (Class 4C) are also available. The PMRA has recently issued proposed decision documents related to the re-evaluation of thiamethoxam and clothianidin and is proposing de-registration of these compounds. The major alternative is cyantraniliprole. The striped flea beetle is less sensitive to both neonicotinoid and diamide insecticides than the crucifer flea beetle, therefore comparison of product performance in regions dominated by either species are essential and will inform grower decisions. Mitigation of the effects of neonicotinoids on water bodies is the subject of an AAFC-led working group. Limiting the on-site volume of neonicotinoids used has been proposed by PMRA as a potential mitigation technique worth exploring. This work will contribute to the validity of flea beetle control recommendations made by Ministry staff and professional agronomists and build evidence for effective alternative mitigation strategies.

The objective of this study is to demonstrate the relative efficacies of registered seed treatments to control flea beetle damage in seedling canola.

## Research Plan

The trial was established at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC Field #12). The trial was established in a randomized complete block design (RCBD) with four replications. Canola hybrid 45H33 was obtained from Corteva Agriscience and seed treatments applied through various cooperating seed treatment companies. Seed treatments applied are shown in Table 1. Delays in seed delivery meant that this trial was not seeded until May 31. Seeding rate was adjusted to seed 200 viable seeds/$m^2$ after adjusting for % germination and seed weight. Seeded plot size was 10m x 1.5m. All treatments received 140 kg N/ha as 46-0-0 and 40 kg $P_2O_5$/ha as 11-52-0, both fertilizer products were side-band at seeding. Weed control consisted of a pre-emergent application of Edge (ethalfluralin) and post-emergent tank-mix application of Muster Toss-N-Go (ethametsulfuron @ 12 gm/ac) on June 26, 2019, supplemented by periodic hand weeding. The trial received a foliar application of Priaxor (fluxapyroxad & pyraclostrobin) applied July 15 at the 50% bloom for disease control or suppression. Individual plots were mechanically separated and swathed on September 6, and harvested with a small plot combine September 19.

Flea beetle damage was evaluated weekly from cotyledon stage for four weeks by photographs taken from each plot, so that a 30cm x 30cm quadrat filled the field of view of camera; all damage was evaluated from photographs by Dr. James Tansey. Four randomly chosen quadrat's were photographed within each plot at each evaluation time.

Total in-season rainfall from May through September was 225 mm (8.8"). Total in-season irrigation was 234 mm (9.2").

Table 1. Canola Flea Beetle Seed Treatments

| **Treatment** | **Fungicides** |
|---|---|
| 1 | Control |
| 2 | Fungicide seed treatment (difenoconazole) |
| 3 | Lumiderm (cyantraniliprole diamide) |
| 4 | Prosper (clothianidin) |
| 5 | Helix Vibrance (thiamethoxam + difenoconozole + metalaxyl + fludioxonil + sedaxane) |
| 6 | Visivio (sulfoxaflor) |
| 7 | Helix + JumpStart (thiamethoxam + difenoconozole + metalaxyl + fludioxonil + *P. bilaii*) |
| 8 | Helix + Lumiderm (thiamethoxam + difenoconozole + metalaxyl + fludioxonil + cyantraniliprole diamide) |

## Results
Results obtained for the study are shown in Table 2.

Seed treatments had no strong agronomic influence on any factor measured. The late planting possible diminished any seed treatment effect, both for disease and flea beetle activity. Flea beetle damage from photographic assessment is shown in Table 3. At this site, a significant effect of treatment was detected ($F_{7, 42} = 56.64$; $P < 0.001$). Greater flea beetle feeding damage to seedlings was found in control and fungicide-treated plots than in any insecticide-treated plots (Table 3). Significant ($P < 0.05$) increases in damage occurring between 10 June (mean: 1.60%) and 13 June (mean: 2.03%). However, these reductions in flea beetle damage failed to translate into an economic benefit.

A summary of results from all contributing sites will be completed and available under the projects title from the Ministry of Agriculture.

## Acknowledgements
Financial support was provided by the Strategic Field Program (SFP). All funding is gratefully acknowledged.

Table 2. Influence of Seed Treatments on Canola Yield, Seed and Plant Characteristics.

| Treatment | Yield (kg/ha) | Oil (%) | Test weight (kg/hl) | Seed weight (gm/1000) | Maturity (days) | Height (cm) | Lodging 1=erect; 9=flat |
|---|---|---|---|---|---|---|---|
| Control | 2663 | 46.9 | 67.8 | 2.8 | 97 | 121 | 1 |
| Fungicide | 3087 | 47.8 | 67.7 | 2.8 | 97 | 123 | 1 |
| Lumiderm | 3029 | 47.6 | 67.3 | 2.9 | 97 | 123 | 1 |
| Prosper | 2698 | 46.9 | 67.9 | 2.9 | 97 | 116 | 1 |
| Helix Vibrance | 2951 | 47.0 | 68.2 | 3.0 | 97 | 119 | 1 |
| Visivio | 2900 | 47.3 | 67.9 | 3.0 | 97 | 119 | 1 |
| Helix & JumpStart | 2853 | 47.0 | 68.3 | 2.9 | 97 | 122 | 1 |
| Helix & Lumiderm | 2951 | 46.7 | 68.2 | 3.0 | 97 | 125 | 1 |
| LSD (0.05) | NS | NS | NS | 0.13 | NS | NS | NS |
| CV (%) | 12.4 | 2.2 | 0.8 | 3.1 | 0.5 | 5.7 | 0 |

NS = not significant

Table 3. Flea Beetle Assessment Damage.

| Treatment | Mean feeding damage rating (% defoliation) |
|---|---|
| Control | 42.1 |
| Fungicide | 33.6 |
| Lumiderm | 14.5 |
| Prosper | 12.8 |
| Helix Vibrance | 9.9 |
| Visivio | 13.1 |
| Helix & JumpStart | 10.3 |
| Helix & Lumiderm | 8.6 |

# AC Saltlander Green Wheatgrass Saline Tolerance Study

## Funding

Funded by the Agricultural Development Fund

## Project Lead

- Project P.I: Dr. Alan Iwaasa, AAFC Swift Current
- ICDC Lead: Garry Hnatowich
- Cara Drury & Kelly Farden, Saskatchewan Ministry of Agriculture

## Organizations

- Agriculture & Agri-Food Canada
- Irrigation Crop Diversification Corporation (ICDC)
- Saskatchewan Ministry of Agriculture

## Objectives

AC Saltlander green wheatgrass is a perennial wheatgrass with saline tolerance and a yield potential similar to tall wheatgrass. This variety might have the ability to be used on reclamation of saline areas presently unsuitable for crop growth. The objectives of this study are to:

- Determine the effects of seeding rates, time and methods of AC Saltlander under irrigated production and
- Evaluate these factors under two soil salinity levels.

## Research Plan

This trial was established on the AAFC Knapik land base during 2016. Two independent but closely positioned trials were conducted. Treatments were identical between these trials, and both trials were established in a RCBD with four replicates. The trials differed in their soil salinity levels and were designated “slight to moderate” and “moderate to severe.” Sites were selected from EC mapping conducted by the Saskatchewan Ministry of Agriculture (MOA). Treatments were either seeded in the spring or fall of 2016. Two seeding rates of AC Saltlander were used; 5.7 kg/ha or 11.4 kg/ha. Seeding rates were adjusted to reflect % germination and seed weights. To assist gravity flow through seed tubes each AC Saltlander pre-weighed package also contained a 9 kg/ha of heat treated (zero germination) barley. Plots were seeded using two differing production systems; conventional and direct. Treatments are outlined in Table 1. Plot size of ach treatment was 10m x 1.5m. Both trials were established on land previously seeded to alfalfa but terminated in the fall of 2015 with the application of 1 L/acre glyphosate. Prior to seeding, conventional spring seeded plots were cultivated and harrowed. Each plot received a pre-plant application of glyphosate at a rate of 1 L/acre. Spring seeding occurred on both trials June 1, and fall seeding occurred on November 21, 2016. All treatments recieved phosphorus fertilizer (monoammonium phosphate 11-52-0) applied with the seed at a rate of 25 kg P2O5/ha. Plots intended for fall seeding were seeded to spring barley, June 1, at a rate of 125 kg/ha. These plots were harvested at grain maturity and AC Saltlander seeded as per appropriate treatment and method.

Prior to establishment on May 18$^{th}$ an EM 38 survey and collection of 4 soil samples (separated into 4 depths 0-30, 30-60, 60-90 and 90-120 cm) was conducted by the MOA. MOA sent these soil samples into ALS for analysis and used the data in generating preliminary salinity maps. These maps have been forwarded onto ICDC and AAFC-SCRDC (results not shown in this report).

On September 20th a detailed and extensive soil sampling of both saline level AC Saltlander trials were conducted by both MOA and ICDC staff. Sampling included 3 depths per hole (0-15, 15-30 and 30-60 cm), 4 holes per treatment, 6 treatments per rep, 4 reps per salinity gradient and 2 salinity gradients. Overall a total of 576 individually bagged soil samples were collected. These soil samples were taken to a greenhouse at CSIDC and left to air dry. Soil samples were delivered by MOA to AAFC in Swift Current on October 11th for detailed analysis (results not shown and still being analyzed).

On October 21st the MOA conducted a further EM38 survey and collection of 10 soil samples (separated into 4 depths 0-30, 30-60, 60-90 and 90-120 cm). These soil samples were delivered to AAFC in Swift Current for processing and analysis. MOA generated additional soil maps (results not shown in this report).

Table 1. AC Saltlander Treatment List, trials established 2016.

| **Two trials established: slight-moderate and moderate-severe salinity** | | |
|---|---|---|
| Method of Seeding | **Date of Seeding** | **Seeding Rate** |
| Conventional | Spring | 5.7 kg/ha |
| Conventional | Spring | 11.4 kg/ha |
| Direct | Spring | 5.7 kg/ha |
| Direct | Spring | 11.4 kg/ha |
| Direct | Fall | 5.7 kg/ha |
| Direct | Fall | 11.4 kg/ha |

## Results

Forage biomass from this study was collected for the field seasons of 2017 – 2019. Results obtained from this trial will not be discussed at this time. Technically this trial was completed with the final forage harvest taken in 2019. Maintenance of the slight-moderate salinity site is being considered in order to assess stand longevity. A final three-year report of this study is presently under development and will be included in the 2020 Research and Demonstration Report.

## Acknowledgements

Financial support was provided by the Agricultural Development Fund (ADF) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. All funding is gratefully acknowledged.

# Yellow clover/Tillage Radish Green Manure on Heavy Textured Soils

## Funding

Funded by the Irrigation Crop Diversification Corporation

## Project Leads

- Gary Kruger, PAg, Irrigation Agrologist, Saskatchewan Ministry of Agriculture
- Cara Drury, Irrigation Agrologist, Saskatchewan Ministry of Agriculture
- Darren Clay, Irrigation Technologist, Saskatchewan Ministry of Agriculture
- Brittany Neumeier, Irrigation Technologist, Saskatchewan Ministry of Agriculture
- Kelly Farden, Agronomy Manager, Saskatchewan Ministry of Agriculture

## Co-operator

- Greg Oldhaver, Irrigator, Miry Creek Irrigation District, Cabri, SK
- Neil McLeod, Regional Sales Manager, Northstar Seeds

## Organizations

- Saskatchewan Ministry of Agriculture
- Irrigation Crop Diversification Corporation

## Objectives

Heavy clay soils often have pockets of high sodium in the soil profile. Such is the case at Miry Creek Irrigation District. The soil at the site is classified as Kindersley soil association. These dense soil horizons impede water infiltration and contribute to temporary ponding on the soil surface, especially in lower lying areas. Portions of the heavy textured fields at Miry Creek Irrigation District behave in this manner and contribute to loss of alfalfa stand. Clover has been used in California to improve pockets of irrigated sodium affected heavy textured soils. The same strategy was implemented on portions of Miry Creek Irrigation District to see if water infiltration could be improved on those areas that are prone to waterlogging.

The objective is to demonstrate the benefit of novel cover crops to improve unfavourable soil conditions on heavy textured irrigated soils.

## Demonstration Site

Several areas of Miry Creek Irrigation District are prone to surface water ponding due to restricted infiltration into the soil profile. The issue of reduced water infiltration appears when heavy bursts of showers occur during the growing season. Soil mapping with the GPS enabled technology used by the Soil Environmental Unit to determine irrigation suitability was conducted on four small fields (Fields 3,6,11 and 13) within the Irrigation District. The maps (shown as Figure 1 and 2) show the distribution of salinity throughout the site. The green manure project is located on SW-19-21-18-W3 on the eastern edge of the south west field in the diagram.

