2021

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 2021

ICDC STAFF

Garry Hnatowich, PAg
Research Director
306-867-5405
garry.icdc@sasktel.net

Gursahib Singh, PhD.
Research Director
306-867-5405
gursahib.icdc@sasktel.net

Damian Lee
Field Research Technician
306-867-2101
damian.icdc@sasktel.net

Theodore Nodge, AAg
Research Associate
306-867-9104
ted.icdc@sasktel.net

Brenda Joyes
Executive Administrator
306-867-5669
admin.icdc@sasktel.net

SASKATCHEWAN MINISTRY OF AGRICULTURE CROPS AND IRRIGATION BRANCH STAFF

Kelly Farden, PAg
Manager, Agronomy Services
Crops and Irrigation, Ministry of Agriculture
306-867-5507
kelly.farden@gov.sk.ca

Mark O'Connor, AAg,
Provincial Irrigation Agrologist
Field crops, Irrigation Scheduling and Fertility Management
Ministry of Agriculture
306-860-7201
mark.oconnor@gov.sk.ca

Cara Drury, PAg
Provincial Irrigation Agrologist
Crops and Irrigation, Ministry of Agriculture
306-867-5517
cara.drury@gov.sk.ca

Travis Peardon, PAg
Livestock and Feed Extention Specialist
Crops and Irrigation, Ministry of Agriculture
306-867-5504
travis.peardon@gov.sk.ca

Jay Bauer, MSc.
Irrigation Soils Agrologist
Crops and Irrigation, Ministry of Agriculture
306-867-5512
jay.bauer@gov.sk.ca

ICDC Research and Demonstration Report 2021

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:

Irrigation Crop Diversification Corporation
Box 1460
Outlook, SK S0L 2L0
Phone: 306-867-5669
Email: admin.icdc@sasktel.net
http://irrigationsaskatchewan.com/icdc

VISION

To be the primary source of irrigation research and education for irrigation producers in the province of Saskatchewan to maximize profitability and sustainability in the irrigation sector.

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

Irrigation Crop Diversification Corporation

901 McKenzie Street South
Box 1460
OUTLOOK, SK S0L 2N0
Bus: 306-867-5669 Fax: 306-867-2102
email: admin.icdc@sasktel.net
Web: http://irrigationsaskatchewan.com/icdc

BOARD OF DIRECTORS

Director	Position	Irrigation District	Development Area Represented	Term Expiry (current term)
Anthony Eliason	Chairman	Individual Irrigator	Non-District	2021 (2nd)
Jeff Ewen	Vice Chairman	Riverhurst	SEDA	2022 (1st)
Murray Purcell	Director	Moonlake	NDA	2023 (2nd)
Nick Eliason	Director	Riverhurst	LDDA	2022 (1st)
Paul Heglund	Director	Consul-Nashlyn	SWDA	2021[1]
Kaitlyn Gifford	Director	LDDA	SSRID	2023 (2nd)
Greg Oldhaver	Director	Miry Creek	SWDA	2021[2]
Larry Lee	Director	SSRID	SIPA representative	Appointed
Aaron Gray	Director	Miry Creek	SIPA representative	Appointed
Kelly Farden	Director	N/A	SA representative	Appointed
Dianna Emperingham	Director	N/A	SA representative	Appointed

[1] Pursuant to Bylaw 7, Paul Heglund 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, 2019*, the majority of the ICDC board must be comprised of irrigators.

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FIELD CROP VARIETY TRIALS

Irrigated Canola Performance Trial – Swathed Varieties

Funding

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

Principal Investigators

- Garry Hnatowich, PAg, Co-Research Director, ICDC
- Gursahib Singh, PhD, PAg, Co-Research Director, ICDC

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- SK Canola

Objectives

The objectives of this study were to:

(1) Provide relevant, unbiased canola variety data on a selection of leading and newly released canola varieties.
(2) Update the Canola Council of Canada's variety performance database.
(3) Update the MOA's annual *Varieties of Grain Crops*.
(4) Update ICDC's annual *Crop Varieties for Irrigation* guide.

Research Plan

The Swathed Canola Performance Trial (CPT) was seeded at the ICDC Pederson off-station location (NE17-28-07 W3). Canola varieties were tested for their agronomic performance under irrigation. Varieties entered included three TruFlex, four Roundup and five Liberty Link canola hybrids. The trial was seeded on May 18. 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. Treatment entries were replicated four times. All varieties had a seed treatment applied by the trial coordinator 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 76 kg N in the top 60 cm. Supplemental nitrogen fertilizer was applied at 90 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. The appropriate herbicides were applied on June 17 to their respective herbicide tolerant variety. All herbicides were applied at recommended rates. A fungicide application of Priaxor® (fluxapyroxad + pyraclostrobin; 0.18 L/ac) was applied on July 8. All varieties were swathed at the appropriate time and combined on August 30. Harvested samples cleaned and yields adjusted to a moisture content of 10%. In-season precipitation from May through August was 106.3 mm (4.2") and in-season irrigation was 208.3 mm (8.2").