## Research Plan

This trial was The site was sown with a John Deere air drill on May 31, 2018. The strips were arranged in a north-south orientation. Four plots were seeded. From east to west, the treatments were: 1) tillage radish @ 4 lb/ac mixed with yellow clover @ 6.5 lb/ac, 2) yellow clover @ 9 lb/ac, 3) tillage radish @ 7

lb/ac and 4) Maverick green feed barley sown at 75 lb/ac. A timely shower occurred on June 1, 2018 which germinated the seeded forages and provided excellent establishment.
The soil mapping data collected by the Environmental Unit of the Ministry of Agriculture is presented in Figure 1. The maps indicate that severely saline soils are limited at the site. The higher readings of conductivity may be more indicative of a high proportion of fine clay particles than a high level of salinity. The high proportion of fine clay particles contributes to a high risk of surface water ponding when heavy cloud bursts occur from thunderstorm activity.

The red box in Figure 1 shows the location of the site sown to cover green feed crops. The significant learning from completing this GPS assisted survey at the site is that salinity and sodicity play a relatively minor role in the cropping difficulties experienced at the site. Most of the difficulties stem from the extremely high proportion of clay in the soil texture. The soil absorbs water relatively slowly because of the high fine clay content.

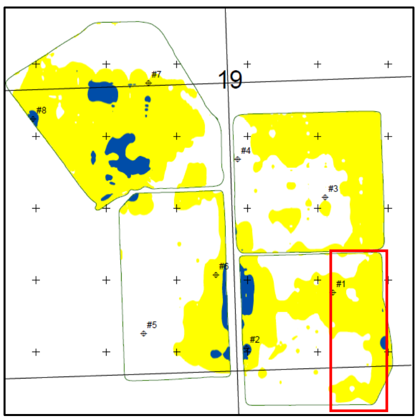



Figure 1: EM 38 Readings for 0-75 cm depth

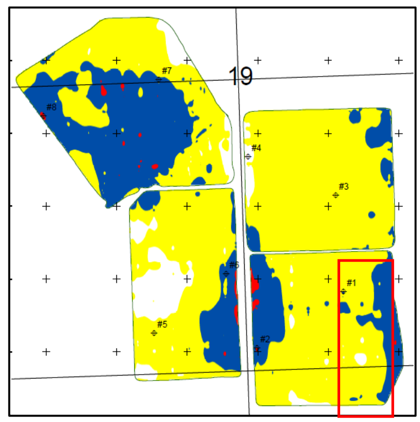
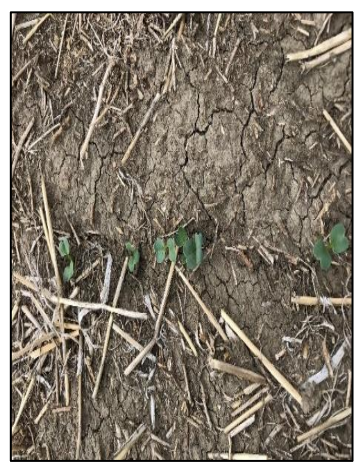



Figure 2: EM 38 Readings for 0-150 cm depth

White area – Nonsaline
Blue area – Moderately saline
Yellow area – Slightly saline
Red area - Severely saline



These photographs show the excellent establishment achieved on the area which suffers from poor water infiltration. The results show how dry weather conditions in spring allow for excellent forage establishment on heavy clay soils when wheel line irrigation is available to support establishment under dry conditions. These photographs (left to right) show yellow clover, tillage radish and seedling emergence of the intercrop.

Table 1 shows the excellent growth attained with the residual moisture in the soil as well as the applied irrigation water. The grower hopes that the organic matter provided by the clover green manure will assist in improving the soil conditions at the site.

Table 1: Evaluation of cover crops seeded at Miry Creek on heavy clay soils in 2018.

| Measurement | Barley | Tillage Radish | Yellow Clover | Clover/Radish Mixture |
|---|---|---|---|---|
| Seedlings/$ft^2$ | 47 | 21 | 63 | 47/17 |
| Dry Matter (square meter sample)<br>July 14, 2018 | 2.02 t/ac | 0.76 t/ac | 0.82 t/ac | 0.77 t/ac |
| Dry Matter (bale scale)<br>August 24, 2018 | 2.99 t/ac | Not possible | 2.29 t/ac | 0.93 t/ac |
| Green feed production in 2019 | 3.35 t/ac | 3.55 t/ac | Not determined | Not determined |

## Final Discussion

The cover crops and green feed forages responded very well to the irrigation regimen followed by the Miry Creek Water Users Association. The usual irrigation regimen at Miry Creek is as follows: 3 inches in late June, 3 inches in late July, 3 inches in late August, and 3 inches in mid September. The final irrigation also acts as moisture recharge for early spring growth as the water inlet in Lake Diefenbaker is often not available to pump water until the spring meltwaters replenish the water level in the lake and raise it above the water inlet. Monitoring of the site will continue in the coming years. Frost killed the tillage radish in winter 2018-19 and hopefully, the biennial yellow clover in winter 2019-20.

## Acknowledgements

Greg Oldhaver for timely field operations which allowed the phenomenal crop establishment achieved.
Reference: Kelley, WP. 1937. The reclamation of alkali soils. Bulletin #617. University of California.

# Action 5% As a Treatment to Minimize Impact of Salinity

## Project Funding

Funded by the Irrigation Crop Diversification Corporation

## Project Leads


- Gary Kruger, PAg, Irrigation Agrologist, Saskatchewan Ministry of Agriculture
- Garry Hnatowich, Research Director, Irrigation Crop Diversification Corporation
- Joel Peru, PAg, Irrigation Agrologist, Saskatchewan Ministry of Agriculture


## Co-operator

- Travis Peardon, Irrigator, SSRID
- Kent Clark, Agronomist, The Rack, Broderick
- Scott Anderson, Agronomist, The Rack, Broderick
- Darrin Johnson, Field Representative, Stoller Canada

## Objectives

The demonstration will evaluate the benefit of Action 5% for aiding crops to minimize the impact of salts on crop growth. The project will measure the potential benefit of the seed treatment Action 5% on the grain yield in wheat.

## Demonstration Plan

This irrigated field grew significant patches of kochia last year where barley was sown. The grower would like to reduce the impact of salinity on his crops and was hoping Action 5% would provide some improvement in crop growth. For 2019, AC Brandon spring wheat was sown on the site using Action 5% as a tool to help the crop deal with the stress of salinity.

Action 5% is a seed treatment that supplies calcium to reduce the impact of sulphate on the germinating seed by attempting to precipitate some of the salinity in an insoluble form in the soil.

## Demonstration Site

The field was seeded May 6, 2019 on SW22-28-7-W3. The field is dissected by the north-south canal linking Gardiner Dam with the Broderick Reservoir. Salinity outcrops of kochia patches are interspersed throughout the site.

## Research Plan

Salinity in Saskatchewan soils is predominantly sulphate based. The wheat field was harvested October 13, 2019. The yield from the control area was 84 bu/ac while the yield from the area receiving the seed treatment was 81 bu/ac.

## Results

As the yield of the control treatment was 3 bu/ac greater than that of the treated area, this demonstration did not show benefit for reducing the impact of salinity with Action 5% in 2019.

## Acknowledgements

Thanks to Kent Clark and Scott Anderson of The Rack in Broderick for their assistance in conducting this demonstration.  The assistance of Travis Peardon and his family in conduct of the demonstration is appreciated.  Darrin Johnson with Stoller Canada provided the product for the demonstration.

# FRUIT AND VEGETABLE CROPS

## Demonstration of Beet Cultivars

### Funding
- Irrigation Crop Diversification Corporation (ICDC)
- Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canadian Agricultural Partnership Program

### Project Lead
- Cara Drury, PAg, Irrigation Agrologist, Saskatchewan Ministry of Agriculture

### Co-operators
- Irrigation Crop Diversification Corporation (ICDC)
- Conservation Learning Centre (CLC)
- Canada-Saskatchewan Irrigation Diversification Centre (CSIDC)
- Saskatchewan Vegetable Growers' Association (SVGA)

### Project Objective
The objective of this project is to ensure that the varieties grown in Saskatchewan produce the highest yields of marketable beet roots for the various markets identified.

### Project Background
Beets grow very well in Saskatchewan, unfortunately the fresh market demand for beets is very limited. Saskatchewan producers are harvesting early and selling baby beets as a premium product and are filling the traditional fresh beet market. Once beets reach 3 inches in diameter, they are no longer marketable to the fresh market. In order to create efficiencies in production it is imperative that producers find new markets for beets. Currently, producers are discussing new processing opportunities that could potentially use the oversized beets for ethanol production. Producers need to find the right cultivars for these different markets and also need to understand their potential yields.

### Project Plan
This project consisted of six beet varieties suitable for the fresh market, replicated three times in a randomized complete block design. For each variety six, six-meter rows were planted. The two outside rows are guards and the four inside rows were harvested at 25 day intervals, once a marketable size was achieved. The harvests in Outlook occurred on July 23, Aug. 14, Sept. 10 and Oct. 8. Harvests in Prince Albert took place on July 18, Aug. 12, Sept. 6 and Oct. 1.
A 0-12" soil sample was taken for the plot area at both sites and found that background nutrient levels were adequate for growing beets in Outlook; therefore, no fertilizer was applied. In Prince Albert fertilizer was broadcasted and incorporated prior to seeding to achieve 65 lb/ac N, 145 lb/ac P, 150 lb/ac K and 25 lb/ac S.

Seeding for all harvest dates took place on May 15$^{th}$, 2019, in Outlook and May 21$^{st}$, 2019, in Prince Albert. Non-pelletized seed was planted with a precision wheel planter at a depth of 1 -2 cm. Row spacing was 40 cm and in-row seed spacing was 1 cm.

Overhead irrigation was utilized at the Outlook site and drip irrigation was used at the Prince Albert site. Soil moisture was monitored with tensiometers at both sites and maintained at 65% field capacity throughout the growing season.

Dual Magnum was applied at the label's recommended rate for pre-emergent control of weeds, Betamix and Centurion were applied at the labels' recommended rate for post emergent weed control at both sites.

## Demonstration Site

This project was located at two sites, the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) near Outlook and at the Conservation Learning Centre (CLC) near Prince Albert. The CSIDC site has a sandy loam soil texture and the CLC has a fine sandy loam to silty loam soil texture. At both sites the plots were cultivated and rototilled prior to seeding.

## Results

Harvested beets were sorted into four size categories, counted and weighed. The size categories are Undersize (< 1" diameter), Baby (> 1" < 1.5" diameter), Regular (>1.5" <3" diameter) and Oversized (> 3" diameter). The total counts and weights for all four harvest dates per variety are reported in Table 1 for the Outlook site and Table 2 for the Prince Albert site.

Table 1. Harvest Totals Per Variety for All Dates, in Outlook.

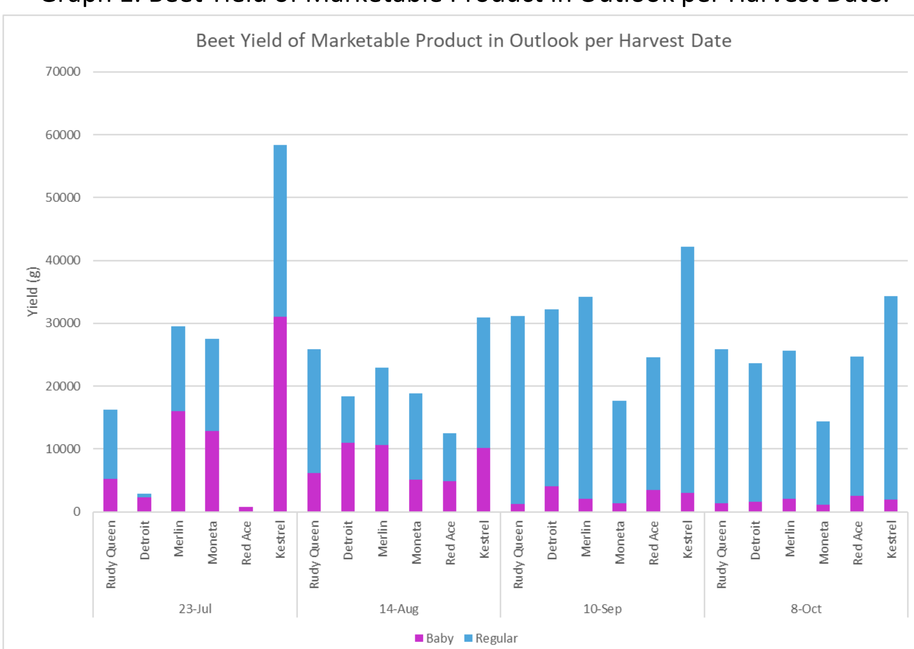
| Date | Variety | Undersized <1" | | Baby 1" - 1.5" | | Regular 1.5" - 3" | | Oversized >3" | |
|---|---|---|---|---|---|---|---|---|---|
| | | Count | Weight (g) | Count | Weight (g) | Count | Weight (g) | Count | Weight (g) |
| 23-Jul | | | | | | | | | |
| | Rudy Queen | 284 | 3280 | 151 | 5275 | 20 | 10970 | 0 | 0 |
| | Detroit | 194 | 2750 | 55 | 2275 | 8 | 605 | 0 | 0 |
| | Merlin | 261 | 1890 | 94 | 16045 | 27 | 13450 | 0 | 0 |
| | Moneta | 206 | 12180 | 79 | 12810 | 22 | 14700 | 0 | 0 |
| | Red Ace | 264 | 12280 | 22 | 715 | 0 | 0 | 0 | 0 |
| | Kestrel | 273 | 25960 | 152 | 31060 | 76 | 27300 | 8 | 700 |
| 14-Aug | | | | | | | | | |
| | Rudy Queen | 114 | 1128 | 181 | 6139 | 240 | 19704 | 6 | 1380 |
| | Detroit | 176 | 744 | 338 | 10965 | 63 | 7380 | 4 | 1406 |
| | Merlin | 168 | 1055 | 306 | 10674 | 96 | 12214 | 9 | 3314 |
| | Moneta | 65 | 429 | 158 | 5096 | 123 | 13709 | 36 | 10312 |
| | Red Ace | 224 | 1350 | 185 | 4826 | 92 | 7704 | 10 | 2554 |
| | Kestrel | 136 | 802 | 259 | 10147 | 226 | 20821 | 13 | 3370 |
| 10-Sep | | | | | | | | | |
| | Rudy Queen | 50 | 200 | 87 | 1200 | 343 | 29980 | 32 | 9990 |
| | Detroit | 106 | 890 | 137 | 4090 | 247 | 28120 | 44 | 17120 |
| | Merlin | 91 | 600 | 105 | 2040 | 318 | 32120 | 33 | 11870 |
| | Moneta | 37 | 260 | 57 | 1340 | 152 | 16330 | 78 | 32590 |
| | Red Ace | 172 | 1200 | 140 | 3500 | 214 | 21050 | 25 | 9930 |
| | Kestrel | 47 | 300 | 119 | 2940 | 382 | 39260 | 44 | 14470 |
| 8-Oct | | | | | | | | | |
| | Rudy Queen | 48 | 290 | 76 | 1340 | 280 | 24560 | 92 | 29120 |
| | Detroit | 54 | 340 | 81 | 1580 | 238 | 22070 | 98 | 33290 |
| | Merlin | 129 | 560 | 119 | 2090 | 297 | 23500 | 95 | 32710 |
| | Moneta | 41 | 220 | 57 | 1090 | 143 | 13230 | 106 | 42630 |
| | Red Ace | 99 | 690 | 112 | 2470 | 246 | 22260 | 79 | 32200 |
| | Kestrel | 92 | 550 | 94 | 1970 | 343 | 32320 | 114 | 35640 |

Table 2. Harvest Totals Per Variety for All Dates, in Prince Albert.

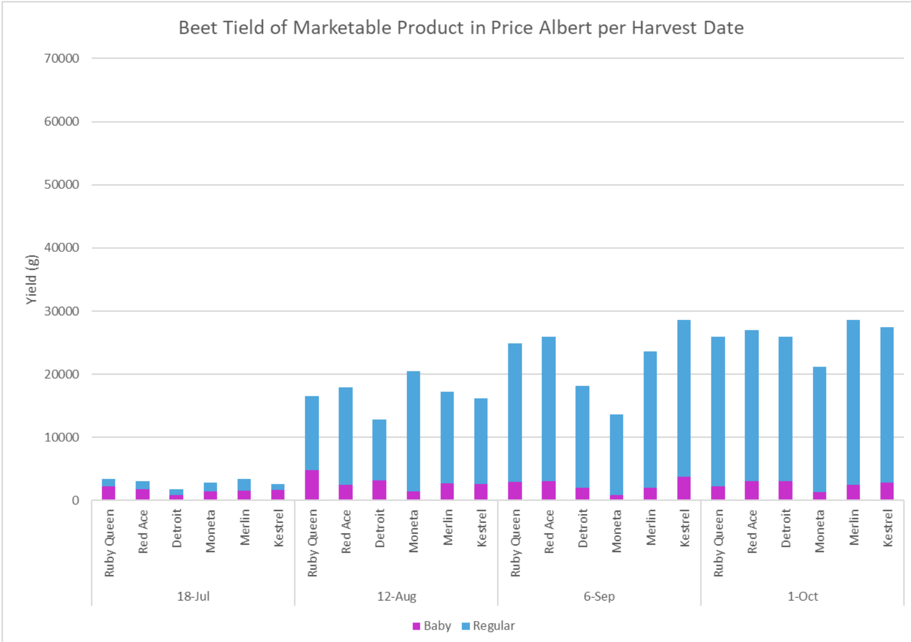
| Date | Variety | Undersized | | Baby | | Regular | | Oversized | |
|---|---|---|---|---|---|---|---|---|---|
| | | <1" | | 1" - 1.5" | | 1.5" - 3" | | >3" | |
| | Variety | Count | Weight (g) | Count | Weight (g) | Count | Weight (g) | Count | Weight (g) |
| 18-Jul | | | | | | | | | |
| | Ruby Queen | 557 | 3121 | 108 | 2253 | 25 | 1155 | 0 | 0 |
| | Red Ace | 344 | 1868 | 85 | 1836 | 26 | 1224 | 0 | 0 |
| | Detroit | 251 | 1114 | 45 | 859 | 16 | 903 | 0 | 0 |
| | Moneta | 195 | 1104 | 65 | 1431 | 29 | 1382 | 0 | 0 |
| | Merlin | 313 | 1400 | 73 | 1562 | 32 | 1813 | 0 | 0 |
| | Kestrel | 420 | 2077 | 89 | 1633 | 23 | 984 | 0 | 0 |
| 12-Aug | | | | | | | | | |
| | Ruby Queen | 283 | 1029 | 289 | 4748 | 211 | 11801 | 12 | 2675 |
| | Red Ace | 220 | 712 | 166 | 2540 | 223 | 15425 | 7 | 1888 |
| | Detroit | 267 | 892 | 199 | 3136 | 158 | 9718 | 6 | 1893 |
| | Moneta | 109 | 368 | 86 | 1408 | 252 | 19098 | 16 | 4046 |
| | Merlin | 292 | 793 | 180 | 2659 | 210 | 14529 | 15 | 4662 |
| | Kestrel | 271 | 1051 | 166 | 2546 | 223 | 13635 | 12 | 2902 |
| 6-Sep | | | | | | | | | |
| | Ruby Queen | 233 | 1157 | 165 | 2966 | 325 | 21865 | 21 | 6904 |
| | Red Ace | 213 | 691 | 196 | 3115 | 309 | 22793 | 23 | 7343 |
| | Detroit | 195 | 664 | 112 | 2005 | 201 | 16107 | 13 | 3819 |
| | Moneta | 137 | 570 | 60 | 911 | 156 | 12748 | 34 | 11584 |
| | Merlin | 362 | 1524 | 117 | 2060 | 287 | 21568 | 25 | 8759 |
| | Kestrel | 410 | 1405 | 232 | 3796 | 363 | 24758 | 27 | 9284 |
| 1-Oct | | | | | | | | | |
| | Ruby Queen | 172 | 823 | 137 | 2305 | 328 | 23630 | 13 | 4402 |
| | Red Ace | 236 | 1034 | 175 | 3064 | 300 | 23956 | 16 | 5863 |
| | Detroit | 319 | 1446 | 184 | 3084 | 323 | 22827 | 13 | 3162 |
| | Moneta | 167 | 626 | 82 | 1327 | 230 | 19822 | 40 | 13296 |
| | Merlin | 257 | 1029 | 138 | 2461 | 339 | 26129 | 35 | 11020 |
| | Kestrel | 350 | 1437 | 169 | 2868 | 368 | 24617 | 23 | 7742 |

The largest differences between sites occurred at the first harvest date, as can be seen by comparing Graph 1 and 2, Beet Yield of Marketable Product in Outlook and Prince Albert per Harvest Date. The yields at Outlook are markedly better than the Prince Albert yields for the first harvest date and then become more comparable as the season continues.

Graph 1. Beet Yield of Marketable Product in Outlook per Harvest Date.

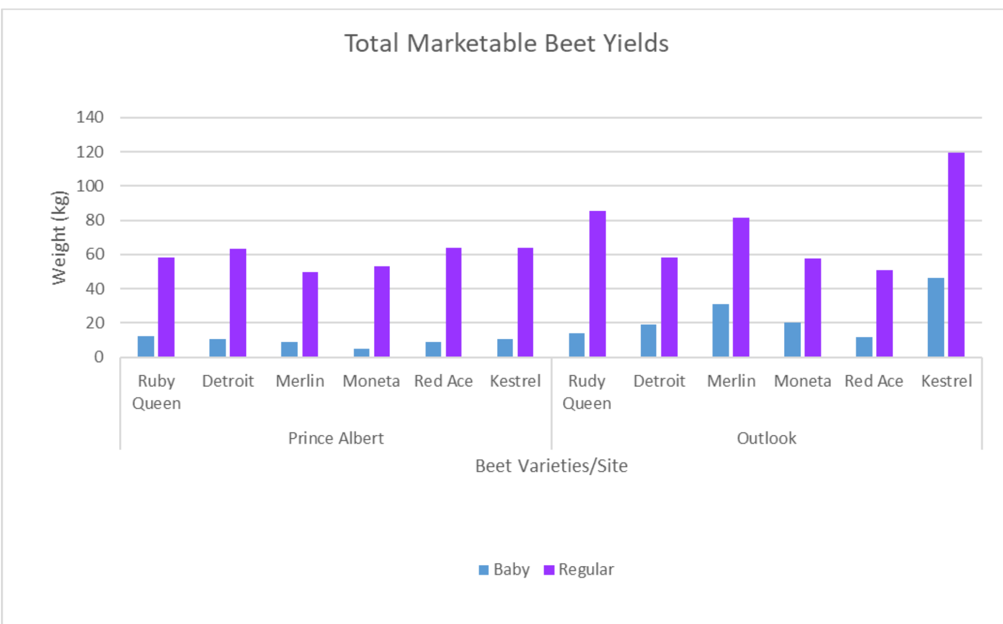


Graph 2. Beet Yield of Marketable Product in Prince Albert per Harvest Date.




The top three producers for marketable weight are Kestrel, Merlin and Ruby Queen at Outlook. In Prince Albert, the top three producers for marketable weight are Kestrel, Detroit and Red Ace. Differences in marketable weights were more pronounced at the Outlook site than Prince Albert. As well, the Outlook site out produced the Prince Albert site on total marketable yields for every variety except Red Ace, see Graph 3, Total Marketable Beet Yields. Graph 3 combines the marketable yields for each harvest date to look at the total yields per variety per site.

Graph 3. Total Marketable Beet Yields per Variety for the Outlook and Prince Albert Sites.



## Final Discussion

The objective of this project was to compare beet variety yields for the identified fresh market standards, baby and regular. The current producer favorite is Detroit. We have found that at both of our sites the variety Kestrel, out yielded Detroit in count and weight for both standards, baby and regular. As expected, the earliest harvest date in Outlook produced the largest amount of baby beets. It is worth noting that Kestrel far out produced the other varieties at this stage for both baby and regular standards. These findings were not replicated at the Prince Albert site, the first harvest recorded the lowest yields of both baby and regular standards.

The differences in yields per variety were much more noticeable at the Outlook site compared to Prince Albert. It was also noted that the earliest harvest in Outlook greatly out produced the earliest harvest in Prince Albert. It is speculated that the difference in the sites' overall yields may have been caused by the differing irrigation systems and water supply. Outlook's irrigation system was a well-established overhead linear with pressurized pipeline for a water source. In Prince Albert, this was the first year of a trickle irrigation system that used a domestic line as a water source. Therefore, water volumes may have not been adequate to reach the full potential for growth that was seen in Outlook.

The economic analysis of this crop is based on a 12-inch row spacing and the farm gate price of the crop as reported by a 2018 farmer's market survey ($2.00/lbs or $4.40/kg). The $/ac yield is gross and does not take into account the cost of any field operations, labour, trucking, storage or spoilage. The average yield is a combination of the average baby and regular standard, no price premiums were accounted for in the baby standard, and undersized and oversized beets were considered culls. The numbers in Table 3 and 4 report only on the average marketable yield per variety and use the assumption that all of the crop was sold.

Table 3. Economic analysis of the average total marketable yield (baby and regular standard) per variety of beet in Outlook.

| Variety | Average Yield (kg/ac) | Price ($/kg) | Average Yield ($/ac) |
|---|---|---|---|
| **Rudy Queen** | 74317.84 | 4.40 | 326998.51 |
| **Detroit** | 57768.24 | 4.40 | 254180.23 |
| **Merlin** | 84034.56 | 4.40 | 369752.08 |
| **Moneta** | 58682.82 | 4.40 | 258204.43 |
| **Red Ace** | 46857.77 | 4.40 | 206174.18 |
| **Kestrel** | 124267.11 | 4.40 | 546775.27 |

**Table 4.** Economic analysis of the average total marketable yield (baby and regular standard) per variety of beet in Prince Albert.

| Variety | Average Yield (kg/ac) | Price ($/kg) | Average Yield ($/ac) |
|---|---|---|---|
| **Ruby Queen** | 53001 | 4.40 | 233203.26 |
| **Detroit** | 55422 | 4.40 | 243856.62 |
| **Merlin** | 43944 | 4.40 | 193353.75 |
| **Moneta** | 43561 | 4.40 | 191669.42 |
| **Red Ace** | 54543 | 4.40 | 239988.73 |
| **Kestrel** | 56083 | 4.40 | 246766.94 |

Areas of further study for this project include exploring new value-added markets for beets such as, ethanol production and or processed foods.