Results

Results are outlined in Table 1. Median grain yield of all varieties was 3700 kg/ha (66.0 bu/ac). Yields were adversely influenced by the extreme heat occurring particularly during the flowering period. The Liberty tolerant variety PC 680 LC was statistically higher yielding than all other varieties with yields less than 3800 kg/ha. Median oil content was 49.9%, test weight 65.3 kg/hl and 1000 seed weight (TKW) 4.2

grams. Plant heights ranged from 81 to 98 cm. Maximum difference in maturity between the earliest and latest maturing hybrids was 6 days.

The results from this trial will be used to update the irrigation variety database at ICDC and provide information to irrigators on the best canola varieties suited to irrigation production practices.

Table 1. Yield and agronomic data for the 2021 Irrigated Canola Performance Trial – Swathed Varieties.

Variety	**Yield (kg/ha)**	**Oil (%)**	**Test Weight (kg/hl)**	**TKW (gm/1000 seed)**	**Height (cm)**	**Maturity (days)**	**Lodge rating (1=erect; 5=flat)**
Liberty Link							
P 501 L	3732	49.9	64.8	4.1	88	85	1.0
B3011	3223	48.9	66.2	4.1	85	89	1.0
PV 680 LC	4157	50.7	65.1	4.1	94	90	1.0
PV 681 LC	3228	48.8	66.5	4.2	88	89	1.3
CP21L3C	3425	49.5	65.3	3.8	84	88	1.0
Roundup Ready							
45CM39	3898	50.7	63.9	4.4	81	90	1.0
45CS40	3741	49.3	64.4	4.0	89	90	1.0
1028 RR	4077	52.4	66.5	4.2	87	90	1.0
CS2300	3923	50.5	65.2	4.3	98	91	1.0
TruFlex							
DKTF 98 CR	3486	49.7	66.1	4.8	83	88	1.0
BY 6207TF	3898	50.0	65.7	4.5	92	90	1.0
BY 6204TF	3558	49.3	64.7	4.3	86	87	1.0
LSD (0.05)	396	1.5	0.8	0.3	6.2	2.7	NS
CV (%)	7.4	2.2	0.9	4.3	4.9	2.1	14.1

NS = Not Significant

Irrigated Canola Performance Trial – Straight Cut Varieties

Funding

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

Principal Investigators

- Garry Hnatowich, PAg, Co-Research Director, ICDC
- Gursahib Singh, PhD, PAg, Co-Research Director, ICDC

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- SK Canola

Objectives

The objectives of this study were to:

(1) Provide relevant, unbiased canola variety data on a selection of leading and newly released canola varieties.
(2) Update the Canola Council of Canada's variety performance database.
(3) Update the MOA's annual *Varieties of Grain Crops*.
(4) Update ICDC's annual *Crop Varieties for Irrigation* guide.

Research Plan

The Straight Cut Canola Performance Trial (CPT) was seeded at the ICDC Pederson off-station location (NE17-28-07 W3). Canola varieties were tested for their agronomic performance under irrigation. Varieties entered included seven TruFlex, two Roundup and ten Liberty Link canola hybrids. The trial was seeded on May 18. 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. Treatment entries were replicated four times. All varieties had a seed treatment applied by the trial coordinator 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 76 kg N in the top 60 cm. Supplemental nitrogen fertilizer was applied at 90 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. The appropriate herbicides were applied on June 17 to their respective herbicide tolerant variety. All herbicides were applied at recommended rates. A fungicide application of Priaxor® (fluxapyroxad + pyraclostrobin; 0.18 L/ac) was applied on July 8. All varieties were swathed at the appropriate time and combined on August 30. Harvested samples cleaned and yields adjusted to a moisture content of 10%. In-season precipitation from May through August was 106.3 mm (4.2") and in-season irrigation was 208.3 mm (8.2").

Results

Results are outlined in Table 1. Median grain yield of all varieties was 4317 kg/ha (77.0 bu/ac). Yields were adversely influenced by the extreme heat occurring particularly during the flowering period. The Liberty tolerant variety L340 PC was statistically higher yielding than all other varieties with yields less than 4400 kg/ha. Median oil content was 49.5%, test weight 67.0 kg/hl and 1000 seed weight (TKW) 4.2 grams. Plant heights ranged from 71 to 92 cm. Maximum difference in maturity between the earliest and latest maturing hybrids was 33 days.