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- CLC staff for assisting in setup and field work
- CSIDC staff for allowing facilitation of the project and assisting with project work

# Demonstration of Crops with Opportunities

## Funding

- Irrigation Crop Diversification Corporation (ICDC)
- Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canadian Agricultural Partnership Program

## Project Lead

- Cara Drury, PAg, Irrigation Agrologist, Saskatchewan Ministry of Agriculture

## Co-operators

- Irrigation Crop Diversification Corporation (ICDC)
- Canada-Saskatchewan Irrigation Diversification Centre (CSIDC)
- Saskatchewan Vegetable Growers' Association (SVGA)

## Project Objective

As the horticulture industry in Saskatchewan grows, opportunities for crops that are not grown traditionally in the province are brought forward. Industry does not have enough information on these crops to evaluate these opportunities. This project will demonstrate the potential to produce pepita pumpkin, chicory, soft neck garlic, sugar beet, Jerusalem artichoke, mung bean, sweet potato and karela in Saskatchewan.

## Project Background

In the last five years, the produce industry in Saskatchewan has steadily grown to the point where they have exceeded demand for some of the products they are growing. They are now trying to create new fresh markets opportunities. They are also investigating processing opportunities including nutraceuticals, ethanol and the more traditional canned and frozen goods. As they investigate these opportunities, questions often arise regarding potential markets. The producers do not have enough information on these crops to make informed decisions. Often times, they do not have the equipment and land available. Many of these opportunities are high value and deserve further investigation. This project will provide producers with examples of the crops, allowing them to assess growth habit, hardiness in Saskatchewan and some basic idea on potential yields in Saskatchewan.

## Project Plan

This project took place at CSIDC in Outlook, and consisted of eight crops: chicory, sugar beet, Jerusalem artichoke, mung bean, sweet potato, pepita pumpkin, karela and soft necked garlic. Two crops were grown in a high tunnel, sweet potato and karela, the remaining crops were grown in the orchard area. All of the crops were irrigated with trickle irrigation and soil moisture was monitored to maintain a 65% field capacity throughout the growing season. A 0-12" soil sample was taken for the high tunnel and plot area. It was found that background nutrient levels were adequate for growing vegetables; therefore, no fertilizer was applied.

Chicory had two varieties demonstrated, Madgeburgh and a wild type. They were planted on May 28th by hand, in one eight-foot row each. Seeding chicory is similar to carrots and the rows required thinning twice throughout the growing season. Harvesting took place on September 18th, the roots were counted and weighed.

The three varieties grown to demonstrate sugar beets were provided by Lantic. Two varieties, BTS 4512 and BTS 4515 were pre-treated with Cruiser, the third variety BTS 4516 was bare seed. They were planted on May 28th by hand, in one eight-foot row each and thinned twice throughout the growing season. Harvesting took place on October 8th, the roots were counted and weighed.

Four varieties of Jerusalem artichokes were planted on May 28th, Passamaquoddy, Stampede, Clearwater and Skorospelka. Eight tubers of each variety were hand planted. Harvest took place on October 24th, once the tops were killed back by frost. The tubers were counted and weighed.

Mung Beans were soaked for 24 hours, then planted on May 28th in one eight-foot row each. The varieties demonstrated were AC Harosprout and a generic sprouting variety. Harvesting took place on September 25th, a count of total stems, and pods were collected as well as bean weight.

Eight plants per variety of pepita pumpkin were started in seed trays on May 3rd and transplanted into a black plastic mulch on May 29th. The varieties grown were Kakai, Naked Bear and Lady Godiva. Harvest took place on September 24th. All pumpkins were counted and weighed, then five from each variety were randomly selected and had the seeds counted and weighed.

Three varieties of karela were started in seed trays on May 1st, then eight plants per variety were planted into black plastic mulch, inside a high tunnel on May 29th. The varieties were Long thick, Long green and Jade Dragon. Harvesting of the karela started on July 29th and continued two to three times a week. The final harvest date was September 23rd. At each harvest the karela were counted and weighed.

Sweet potatoes were planted quite late, June 19th due to a difficult spring in Ontario where the planting material was sourced from. Eleven slips of three varieties (Radiance, L105 and B456) each were planted in black plastic mulch, inside a high tunnel. Harvest of the sweet potatoes took place on September 25th, a total count and weight of each variety per marketable size standard was recorded.

Eight cloves of Western Rose, a soft necked garlic variety, were hand planted on May 28th. Harvesting did not take place due to crop failure.

## Demonstration Site

This project was located in the orchard area of the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC). The site has a sandy loam soil texture and the plot was cultivated and rototilled prior to seeding.

## Results

In general, the crops with opportunities grew well and all demonstrated potential for growers with the exception of soft necked garlic and mung beans. Soft necked garlic did not respond well to a spring planting and mung beans did not thrive in Saskatchewan's growing conditions.

Chicory is cultivated for its root, which is roasted and ground, producing a coffee substitute (Figure 1). The roots produce a high quality inulin, used as a food ingredient in low-fat, calorie reduced products and can act as a natural sugar replacement for diabetics. The two varieties that we demonstrated were Madgeburgh and a wild type. Madgeburgh has been bred for its increased root size, which was quite evident in this demonstration. Table 1, shows how the variety Madgeburgh produced over two and a half times the root yield as the wild type.

Table 1. Chicory yields per variety.

| Variety | Count | Yield (kg) |
|---|---|---|
| Madgeburgh | 102 | 5.1636 |
| Wild Chicory | 81 | 1.7905 |

Table 2. Sugar beet yields per variety.

| Variety | Count | Yield (kg) |
|---|---|---|
| BTS 4512 | 51 | 10.27 |
| BTS 4515 | 57 | 7.14 |
| BTS 4516 | 63 | 9.68 |

Saskatchewan beet growers are currently discussing an opportunity for ethanol production using red beets. This potential opportunity could also exist for sugar beets (Figure 2), which may have higher ethanol yields due to their higher sugar content. Of the three varieties provided by Lantic, BTS 4512 produced the highest yields as seen in Table 2.

Table 3. Jerusalem artichoke yields per variety.

| Variety | Count | Yield (kg) |
|---|---|---|
| Stampede | 222 | 4.76 |
| Skorospelka | 162 | 1.19 |
| Passamaquaddy | 149 | 2.74 |
| Clearwater | 260 | 4.88 |

In Canada, Jerusalem artichoke (sunchoke) is mainly grown in Ontario, but has successfully been grown on the prairies. It has culinary uses, as well as uses as a forage crop. It is from the sunflower family. The tubers produced contain no starch and are a good source of inulin. In recent years, the Jerusalem artichoke has also attracted interest as a source of fuel-grade ethanol.

Figure 1: Chicory varieties, Madgeburgh (left) wild type (right)

Figure 2: Sugar beets

Figure 3: Jerusalem Artichokes

The Jerusalem artichokes grew very well here, with the above ground material reaching a height above six feet (Figure 3). Harvesting was done by hand and found to be quite difficult due to tubers being up to 60 cm away from the main stalk in all directions. The yields per variety can be seen in Table 3.

Mung Bean is traditionally a warm season crop. Since 2010, AAFC has been doing research to find varieties suitable to Manitoba and Alberta. These varieties mature in 100 days while producing good yields. Alberta and Manitoba have had a head start at developing markets for this crop, but a number of inquiries have been made in Saskatchewan. The variety AC Harosprout was sourced from AAFC and demonstrated with a sprouting variety sourced from a local store (Figure 4). Neither variety did well on a visual basis and both did not yield well, as can be seen in Table 4.

Table 4. Mung bean yields per variety.

| Variety | Stem Count | Total Pods | | Marketable | |
|---|---|---|---|---|---|
| | | Count | Weight (g) | Pod Count | Seed Weight (g) |
| **AC Harosprout** | 61 | 131 | 4.18 | 53 | 2.31 |
| **Store Variety** | 57 | 24 | 3.91 | 4 | 0.41 |

Figure 4. Mung beans

Figure 5. Pepita pumpkins

Pepita Pumpkins (Figure 5 and 6) are successfully grown in home gardens in Saskatchewan. While slightly less hardy than traditional pumpkins, they mature in 90 days and when transplanted should produce good yields of hulless pumpkin seeds. The seeds can be eaten as pepitas or pressed to extract oils. Pepitas are high in omega 6 and omega 9 fatty acids, zinc and vitamin E. The pumpkins are also large enough to be used as Halloween pumpkins as well.

There was a noticeable size difference between the varieties that were demonstrated. The variety Naked Bear were consistently small sized, but did produce the largest count of pumpkins. Lady Godiva were the largest sized pumpkins and produced the smallest count of pumpkins, see Table 5.

Figure 6. Pepita pumpkins, Naked Bear (left), Lady Godiva (middle) and Kakai (right)

Table 5. Pepita pumpkin yields and seed yields per variety.

| Variety | Naked Bear | | | Kakai | | | Lady G | | |
|---|---|---|---|---|---|---|---|---|---|
| Pumpkin Count | Pumpkin Weight (g) | Seed Count | Seed Weight (g) | Pumpkin Weight (g) | Seed Count | Seed Weight (g) | Pumpkin Weight (g) | Seed Count | Seed Weight (g) |
| 1 | 961.6 | 199 | 52.5 | 2809.4 | 384 | 101.9 | 4800.8 | 320 | 85.8 |
| 2 | 709.4 | 72 | 20.4 | 2380.8 | 339 | 77.6 | 4963.3 | 256 | 73.7 |
| 3 | 1122.5 | 377 | 84.9 | 5040.1 | 412 | 131 | 3863.7 | 464 | 110.5 |
| 4 | 957.1 | 267 | 64.6 | 2413.2 | 342 | 54.5 | 7075 | 472 | 146.7 |
| 5 | 1559.8 | 392 | 98.4 | 1145.4 | 225 | 45.5 | 4374.1 | 364 | 91.2 |
| 6 | 1036.1 | | | 2030 | | | 6907.1 | | |
| 7 | 1122.6 | | | 1449.5 | | | 3905.3 | | |
| 8 | 805.5 | | | 3569.6 | | | 3319 | | |
| 9 | 795.2 | | | 2782.4 | | | 4068.9 | | |
| 10 | 718.6 | | | 8094.1 | | | 8561.4 | | |
| 11 | 1028.3 | | | 7409.6 | | | 8087.3 | | |
| 12 | 1303.2 | | | 2704.4 | | | 8388.8 | | |
| 13 | 1146.5 | | | 2555.2 | | | 11614.5 | | |
| 14 | 1285.2 | | | 2803.5 | | | 1631.6 | | |
| 15 | 1029.9 | | | 940.1 | | | 3518.3 | | |
| 16 | 1030.5 | | | 4954.8 | | | 6881.5 | | |
| 17 | 1192.8 | | | 3134.8 | | | 9586 | | |
| 18 | 950.9 | | | 941.1 | | | 5847.4 | | |
| 19 | 795.6 | | | 2094.9 | | | | | |
| 20 | 530.6 | | | 2778.1 | | | | | |
| 21 | 908.3 | | | 3961.8 | | | | | |
| 22 | 305.1 | | | 11070.8 | | | | | |
| 23 | 1341.6 | | | | | | | | |
| 24 | 1199.1 | | | | | | | | |
| 25 | 408.3 | | | | | | | | |
| 26 | 1550.5 | | | | | | | | |
| 27 | 589.4 | | | | | | | | |
| 28 | 1032.9 | | | | | | | | |
| 29 | 1009.7 | | | | | | | | |
| 30 | 732.7 | | | | | | | | |
| Variety | Naked Bear | | | Kakai | | | Lady G | | |
| | Pumpkin Weight (g) | Seed Count | Seed Weight (g) | Pumpkin Weight (g) | Seed Count | Seed Weight (g) | Pumpkin Weight (g) | Seed Count | Seed Weight (g) |
| Average | 971.98 | 261.40 | 64.16 | 3502.89 | 340.40 | 82.10 | 5966.33 | 375.20 | 101.58 |

Karela, is popular in Asian cuisine and also as a medicinal (Figure 7). Retailers in Saskatchewan and from National chains have requested karela as it is not readily available. Research done in high tunnels at the University of Guelph shows that karela production should be possible in high tunnels in Saskatchewan. All three varieties of karela grew well in high tunnels based on a visual basis, but the variety Jade far out yielded the other varieties. Karela fruit count and yields can be seen in Table 6.

Table 6. Karela yields per variety.

| **Variety** | **Count** | **Yield (kg)** |
|---|---|---|
| **Long Thick** | 62 | 8.14 |
| **Jade** | 307 | 38.56 |
| **Long Green** | 61 | 9.33 |

Figure 7. Karela vines (left) and fruits (right)

Sweet potatoes were the subject of ADOPT 20150496 where they were determined to not be a viable crop option in Saskatchewan. However, Vineland Research and Innovation Centre in Ontario has released a new short season variety, Radiance, with a shorter growing season. Local retailers are very interested in this variety.

Unfortunately, Vineland had a very difficult spring and the planting material required for this demonstration was delayed. Despite the shortened growing season, marketable tubers were still produced for each variety as can be seen in Table 7 and Figure 8.

Table 7. Sweet potato yields per market standard per variety.

| Variety | Undersized | | Petite | | No. 1 | | Oversized | |
|---|---|---|---|---|---|---|---|---|
| | Count | Weight (g) | Count | Weight (g) | Count | Weight (g) | Count | Weight (g) |
| **Radiance** | 38 | 1534.3 | 20 | 2542.76 | 4 | 1077.68 | 2 | 333.4 |
| **L105** | 24 | 586.71 | 12 | 1155.86 | 0 | 0 | 0 | 0 |
| **B456** | 70 | 2138.73 | 21 | 2750.27 | 4 | 664.56 | 0 | 0 |

Softnecked garlic produces many, smaller cloves when compared to the hardnecked varieties. Typically, hardnecked varieties are grown on the prairies due to its hardiness and strong flavors. This has left a gap in the market for smaller cloves that is not being filled locally.

Figure 8. Sweet potato

Spring planting is not the recommended practice for garlic, but because softnecked varieties are less hardy spring planting was demonstrated. This resulted in a total crop failure. There will be no discussion of economic analysis of this crop in the conclusion.

## Final Discussion

The objective of this project was to demonstrate the potential to produce pepita pumpkin, chicory, soft neck garlic, sugar beet, Jerusalem artichoke, mung bean, sweet potato and karela in Saskatchewan. An economic analysis was completed for each crop. This is not to indicate the expected profit to be made by growing these crops, such small sample sizes are not able to adequately represent field scale production. The analysis is meant to be an indicator for what warrants further investigation. If a crop does not look profitable at this small scale it will not be profitable at a larger scale with increased labor costs and logistical issues.

Chicory is typically sold as a dried and chipped or ground product. Due to the yields being recorded as fresh weights, no direct estimates can be determined on this crop's economic analysis. Estimated yields on a per acre basis can be calculated and with that it becomes obvious that the variety Madgeburgh produced over two and a half times the marketable product as the wild type, see table 8.

Table 8. Estimated yield of chicory per acre.

| Variety | Yield (kg/ac) |
|---|---|
| **Madgeburgh** | 28116 |
| **Wild Chicory** | 9749 |

Sugar beets in Alberta are projected to range between $50-$52 per tonne this year for an average quality. Based on that estimate the highest yielding variety BTS 4512 would bring in roughly $2,800/ac gross. The lowest yielding variety BTS 4515 would gross roughly $1,950/ac, as seen in Table 9. These prices are based on processing for refined sugar and do not take into account the possible prices for ethanol production. It is also worth noting that the Alberta Sugar Beet Grower Association reports an average yield of 26 tonnes/ac. Based on these analysis sugar beets do grow well in Saskatchewan and warrant further research into possible production and market development.

Table 9. Economic analysis of sugar beets.

| Variety | Yield (kg) | Yeild (kg/ft$^2$) | Yield Conversion (tonnes/ac) | Price ($/tonne) | Yield ($/ac) |
|---|---|---|---|---|---|
| **BTS 4512** | 10.27 | 1.28 | 55.89 | 50 | 2794.62 |
| **BTS 4515** | 7.14 | 0.89 | 38.90 | 50 | 1944.82 |
| **BTS 4516** | 9.68 | 1.21 | 52.70 | 50 | 2634.85 |

The estimated price on Jerusalem artichokes vary considerably. Often sold at farm gate or farmers markets, they can be priced from $10/lb, $5/lb to $1/tuber. This makes an economic analysis difficult. Using $7.50/lb as a price the economic analysis is somewhat deceiving and looks very promising, see Table 10. This does not take into account the difficulty of harvest, poor storage or the current lack of market. Jerusalem artichoke do grow well in Saskatchewan and should be further evaluated if marketing opportunities are identified.

Table 10. Economic analysis of Jerusalem artichokes.

| Variety | Count | Yield (kg) | Yield (kg/ft$^2$) | Yield Conversion (lb/ac) | Price ($/lb) | Yield ($/ac) |
|---|---|---|---|---|---|---|
| **Stampede** | 222 | 4.76 | 0.20 | 19056.64 | 7.50 | 142924.81 |
| **Skorospelka** | 162 | 1.19 | 0.05 | 4758.16 | 7.50 | 35686.18 |
| **Passamaquaddy** | 149 | 2.74 | 0.11 | 10952.97 | 7.50 | 82147.25 |
| **Clearwater** | 260 | 4.88 | 0.20 | 19520.85 | 7.50 | 146406.39 |

Mung beans did not fare well in this trial and economic analysis was not warranted. Further research is not needed until new varieties suited to Saskatchewan's growing conditions are released.

Pepita pumpkins do work out economically when they are considered solely for pepita production, see Table 11. Pepita pumpkins potentially work even more profitably when they are considered as part of a marketing stream. Growing the pumpkins as a jack-o-lantern crop and processing the remainder of the crop that has had frost damage to the fruit, or fruit that has not fully ripened by October 31st is a possibility. Further investigation into processing options and alternative market streams is needed.

Table 11. Economic analysis of pepita pumpkins.

| Variety | Plot Size $ft^2$ | Plot Size ac | Pumpkins /Plot | Average Seeds kg/ Pumpkin | Average Seeds kg/Plot | Average Seeds kg/ac | Price Seeds $/kg | Yield $/ac |
|---|---|---|---|---|---|---|---|---|
| **Naked Bear** | 72 | 0.0016529 | 30 | 0.06 | 1.92 | 1164.51 | 16.60 | $19,330.84 |
| **Kakai** | 72 | 0.0016529 | 22 | 0.08 | 1.81 | 1092.76 | 16.60 | $18,139.74 |
| **Lady Godiva** | 72 | 0.0016529 | 18 | 0.10 | 1.83 | 1106.21 | 16.60 | $18,363.10 |

The economic analysis of karela as a high tunnel crop in Saskatchewan looks very promising, see table 12. Given the relative ease of production for the variety Jade, and the anecdotal local preference for the variety, more research into the agronomics and marketing of this crop is warranted.

Table 12. Economic analysis of karela.

| Variety | Yield (kg) | Yield ($kg/ft^2$) | Yield (kg/ac) | Price $/kg | Yield $/ac |
|---|---|---|---|---|---|
| **Long Thick** | 8.14 | 0.37 | 16116.57 | 5.47 | 88157.62 |
| **Jade** | 38.56 | 1.75 | 76340.87 | 4.37 | 333609.60 |
| **Long Green** | 9.33 | 0.42 | 18461.75 | 5.47 | 100985.78 |

Despite the late start for the sweet potatoes, the economic analysis for these varieties do look positive, see Table 13. The economic analysis looked at the marketable product produced. It is noted that there was a substantial amount of undersized tubers that may have become marketable if an earlier planting date was utilized. Vineland Research and Innovation Centre in Ontario is also interested in having further research into these shorter season sweet potatoes ability to grow in Saskatchewan's growing conditions.

Table 13. Economic analysis of sweet potatoes.

| Variety | Yield (kg) | Yield ($kg/ft^2$) | Yield (kg/ac) | Price $/kg | Yield $/ac |
|---|---|---|---|---|---|
| **Radiance** | 3.62 | 0.16 | 7167.48 | 4.40 | 31536.93 |
| **L105** | 1.16 | 0.05 | 2288.29 | 4.40 | 10068.47 |
| **B456** | 3.41 | 0.16 | 6760.43 | 4.40 | 29745.91 |

Areas of further study for this project include exploring further development of markets for the crops presented with promising economic analysis. As well as, improved agronomics and value added products such as, ethanol production and or processed foods.

## Acknowledgements

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- Angela Stoppler, ICDC Acting Horticultural Research Technician, for project implementation and plot maintenance
- Connie Achtymichuk, Ministry of Agriculture, Provincial Vegetable Specialist, for project setup and agronomic guidance
- ICDC staff for assisting in setup and field work
- CSIDC staff for allowing facilitation of the project and assisting with project work

# Apogee (Prohexadione calcium) Application to Strawberry and Sour Cherry

## Funding

Saskatchewan Fruit Growers Association (SFGA)

Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canadian Agricultural Partnership Program

## Project Lead

Forrest Scharf, PAg, Provincial Fruit Specialist, Saskatchewan Ministry of Agriculture

## Co-operators

- Irrigation Crop Diversification Corporation (ICDC)
- Canada-Saskatchewan Irrigation Diversification Centre (CSIDC)
- Saskatchewan Fruit Growers Association (SFGA)

## Project Objective

The objective of this project is to demonstrate the positive effects application of Apogee (prohexadione calcium) can have on strawberry and sour cherry production in Saskatchewan**.**

## Project Background

Apogee is a gibberellin inhibitor that can have a number of beneficial physiological effects on fruit species. It inhibits spread of diseases and reduces the need to prune in apples. It reduces "runnering" in strawberry; and improves fruit quality in apples, strawberry, and cherry. The product is widely used outside Saskatchewan, but has not been adopted by Saskatchewan producers. Improved consistency of fruit production would improve grower profitability, allow retailers and processors to have a higher level of confidence that local producers can consistently supply high quality fruit, and potentially lead to increased value-added processing in the province.

## Project Plan

The project consisted of three sour cherry cultivars (Cupid, Valentine, and Romeo) and six strawberry varieties (day-neutral cultivars Cabrillo, and Mara de Bois; and June-bearing cultivars Serenade, Serenity, Kent, and AC Wendy).

Apogee (prohexadione calcium) was mixed into 100 L of water held within a tow-behind boom sprayer that also includes a hand wand applicator. Plants were sprayed using the hand sprayer held at sufficient distance to ensure even application coverage, and the applicator moved at a consistent speed while moving over the plots to ensure even application rates to the plots.

All plants were assessed for growth, fruit production, and disease resistance. Fruit quality was assessed (via brix readings) as well average fruit size (in grams).

A major fertilizer application was initially applied according to soil sample (N-P-K-S at 100-60-40-5 lbs./acre), and applications were made at rates based upon fertilizer product nutrient percentages to ensure 110-60-40-5 lbs was available. The initial fertilizer application occurred on May 16th to sour cherry. Subsequent fertilizer applications were made according to plant need using a water soluble Plant Prod 20-20-20 mix and a Dosatron injector (starting June 7th in Strawberry). All strawberries were planted into 1m wide black plastic mulch with ½ inch drip line running in the middle of the mulch width spaced 12 inches apart.

The strawberry varieties were randomized according to the “2019 Strawberry plot arrangement”. Treatments included: Row 1 plots treated with Apogee at a rate of 27 grams/100 litres; row 2 plots treated with Apogee at 45 grams/100 litres; Row 3 plots were Control (No Spray); Row 5 received 45 g/100 L; and Row 4 plots were treated with 27 grams/100 L. Spray application occurred when new plant growth had been well initiated (May 25th, 2018).

Plant growth was monitored over the summer and final measurements were taken September 4th, 2019. Strawberries were harvested throughout the summer, and cherries were harvested in late August.

## Demonstration Site

This project was located within the fruit orchard at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) near Outlook. The CSIDC orchard has a Bradwell Orthic Dark Brown sandy loam soil, pH 8.4.

## Results

Spring conditions in 2019 were exceptionally dry, and the winter was exceptionally cold. February averaged the coldest period for that month in over 100 years. The cold temperatures and dryness caused extensive damage to strawberries, and was likely a significant factor in development of “blindwood” in sour cherry resulting in poor yield and less than average fruit quality.

Blindwood is a physiological condition in which leaf buds only form at the distal ends of branches or very sporadically along the branch length (Figure 1). The lack of leaf development reduces the capacity for photosynthesis to occur, and essentially weakens the plant. The low energy status causes plants to abort more fruit than would normally occur, and it reduces the capacity to develop high sugar content in the remaining fruit.

Figure 3: Blindwood in sour cherry June 7, 2019

Although some winter-kill occurred in some of the June bearing strawberries, the majority of plant death was experienced by the day-neutral varieties Seascape, and Albion (Figure 2). The day-neutrals were less tolerant of high pH soil, so they were predisposed to be weaker going into winter. In any event, they had survived less severe winters and therefore the sustained cold may have pushed them beyond their absolute tolerance threshold. Since those varieties did not survive, the decision was made to replace them with varieties that might be more high pH tolerant and perhaps more winter-hardy. Mara des Bois and Cabrillo were selected as their replacements based on the success Quebec growers have had with those varieties.