The results from this trial will be used to update the irrigation variety database at ICDC and provide information to irrigators on the best canola varieties suited to irrigation production practices.

Table 1. Yield and agronomic data for the 2021 Irrigated Canola Performance Trial – Swathed Varieties.

Variety	Yield (kg/ha)	Oil (%)	Test Weight (kg/hl)	TKW (gm/1000 seed)	Height (cm)	Maturity (days)	Lodge rating (1=erect; 5=flat)
Liberty Link							
L233P	4406	48.1	65.7	4.0	81	87	2.3
L340PC	4805	47.3	64.0	4.1	86	88	1.0
L345PC	4678	48.2	66.4	4.0	79	88	1.8
L357P	4496	50.3	67.0	4.1	92	89	1.0
L255PC	4307	51.3	67.0	4.0	85	90	1.3
B3010M	3838	49.4	65.2	4.2	87	88	1.5
P506ML	4183	48.6	65.3	3.9	77	88	2.0
CS4000 LL	4306	49.1	67.1	4.2	71	89	2.8
DKLL 82 SC	3714	49.4	67.2	4.1	72	89	2.0
DKTFLL 21 SC	4210	50.1	67.0	4.0	80	88	1.3
Roundup Ready							
45CM39	4051	50.4	63.0	4.3	84	90	1.0
D3158CM	4475	49.6	66.9	4.0	81	89	1.0
TruFlex							
DKTF 99 SC	4635	49.6	67.8	4.4	85	87	1.5
DKTF 96 SC	4229	48.8	68.1	4.2	79	90	1.3
DKTF 97 CRSC	4142	49.3	67.4	4.3	86	88	1.3
PV 761 TM	4237	49.6	67.2	4.5	86	89	1.0
CP21T3P	4112	49.2	66.9	4.7	82	90	1.0
BY 6211TF	4031	49.4	67.2	4.5	84	89	1.0
CS2600 CR-T	4510	50.1	67.0	4.2	83	88	1.0
LSD (0.05)	436	0.9	0.7	0.16	6.1	1.2	0.8
CV (%)	7.2	1.3	0.8	2.7	5.3	1.0	39.9

NS = Not Significant

Irrigated Flax Variety Trial

Funding

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

Principal Investigators

- Garry Hnatowich, Co-Research Director, ICDC
- Gursahib Singh, Co-Research Director, ICDC

Organizations

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

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 established on ICDC On-station (Field 8).

Fourteen flax varieties, seven registered and seven experimental entries, were tested for their agronomic performance under irrigation. The ICDC site was seeded May 7. 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 60 kg N/ha (side band), as 46-0-0, and 20 kg P_2O_5/ha (seed placed) as 12-51-0. Weed control consisted of a post-emergence applications of Buctril M (bromoxynil +MCPA ester) + Centurion (clethodim) + Amigo adjuvant, supplemented by some hand weeding.

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%. Harvested samples were cleaned and yields were adjusted to a moisture content of 10%. In-season precipitation from mid-May through to September 23, 2021 was 105.4 mm (4.1"), total in-season irrigation was 218.4 mm (8.6").

Results

Results obtained at the ICDC location are shown in Table 1. Yield in 2021 were very low, the possible reason for abnormal yield results might be high temperatures through 2021 growing season. Test weight, TKW, flowering and height of all varieties were in close range. CDC Glas was the earliest maturing variety 102 days and CDC Dorado and experimental line FP2606 was among the late maturing 120 days. No difference in lodging between entries was evident.

Results from these trials are used to update the irrigation variety database at ICDC and provide recommendations to irrigators on the best flax 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 2022*.

Table 1. Yield and agronomic data for the Saskatchewan Variety Performance Group Irrigated Flax Regional Trial, ICDC On-Station Location (Field 8), 2020.

Variety	**Yield** (kg/ha)	**Yield** (% of CDC Bethune)	**Test Weight** (kg/hl)	**Seed Weight** (g/1000)	**Flower** (days)	**Maturity** (days)	**Height** (cm)	**Lodging** (1=erect; 9=flat)
CDC Glas	940.3	89.4	67.6	5.2	56	102	62.5	1
AAC Bright	930	80.2	67.5	5.5	56	108	62.2	1
AAC Marvelous	1336.3	113.3	69.0	5.6	57	110	64.8	1
CDC Bethune	1051.7	105.7	68.6	5.8	54	102	61.8	1
AAC Prairie Sunshine	1159	95.0	68.4	5.5	57	112	64.5	1
CDC Rowland	1179.3	88.8	68.5	6.2	55	113	65.8	1
CDC Dorado	995	70.0	68.3	6.0	52	120	55.2	1
Experimental Lines								
FP2606	1220.3	112.1	67.8	5.9	58	120	61.0	1
FP2573	1327.7	115.3	69.1	5.8	57	112	66.3	1
FP2591	1421.7	164.5	68.7	5.9	57	113	64.8	1
FP2600	1089	110.0	68.2	5.5	59	102	68.5	1
FP2592	1151.7	109.5	68.5	6.3	57	110	67.7	1
FP2602	864.3	5576.1	67.8	5.3	58	112	66.5	1
FP2604	990		69.0	5.4	59	114	60.2	1
LSD (0.05)	0.0115		0.0001	0.0001	0.004	0.0001	0.0001	
CV (%)	15.5		0.55	2.88	3.25	3.2	3.66	