Figure 2: Strawberry winter-kill March 22, 2019

In the 2019 season, there appears to have been a significant increase in average yield as the rate of Apogee increased. Unfortunately, these averages are all quite low and there is a considerable amount of variation (Table 1). Winter-kill affected the averages with no production in plots 6 (Kent at 45 g/100L) and 16 (Serenity at 27 g/100L), but other plots were also affected and their production was less than it should have been. Kent and Serenity were strong producers and the 0 yield plots were in Apogee treated plots, so the yield trends may be indicative of an actual treatment effect.

Table 1. Apogee strawberry yield 2019

| Apogee Strawberry Yield 2019 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date picked | | 2-Jul | 5-Jul | 9-Jul | 12-Jul | 15-Jul | 18-Jul | 22-Jul | 26-Jul | 29-Jul | 4-Sep | Total | Apogee |
| Variety | Plot | weight (g) | weight (g) | weight (g) | weight (g) | weight (g) | weight (g) | weight (g) | weight (g) | weight (g) | weight (g) | weight (g) | Treatment |
| Mara des Bois | 1 | 69 | | | | 27 | | | 16 | 6 | 24 | 142 | 27 g/100L |
| Cabrillo | 2 | 49 | | | | 29 | | 90 | 56 | 11 | 36 | 271 | 27 g/100L |
| Kent | 3 | 44 | 48 | 85 | 180 | 67 | 50 | 45 | 20 | 11 | | 550 | 27 g/100L |
| Sapphire | 4 | | 56 | 13 | 127 | 46 | 22 | 67 | 30 | 58 | | 419 | 27 g/100L |
| Serenity | 5 | | | 98 | 84 | 221 | 96 | 96 | 65 | | | 660 | 27 g/100L |
| Kent | 6 | | | | | | | | | | | 0 | 45 g/100L |
| Sapphire | 7 | | 27 | 39 | 29 | 16 | 38 | | | | | 149 | 45 g/100L |
| Serenity | 8 | | 36 | 42 | 61 | 32 | 68 | | | | | 239 | 45 g/100L |
| Mara des Bois | 9 | | | | | 40 | 32 | 48 | 32 | | 12 | 164 | 45 g/100L |
| Cabrillo | 10 | | | | | 85 | 68 | 159 | 40 | | 28 | 380 | 45 g/100L |
| Sapphire | 11 | 37 | 74 | 29 | 120 | 117 | 76 | 33 | 20 | | | 506 | 0 g/100L |
| Serenity | 12 | 0 | | | 62 | 39 | | 41 | | | | 142 | 0 g/100L |
| Mara des Bois | 13 | | | | | 16 | 40 | 46 | 54 | | 8 | 164 | 0 g/100L |
| Kent | 14 | 87 | 84 | 155 | 149 | 116 | 86 | 129 | 170 | 53 | | 1029 | 0 g/100L |
| Cabrillo | 15 | | | | | 105 | 83 | 193 | 65 | | 36 | 482 | 0 g/100L |
| Serenity | 16 | | | | | | | | | | | 0 | 27 g/100L |
| Mara des Bois | 17 | | | | | 40 | 120 | 43 | 24 | | 14 | 241 | 27 g/100L |
| Sapphire | 18 | 114 | 82 | 48 | 305 | 217 | 86 | 73 | 50 | 34 | | 1009 | 27 g/100L |
| Cabrillo | 19 | | | | | 79 | 239 | 257 | 75 | | 28 | 678 | 27 g/100L |
| Kent | 20 | 135 | 193 | 97 | 450 | 130 | 55 | 40 | 55 | 67 | | 1222 | 27 g/100L |
| Cabrillo | 21 | | | | | | 84 | 105 | 30 | | 16 | 235 | 45 g/100L |
| Kent | 22 | 117 | 168 | 58 | 261 | 129 | 63 | 25 | 70 | 35 | | 926 | 45 g/100L |
| Mara des Bois | 23 | | | | | 38 | 60 | 51 | 26 | | 10 | 185 | 45 g/100L |
| Serenity | 24 | 197 | 59 | 45 | 232 | 526 | 136 | 137 | 55 | 30 | | 1417 | 45 g/100L |
| Sapphire | 25 | 91 | 128 | 486 | 692 | 209 | 305 | 242 | 105 | 27 | | 2285 | 45 g/100L |
| AC Wendy | 26 | | 24 | 38 | 57 | 26 | 103 | 24 | 20 | 26 | | 318 | 27 g/100L |
| AC Wendy | 27 | | 23 | | 32 | 42 | 19 | | 25 | | | 141 | 45 g/100L |
| AC Wendy | 28 | | 43 | 42 | 64 | 34 | 20 | | | | | 203 | 0 g/100L |
| AC Wendy | 29 | 40 | 18 | 13 | 40 | 59 | 43 | 62 | | 21 | | 296 | 27 g/100L |
| AC Wendy | 30 | 49 | 24 | 109 | 80 | 37 | 25 | 11 | | | | 335 | 45 g/100L |

The day-neutral cultivar Mara des Bois was the lowest yielding (over all treatments) with an average production of 180 g/plot. The day-neutral Cabrillo was the third lowest with an average 409 g/plot. The day-neutral cultivars were in their first year of production; so they were expected to be less competitive in 2019.

# Top-Growth Removal and Burning of Raspberry, Saskatoon Berry, and Dwarf Sour Cherry as an Orchard Management Technique

## Funding

- Saskatchewan Fruit Growers Association (SFGA)
- Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canadian Agricultural Partnership Program

## Project Lead

- Forrest Scharf, PAg, Provincial Fruit Specialist, Saskatchewan Ministry of Agriculture

## Co-operators

- Irrigation Crop Diversification Corporation (ICDC)
- Canada-Saskatchewan Irrigation Diversification Centre (CSIDC)
- Saskatchewan Fruit Growers Association (SFGA)

## Project Objective

The objective of this project is to display an efficient rejuvenation technique for overgrown orchard rows of raspberry, Saskatoon berry, and dwarf sour cherry via top-growth removal, and burning.

## Project Background

As Saskatoon berry and sour cherry orchard plants age beyond 10 years old, growers struggle with plants becoming overgrown, filled with disease, and expensive to manage. The cut and burn technique reduces labour costs, limits disease spread, and rejuvenates orchard rows to quickly. The efficiency of the technique ensures growers maximize return on investment in their businesses, and maintain high quality and volume yields on a continuous basis. The more stable fruit supply benefits processors, who therefore have a more consistent supply of fruit. It also benefits young growers who want to take over neglected orchards, to return them to full productive potential quickly.

## Project Plan

The varieties included in this trial are: sour cherry cultivars Valentine and Romeo; Saskatoon berry cultivars Thiessen and Smokey; Raspberry cultivars Prelude, Nova, SK Red Bounty, and SK Red Mammoth.

The control plots were not mowed, and served to compare production with treated plots. Cherry and Saskatoon treatments included cut and burned plots, cut and Apogee treated plots, as well as cut with no other treatment plots. Apogee (Prohexadione calcium) is a gibberellin inhibitor that affects growth and promotes some forms of plant disease resistance (for example, Fire Blight).

All plants were measured for row height, width, yield and number of suckers (or new canes). Fruit quality was assessed (via brix readings) as well average fruit size in grams.

The two northern most raspberry rows were mowed to roughly 2.5 cm height using a heavy duty Brushcat front-mount mower, attached to a Bobcat skid steer. Staff attempted to mow the Saskatoon berry rows with the Brushcat, but the machine was too damaging to the plants. Top-growth was removed using pneumatic pruners followed by chainsaw. Raspberry rows were mowed on April 23,

2019. Saskatoon berry and sour cherry plots were mowed to roughly 2.5 cm above ground level on May 3, 2019**.**

Due to exceptionally dry conditions, fire bans were in place in Southern Saskatchewan throughout April, May, and early to mid-June. The fire bans prohibited the project's ability to burn flax shives on top of burn treatment plots. A small propane torch was used instead to burn plots that were designated for this treatment May 16, 2019. The burn treatment plots were well controlled and irrigation water was present for undesired fire spread.

Apogee treated plots were timed according to standard growth label recommendations, at 45 grams/100 L spray rate.

Some early weeding was performed in plots, but later in the season weeds re-established. Plant regrowth was monitored over the summer and final measurements were taken September 4th, 2019

Cut plots will be monitored in 2020 and 2021; to quantify yield, new growth, and ease of management (including narrowing of the rows).

## Demonstration Site

This project was located within the fruit orchard at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) near Outlook. The CSIDC orchard has a Bradwell Orthic Dark Brown sandy loam soil, pH 8.4.

## Results

Spring conditions in 2019 were exceptionally dry, and the winter was exceptionally cold. In fact, February averaged the coldest February in over 100 years. The cold temperatures and dryness appeared to be beneficial for Saskatoon berries that had exceptional yield and fruit quality. Unfortunately, it caused extensive tip-kill damage to raspberries, and was likely a significant factor in development of blindwood in sour cherry resulting in poor yield and average fruit quality.

Tip-kill in raspberry is typically overcome with the plants being able to adjust and promote more vigorous growth and yield in the non-affected tissues. Unfortunately, sour cherries are not able to overcome the effects of blindwood. This causes a reduction in the number of leaves, viable flowers and a reduction in overall plant vigour and yield. In reference to the sour cherry plots that were cut-down; the winter and drought conditions had no significant impact on their rejuvenation, but the control plots did not provide a standard yield value that would be typical when comparing treated to control plots.

Obviously plots that were not cut, were significantly taller than cut treatments. Cut treatments were not as significantly different when compared to each other, but the general trend was for the burnt plots to be taller than the other cut treatment plots. This likely results from resources of mature roots being directed to relatively fewer new stems in the burnt treatment. Saskatoon berries grew back more vigorously with average regrow height > 1.25 meters, compared to sour cherry at < 1 meter of regrowth. Average heights in Romeo cherry plots were significantly shorter due to weed competition as well as some damage from what appeared to be improper herbicide treatment. Thiessen had the tallest average regrowth at slightly below 1.3 meters, Smokey was close with an average height of roughly 1.25 meters. Valentine sour cherry averaged roughly 1 m in height, which was significantly shorter than the average Saskatoon regrowth. Cherry regrowth may have been impeded due to more significant winter stress when compared to Saskatoon berry. Prior studies of Valentine regrowth, resulted in 1st year (post top growth removal) average height of 1.3 meters.

The average sour cherry Cut, No burn treatment had a slightly wider row at 1.7 meters compared to the Burnt treatment 1.2 m and the Cut Apogee treatment 1.4 meters wide.

Saskatoon berry variation in width averages were less distinct, with all treatments averaging roughly 1.5 meters wide.  It is speculated the inability to employ a Flax shive slow-burn treatment, made the burn less effective across the width of the ground.  The lower and less sustained temperatures perhaps allowed undamaged suckers to survive the burn treatment and send up shoots across the entire width of the former row. Speculation that Apogee might reduce diversion of energy to wider components of plant rows was not confirmed in the trial to date, but will be monitored in 2020.

In regard to fruit production, as expected yields in the treated plots were non-existent (0 kg/plot).  The control plots averaged 1.6 kg in sour cherry versus 13.4 kg in Saskatoon berry.  Sour cherry yields were well below normal in 2019, whereas in general Saskatoon berry yields were at unprecedented high levels.

In regard to fruit quality in Saskatoons, the Thiessen variety averaged 13.9% brix and average fruit weight was 1.6 grams (exceptionally large), Smokey averaged 14.4% brix but average fruit size was smaller than Thiessen at 1.2 grams (still very large for Smokey).

In relation to cherry fruit quality; Brix averaged 16% in Valentine and 14.2 % in Romeo.  These levels are relatively low for this type of sour cherry, and likely reflect blindwood symptomology that plants suffered under. The cherries also suffered from rapid spread of brown rot during the fruit ripening stage of development, due to wet conditions in mid to late August.

In regard to raspberry, in the early stages of the growth season, the cut treatments were significantly shorter than the uncut plots. However, by the end of the 2019 season the mowed down plots of SK Red Mammoth and SK Red Bounty had surpassed the average height of the uncut plots.  The mowed down Nova and Prelude plots remained slightly shorter than the uncut Nova and Prelude plots.

In regard to Raspberry yields (table 2), most of the mowed down plots did not produce fruit in 2019. The exception was the Prelude variety plots that produced as much in the final (September) production phase, as the uncut Prelude plots did at that time.  The uncut Prelude plots exceeded the cut prelude plots in overall yield, because the cut plots did not produce any fruit throughout July and August.

Total yield for cut and uncut rows indicate that Prelude was the highest yielding cultivar (with total average yield in uncut plots = 7768 g), followed by Nova (5812 g), SK Red Bounty (4150 g), and SK Red Mammoth (2359 g).

The SK Red Mammoth and SK Red Bounty cultivars suffered more significant tip-kill than the other cultivars, and took longer to recover from that damage. Prelude had significant early and late yield advantages over other cultivars, and was a more consistent producer over all plots (compared to the other cultivars tested in the demonstration).

Table 2: Raspberry yield 2019

| Raspberry Harvest 2019 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Date picked | | 16-Jul | 23-Jul | 30-Jul | 6-Aug | 13-Aug | 20-Aug | 28-Aug | 12-Sep | 19-Sep |
| Variety | Plot | weight (g) | (g) | (g) | (g) | (g) | (g) | (g) | (g) | (g) |
| SK Red Bounty | 1 | 0 | 0 | 158 | 1073 | 1440 | 763 | 615 | 0 | 0 |
| SK Red Mammoth | 2 | | 1070 | 252 | 504 | 300 | 277 | 302 | | |
| Prelude | 3 | 2068 | 3950 | 456 | 1860 | 150 | 66 | 74 | 330 | 314 |
| Nova | 4 | 1684 | 815 | 714 | 2079 | 1720 | 642 | 148 | | |
| SK Red Mammoth | 5 | | 450 | 109 | 203 | 700 | 550 | | | |
| Nova | 6 | | 800 | 307 | 2000 | 570 | 145 | | | |
| SK Red Bounty | 7 | | 130 | 549 | 1368 | 1280 | 696 | 227 | | |
| Prelude | 8 | | 2850 | 368 | 1650 | 120 | 89 | | 642 | 548 |
| **Cut Plots below:** | | | | | | | | | | |
| Prelude | 9 | | | | | | | | 483 | 468 |
| Nova | 10 | | | | | | | | | |
| SK Red Mammoth | 11 | | | | | | | | | |
| SK Red Bounty | 12 | | | | | | | | | |
| SK Red Bounty | 13 | | | | | | | | | |
| SK Red Mammoth | 14 | | | | | | | | | |
| Prelude | 15 | | | | | | | | 626 | 373 |
| Nova | 16 | | | | | | | | | |

Prelude and Nova had similar average Brix readings (roughly 12% Brix), but Prelude was more consistent. SK Red Mammoth and SK Red Bounty achieved 12 % Brix at the middle of July, but in earlier and later harvest periods they were less sweet (averaging roughly 9% Brix).

Prelude also consistently had the largest fruit size at roughly 3.7 grams/fruit; followed by Nova at 3.5 grams/fruit, SK Red Mammoth at 3.3 g/fruit, and SK Red Bounty at 3.0 g/fruit.

## Final Discussion

The demonstration was most informative with regard to plant responses to the cut and burn treatments. Saskatoon responses were very uniform, but could have benefited from a longer and hotter burn. Apogee and control treatments did not work as well as might have been hoped with too much uncontrolled growth occurring. In Cherry the response was similar to Saskatoon berry but slightly less vigorous. The slightly more subdued response might be superior for the longer-term row control outcomes desired for mechanical harvesting of cherries. 2020 will be instructive with regard to productivity responses, but that is outside the timeline of this demonstration.

In regard to raspberry, all varieties are capable of being mowed, but no production can be expected from standard cultivars in the same year the plants are mowed. All raspberries re-established the row and were roughly as tall as the uncut rows by the end of the production season. The raspberry cultivar Prelude shone in this demonstration because it did produce fruit in the same year, making it a more highly promising candidate for employing this reduced labour raspberry patch management technique.

Growers who are questioning how to manage seriously overgrown orchard rows and raspberry patches, should consider employing the cut and burn technique to reduce long-term labour expense and promote plant rejuvenation.

Plots will continue to be analysed in 2020 to further determine the cost-benefit of employing this rejuvenation strategy.

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- Angela Stoppler, ICDC Acting Horticultural Research Technician, for project implementation and plot maintenance
- ICDC staff for assisting in setup and field work
- The Saskatchewan Ministry of Agriculture's support for these projects was featured in all communications and at grower events
- The project was promoted by the Saskatchewan Fruit Growers Association as well as by SMA, CSIDC, and ICDC staff

# Demonstration of Advanced Dwarfing Apple and Pear Rootstock Selections

## Funding

Saskatchewan Fruit Growers Association (SFGA)

- Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canadian Agricultural Partnership Program

## Project Lead

- Forrest Scharf, PAg, Provincial Fruit Specialist, Saskatchewan Ministry of Agriculture

## Co-operators

- Irrigation Crop Diversification Corporation (ICDC)
- Canada-Saskatchewan Irrigation Diversification Centre (CSIDC)
- Saskatchewan Fruit Growers Association (SFGA)

## Project Objective

The objective of this project was to demonstrate superiority of advanced dwarf rootstock selections compared to dwarf apple industry standards Ottawa #3 (Ott 3), Vineland #3 (V3), as well as to regular pear rootstock. This project will subsequently allow for future demonstration of superior apple and pear (scion wood) cultivars bred by the University of Saskatchewan Fruit Research Program. The fruit scion wood will be grafted onto dwarfing apple/pear rootstock in Spring/early summer 2020.

## Project Background

The use of dwarfing apple and pear rootstock is beneficial because it reduces the juvenile phase of apples and pears, so they start producing fruit at 3 or 4 years versus 10 years of age. It allows more trees per unit area, can improve winter hardiness and allows for a greater range of disease resistance. It also makes harvest operations more efficient because plant structure can be better controlled. The advanced dwarfing apple and pear rootstock selections have been grown outside Saskatchewan; but have not been grown, assessed, or budded to hardy scion wood in Saskatchewan.

The Saskatchewan industry standards, Ott 3 and V3 dwarfing rootstocks have various negative attributes that make them less than ideal for commercial apple producers. Ott 3 is the most widely used cultivar, but is quite susceptible to fire blight damage and possibly Rapid Apple Decline (RAD). V3 has marginal yield efficiency, scion wood compatibility, and fire blight resistance. The advanced selections may have superior disease resistance, cold hardiness, dwarfing effect (expressed as a percentage when compared to standard trees), scion wood compatibility, and production efficiency. Successful grafts between scion wood and dwarf rootstock can be measured for rootstock/scion wood compatibility, not all scion wood is equally compatible with all varieties of rootstock. This project will provide rootstock information to support efficient and vigorous scion wood growth, and lead to earlier fruit production.

In regard to pear rootstock; the featured selections may offer superior hardiness, disease resistance, compatibility, and dwarfing characteristics.

## Project Plan

Plots were planted in groups of 6 dwarfing rootstock per plot (of the same genotype) randomized within 3 orchard rows. Plots were randomized within the row, with every row having a different randomization.

All plots were measured for average height, disease incidence, establishment success, and winter hardiness. Future assessments will include: graft compatibility with scion wood selections, impact on scion wood juvenility phase, impact on yield, impact on scion wood winter hardiness, and impact on scion wood disease susceptibility.

Dwarf Apple Rootstock Attributes:
Ottawa 3 (Ott #3): was released in 1974 by AAFC Ottawa because it was very cold hardy. Its parent's are M.9 and "Robin" crab. Trees on Ottawa 3 are slightly taller than large M.9 but shorter than M.26. It induces early bearing and is resistant to collar rot; but is susceptible to fire blight, and woolly apple aphid. Ottawa 3 (although available for many years) has not been popular with the nursery industry. Young stool beds produce few saleable liners, although as stool beds age they become more productive. Ottawa 3 is also very susceptible to apple mosaic virus.

Vineland #3 (V 3): is slightly smaller than M.9 but yield and yield efficiency is similar. It was bred at Vineland Research Station in Ontario from a Kerr crab x M.9 and was selected from open-pollinated hybrids. It is very cold hardy and somewhat resistant to fire blight. It was included in the 1994 NC-140 dwarf apple rootstock trial at 9 locations in North America. After 10 years, trees on V 3 were smaller than trees on M.9 (about 20 to 25% of standard size). Tree survival was very good. Trees produced few root-suckers and burr knots. At most locations, trees had lower cumulative yield than M.9.

Budagovsky 9 (Bud 9): was selected from a cross between M.8 x 'Red Standard' (Krasnij Standard) from Russia. Bud 9 (or B.9) has been widely tested throughout the U.S. It is slightly more dwarfing than M.9 and is slightly more productive. Other traits of note: Very early precocity; very winter hardy; little suckering; requires support; adapted to well-drained soil; very resistant to crown rot; and is more fire blight resistant than M.9.

EMLA 26: was bred at East Malling from M-9 and M-16 (Metziner Ideal). It creates trees that are about 40 to 45 percent the size of a standard apple tree. It needs some support in early years, but could be self-supporting in later years. EMLA 26 is very early, heavy bearing, and is not as sensitive to mineral deficiencies as many rootstocks. It is very adaptable for close plantings and double rows; but it is susceptible to collar rot and some races of Fire Blight.

Geneva 41: Dwarfing rootstock resulting from a cross between M.27 x Robusta 5 crabapple and introduced by the New York State Agricultural Experimental Station, at Geneva NY. G.41 is highly resistant to fire blight and phytophthora and it appears to be tolerant of replant disease (ARD). Other traits of note: Early bearing; winter hardy; very little suckering, requires tree support.

Geneva 210 (G 210): is a semi-dwarfing rootstock that is resistant to fire blight (Erwinia amylovora) and crown rot (Phytophthora spp.). It is a hybrid from a cross between Ottawa 3 and Robusta 5, and is larger than Ottawa 3 but smaller than Robusta 5. It is similar in size to Malling 7 but more productive and precocious.

Geneva 214 (G 214): is a cross of Robusta 5 x Ottawa 3 (and was tested as "CG 4214"). Trees on this rootstock need to be supported and produce a tree about 30-35% size of seedling with vigor and precocity similar to M.9 Nic.29 and M.26. Trees are more productive than those rootstock, and have better cold hardiness. It is also resistant to fire blight, Phytophthora root rot, and wooly apple aphid.

Geneva 890: is another selection from a cross between Ottawa 3 and Robusta 5. It is a semi-dwarfing rootstock (about 50-60% size of standard); and is resistant to fire blight (Erwinia amylovora), crown rot (Phytophthora spp.) and woolly apple aphid. It displays good cold hardiness. Tree size is approximately the same as M.7 to MM.106 but with yield efficiency similar to M.9. (higher and earlier production). Rootstock was released for use as a free standing tree for processing orchards or to be used with weak scion cultivars.

Geneva 935: Dwarf rootstock resulting from a cross between Ottawa 3 x Robust 5 crabapple and introduced by the New York State Agricultural Experiment Station, Geneva NY. Traits of note include: early bearing; winter hardy; moderate suckering; requires support; very productive; well adapted to most soils; highly resistant to crown rot; highly resistant to fire blight. Dwarfing effect is similar to large M.9.

Geneva 969: another (Ottawa 3 x Robusta 5) semi-dwarfing rootstock that is resistant to fire blight, crown rot, and woolly apple aphid… with good cold hardiness. It is classified as having growth control similar to M.7 at about 45-55% of standard. The rootstock produces few root suckers or burr knots. It is suggested for trial to growers desiring a freestanding tree (in the USA).

Pear Rootstock Attributes:
The OHxF pear rootstocks were bred by Ohio State University Professor F.E. Reimer. The OH moniker stems from "Old Home" the site in Illinois where a fire blight resistant, self-infertile dwarf pear was selected from Bartlett seedlings. "F" stands for Farmingdale Illinois which was the location where another disease resistant dwarfing Bartlett seedling was found; but this seedling was self-fertile. OH and F were crossed ("x") by L. Brooks of Oregon, and the progeny were fireblight resistant, self-fertile, vigorous, had good cold hardiness, and ranged between 60 to 70 per cent of standard Bartlett pear seedlings.

OHxF 87: Outstanding semi-vigorous clonal stock. Excellent anchorage. Tolerant of soil diseases. Very resistant to fire blight. Tolerant of low temperatures. Induces early, heavy production.

OHxF 97: OHXF 97 is very winter hardy, provides good anchorage, superior yield efficiency (but is less precocious than OHxF 870, and superior fire blight resistant. It is more productive than standard Bartlett seedlings.

OHxF 333: Somewhat more dwarfing than OHxF 87, with similar resistances. Some report that fruit size is smaller, but this may be due to excessively heavy fruit set. It is less precocious than the other two varieties.

Ussurian Pear: Also known as "Harbin Pear". It is the cold hardiest of pears, introduced from northeastern Asia. This species is also among the most fire blight resistant of the Pyrus species. The largest tree in North Dakota is 29 feet tall with a canopy spread of 24 feet. In Saskatchewan, it averages less than 20 feet tall.

## Demonstration Site

This project was located within the fruit orchard at the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) near Outlook. The CSIDC orchard has a Bradwell Orthic Dark Brown sandy loam soil, pH 8.4.

## Results

In regard to apple rootstock, the most vigorously growing varieties were Budagovsky 9 (avg. height 70 cm), EMLA 26 (avg. height 66 cm), and Geneva 969 (avg. height 78 cm). For all rootstock heights, see Table 1.

Geneva 41 (avg. height 56 cm) was average with respect to growth, but was stronger than Geneva 214 that is typically within the same height class. Geneva 214 (avg. height 46 cm) was less vigorous than Geneva 41 and experienced some plant death in one of its plots.

V3 rootstock was propagated via tissue culture, and was perhaps at a disadvantage in height due to typical juvenility that is often retained by tissue culture propagated plantlets. Average height of V3 rootstock was 54 cm, which corresponded well with average Geneva 41 height.

Ott 3 was also propagated via tissue culture, and did not get established as early as the other varieties. So, it's 23 cm average height (that was the shortest of all the rootstock) does not fully reflect its true genetic growth potential (that should be closer to Geneva 41 and V3).

Geneva 210 and Geneva 890 appeared to be less consistent or poorly adapted to Saskatchewan conditions. Geneva 210 averaged 37 cm in height but had close to 50% plant loss. Geneva 890 averaged 57 cm but roughly 50% of the plants suffered chlorosis, and were short (avg. 33 cm) whereas those that were not weak minor nutrient absorbers, were taller (avg. 84 cm).

Geneva 935 rootstock averaged 40 cm in height, and there were 2 dead plants in one of its plots. This variety seemed to branch in clusters from the bottom and perhaps this reflects less hardiness (or frost damage that killed the majority of the top growth). It also succumbed to iron chlorosis to a limited extent. The results are somewhat inconsistent with the findings from studies conducted in the USA. Unlike in the USA, Budagovsky 9 grew more vigorously than most varieties (perhaps due to strong winter hardiness and high pH soil tolerance) placing it in a growth category above Geneva 890. Geneva 210 and 935, were shorter than what was anticipated, but this may relate to poor nutrient absorption related to high pH soil intolerance with associated micro-nutrient absorption challenges.

EMLA 26 and Geneva 969 grew surprisingly well and appeared to be quite hardy (Winter 2019/2020 will provide more insight regarding their hardiness).

Aside from Iron Chlorosis caused by high pH soil conditions, no other obvious disease symptoms were observed. It is possible some of the plants that died in Geneva 935, 210, and 214 plots were susceptible to fire blight, but there may be unrelated reasons for their weakness: poor establishment, weak stock plants, pH sensitivity, et cetera.

Table 3: Dwarf Apple and Pear Rootstock Average Height 2019

| **Dwarf Apple and Pear Rootstock Average Height** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Plot # | South West | | Plot # | | | Plot # | North West | |
| | Row 1 | Avg. Height cm | | 2 | Avg. Height cm | | 3 | Avg. Height cm |
| 14 | Ott 3 | 20 | 28 | V3 | 60 | 42 | Ussurian Pear | 36 |
| 13 | Bud 9 | 82 | 27 | Ussurian Pear | 36 | 41 | V 3 | 41 |
| 12 | EMLA 26 | 77 | 26 | Geneva 41 | 52 | 40 | Geneva 890 | 40 |
| 11 | Geneva 41 | 67 | 25 | Geneva 210 | 32 | 39 | Bud 9 | 57 |
| 10 | Geneva 935 | 37 | 24 | Ott 3 | 24 | 38 | Ott 3 | 24 |
| 9 | Geneva 210 | 40 | 23 | Geneva 935 | 40 | 37 | Geneva 969 | 65 |
| 8 | Geneva 890 | 87 | 22 | Geneva 969 | 86 | 36 | EMLA 26 | 68 |
| 7 | Geneva 214 | 47 | 21 | Bud 9 | 69 | 35 | Geneva 41 | 50 |
| 6 | Geneva 969 | 84 | 20 | EMLA 26 | 53 | 34 | Geneva 214 | 45 |
| 5 | Ussurian Pear | 34 | 19 | Geneva 890 | 44 | 33 | Geneva 935 | 44 |
| 4 | V 3 | 60 | 18 | Geneva 214 | 46 | 32 | Geneva 210 | 38 |
| 3 | OHXF Pear 87 | 95 | 17 | OHXF Pear 333 | 72 | 31 | OHXF Pear 97 | 53 |
| 2 | OHXF Pear 97 | 62 | 16 | OHXF Pear 97 | 70 | 30 | OHXF Pear 87 | 66 |
| 1 | OHXF Pear 333 | 90 | 15 | OHXF Pear 87 | 78 | 29 | OHXF Pear 333 | 84 |
| | South East | | | | | | North East | |

In regard to pear rootstock, OHxF 333 was tallest with an average height of 82 cm. This wasn't significantly different than OHxF 87, that averaged 80 cm. Cultural or establishment dynamics could account for a slight difference in average height; the bottom and top growth for OHxF 87 were distinct with the bottom being compact and deep green leaved (whereas top-growth was lighter green and far leggier). OHxF 97 was significantly shorter than the other OHxF varieties with an average height of 62 cm, which is inconsistent with USA studies where OHxF 97 is typically taller than the other varieties. The weak OHxF 97 growth may correspond with poorer high pH tolerance than the other varieties, as it's leaves were more chlorotic.

The shortest pear in the demonstration was the Ussurian that averaged 35 cm in height. It is known to be the shortest of pears, but the plants used in this project were also disadvantaged because they were sourced from a company that propagates the plants via tissue culture (unlike the other pear varieties). Ussurian was unique with purple colored veins and upper stem.

All pear varieties appeared to be susceptible to Leaf Spot, but the symptoms were not significant enough to cause economic loss or to significantly impact growth. Tolerance of high pH soil and the associated inability to absorb some micronutrients (mainly chlorosis) may cause differences in overwintering (impact hardiness) for the 2019/2020 winter period. To date, hardiness appears to be similar.

## Final Discussion

It is recommended that this project be extended into 2020 (with other project data collection in 2020/2021 for scion wood growth characteristics, et cetera).

## Acknowledgements

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- Angela Stoppler, ICDC Acting Horticultural Research Technician, for project implementation and plot maintenance
- ICDC staff for assisting in setup and field work
- The Saskatchewan Ministry of Agriculture's support for these projects was featured in all communications and at grower events
- The project was promoted by the Saskatchewan Fruit Growers Association as well as by SMA, CSIDC, and ICDC staff

# TECHNOLOGY TRANSFER

**CSIDC Irrigation Field Day and Tradeshow, July 11**

- Joel Peru – Irrigated Canola Production Survey
- Cara Drury - Horticulture Trials, Crops with Opportunities and Irrigated Beet Cultivar Demonstration
- Garry Hnatowich – 4R N Fertilizer of Winter & Spring Wheat, Farm Saved Seed vs Certified Seed, Fall Rye N Fertilization, Wheat Seeding Rate & Row Spacing Effect on Weed Density, Spring Wheat Soil & Fertilizer N Response

**Dry Bean Field Tour, Riverhurst, July 27**

- Gary Kruger- ICDC Dry Bean Project Overview

**Conservation Learning Centre Field Day, July 18**

- Cara Drury - Irrigated Beet Cultivar Demonstration

**Riverhurst Bean Festival**

- Tradeshow Booth

**Workshops**

- Growing Corn: From Seeding to Feeding, Outlook, March 21st
- Joel Peru- Irrigation Scheduling and Crop Water Use of Corn
- Gary Kruger – Enhanced Efficiency Nitrogen Fertilizers for Irrigation
- Garry Hnatowich – Agri-ARM Agronomy Update, Dry Bean Production, Jan. 17
- Garry Hnatowich – SeCan Soybean Expo, Soybean Production in SK, Jan. 30
- Garry Hnatowich – Guest Lecture, U of S, Feb. 14
- Garry Hnatowich – WARC Crop Opportunities, March 13

Irrigation Management workshop, Outlook, March 27th

- Joel Peru-AIMM Alberta Irrigation Management Model Demonstration
- Gary Kruger – Irrigation Scheduling – Methods and Tools
- Kelly Farden- Reclamation and Water Management of Saline Soils

Crop Diagnostic School – Scott – July 23-24

- Joel Peru- Apps for Farmers and Agrologists station
- Gary Kruger – Dry bean inoculant and N Fertilization Demonstration Posters
- ICID Conference - Gary Kruger – Specialized Nitrogen for Irrigated Canola (Brassica napus) in Saskatchewan

**Publications**

- Crop Varieties for Irrigation, January
- Irrigator, March - Horticulture trial ventures into value added processing - Cara Drury
- Nitrogen Efficiency Enhancer Fertilizer for Irrigation - Gary Kruger
- Irrigated Corn for Silage or Grazing – Travis Peardon
- Irrigated Wheat Survey Results and Going Forward – Joel Peru

- Saskatchewan Agricultural Hall of Fame – Roger Pederson
- Irrigator, November - ICDC Research and Development – Garry Hnatowich
- Disease Management of Dry Beans – Gary Kruger
- Fababean: Diversification Crop for Lake Diefenbaker Irrigation Area in 2020? - Gary Kruger
- Learn about ICDC's Research on their new YouTube Channel – Joel Peru
- ICDC's Horticulture Program – Cara Drury
- 2019 ICDC Research and Demonstration Report – March

### Presentations

Joel Peru

- 2019 SIPA/ICDC Conference– 2018 Irrigated Canola Survey, December 3

Gary Kruger

- 2019 SIPA/ICDC Conference– 2019 Irrigated Canola Survey, December 3

Cara Drury

- 2019 SIPA/ICDC Conference– Expansion of the Pickling Cucumber Industry in Saskatchewan, December 3
- 2020 SVGA Annual Conference and AGM- Demonstration on Beet Varieties and Demonstration of Crops with Opportunities, January 2020

Garry Hnatowich

- 2019 SIPA/ICDC Conference - ICDC Research Program Overview

### Crop Production Newsletter

Joel Peru

- Crop Production News #1 Crop Walks Return for 2019
- Crop Production News #2 Importance of Irrigation Scheduling 2019
- Crop Production News #6 ICDC's Youtube Channel

Gary Kruger

- Crop Production News #4 – Alternative control products for white mold and bacterial blight in irrigated dry bean
- Lake Diefenbaker Development Area Cropping Survey (Joel Peru, Gary Kruger)
- 2018 Irrigated Canola Survey (Joel Peru, Gary Kruger, Cara Drury)

### Social Media

- Weekly Crop Water Use updates
- Twitter
- YouTube Videos

# ABBREVIATIONS

| | |
|---|---|
| AAFC | Agriculture and Agri-Food Canada |
| ac | acre or acres |
| ACC | Alberta Corn Committee |
| ADF | Agriculture Development Fund |
| ADOPT | Agriculture Demonstration of Practices and Technologies (Canadian Agricultural Partnership Program) |
| AIMM | Alberta Irrigation Management Model |
| bu | bushel or bushels |
| CCC | Canola Council of Canada |
| CDC | Crop Development Centre, University of Saskatchewan |
| cm | centimetre |
| CSIDC | Canada-Saskatchewan Irrigation Diversification Centre |
| DM | dry matter |
| FHB | Fusarium head blight |
| GPS | Global Positioning System |
| ICDC | Irrigation Crop Diversification Corporation |
| ICID | International Commission on Irrigation & Drainage |
| L | litre |
| lb | pound or pounds |
| m | metre |
| MAFRI | Manitoba Agriculture, Food and Rural Initiatives |
| mm | millimetre |
| SPARC | Semiarid Prairie Agricultural Research Centre |
| SVPG | Saskatchewan Variety Performance Group |
| t | tonne |
| TKW | thousand kernel weight |
| WGRF | Western Grains Research Foundation |

The Irrigation Saskatchewan website at http://irrigationsaskatchewan.com is designed so that site visitors have access to irrigation topics related to ICDC, SIPA and the Ministry of Agriculture. The site directs visitors to an ICDC subsection, a SIPA subsection, and a link to the irrigation section of the Saskatchewan Ministry of Agriculture's website.

The ICDC section includes ICDC reports, publications, and events, as well as links to information relevant to irrigation crops.

# ICDC PUBLICATIONS

***ICDC Research and Demonstration Program Report*** Detailed descriptions of the projects undertaken each year.

***Irrigation Economics and Agronomics*** An annual ICDC budget workbook designed to assist irrigators with their crop selection process. Irrigators can compare their on-farm costs and productivity relative to current industry prices, costs and yields. A copy of the workbook is available in an excel format on the ICDC website

***Crop Varieties for Irrigation*** A compilation of yield comparison data from irrigated yield trials managed by ICDC. It is useful as a guide for selecting crop varieties suitable for irrigation.

***Irrigation Scheduling Manual*** Provides technical information required by an irrigator to effectively schedule irrigation operations for crops grown under irrigation in Saskatchewan.

***Irrigated Alfalfa Production in Saskatchewan*** Provides technical information regarding the production practices and recommendations for irrigated alfalfa forage production.

***Irrigator*** A semi-annual newsletter providing irrigators with updates from ICDC

***Management of Irrigated Dry Bean*****s** This factsheet provides a comprehensive overview of agronomic management requirements for producing dry beans under irrigation.

***Corn Production*** This factsheet provides information on corn heat units, variety selection and an overview of agronomic management requirements for producing grain, silage and grazing corn under irrigation in Saskatchewan.

Copies of these and other ICDC publications are available from the Ministry of Agriculture's Irrigation Branch office in Outlook, SK, ICDC office or on the ICDC website at http://irrigationsaskatchewan/icdc.