Irrigated Wheat, Durum, Barley and Oat Regional Variety Trials

Funding

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

Principal Investigators

- Garry Hnatowich, Co- Research Director, ICDC
- Gursahib Singh, Co-Research Director, ICDC

Organizations

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

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 May 17. 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 41. The Hex 2 was comprised of high yielding classes of spring wheat with 8 entries. The durum trial had 14 entries. The barley trial was exclusively 2-row barleys with 28 entries. The oat trial comprised a total of 11 entries. The trial was arranged in a randomized complete block design with three replicates. Plot size was 1.5 m x 6.0 m. All trials were located at the Pederson off-station location, however, a 2nd durum trial was also established at the ICDC station. At the Pederson location nitrogen fertilizer was applied at a rate of 90 kg N/ha as 46-0-0 as a sideband application and 25 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 76 kg/ha). At ICDC durum location fertilizer was applied at a rate of 150 kg N/ha as 46-0-0 as a sideband application and 30 kg P2O5/ha as 12-51-0 seed placed (second durum trial). 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 post-emergence tank mix application of Simplicity™ (pyroxsulam; 28 g/ac) and Buctril® M (bromoxynil +MCPA ester; 0.4 L/ac) to the wheat trials (Hex 1, Hex 2, Durum), while only Buctril® M (bromoxynil +MCPA ester; 0.4 L/ac) was applied to the barley and oat trials. A foliar fungicide application of Priaxor (fluxapyroxad + pyraclostrobin) was applied July 8 to all trials. 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%. Yields were adjusted to 14.5% moisture.

In-season precipitation from mid-May through August was 106.5 mm (4.2"), in-season irrigation at Pederson was 208.3 mm (8.2").

Results

Hex 1, Hex 2 and CWSWS are shown in Tables 1, 2 and 3, respectively. Results of Pederson site and ICDC Area 51 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 and oats in Table 8.

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 2022."*

Table 1. Saskatchewan Variety Performance Group Irrigated Hex 1 Wheat Regional Variety Trial, ICDC Off-Station Pederson Site, 2021.

Variety	Yield (kg/ha)	Yield % of AAC Brandon	Protein (%)	Test weight (kg/hl)	1K Seed weight (gm)	Heading (days)	Maturity (days)	Height (cm)	Lodging 1=erect; 9=flat
AAC Brandon	**7092**	**100**	**13.9**	**80.3**	**36.6**	**49**	**88**	**79**	**1.0**
AAC Broadacres VB	6350	90	12.6	79.3	38.0	48	89	79	1.0
SY Torach	6300	89	14.3	78.5	35.2	48	85	73	1.0
CDC Ortona	6476	91	13.3	78.6	33.5	51	83	82	1.0
AAC Cirrus	6721	95	13.9	80.6	33.7	50	90	75	1.0
AAC Starbuck VB	4599	65	14.1	79.9	36.8	48	91	83	1.0
CDC SKRush	7022	99	13.7	78.2	34.6	48	89	83	1.0
AAC Redstar	5853	83	13.9	78.1	37.8	49	87	84	1.0
AAC Whitehead VB	5677	80	14.1	76.5	37.3	49	88	77	1.0
SY Brawn VB	5824	82	15.4	77.7	35.7	49	87	79	1.0
BW5045	7456	105	14.3	79.5	39.8	52	93	81	1.0
Tracker	5870	83	14.0	77.6	32.5		85	79	1.0

BW5055 VB	6779	96	14.6	80.2	33.9	48	88	78	1.0
LNR15-1741	6824	96	12.9	80.3	34.5	48	87	72	1.0
AAC Leroy VB	7087	100	14.5	79.9	36.4	49	90	80	1.0
BW1085	6987	99	14.4	79.5	38.5	50	90	78	1.0
SY Gabbro	6992	99	14.9	78.9	40.3	48	90	81	1.0
SY Cast	6547	92	14.5	79.6	38.0	49	89	77	1.0
Jake	6436	91	14.7	79.8	35.7	49	85	81	1.0
AAC Hockley	7070	100	14.1	80.7	36.4	49	91	78	1.0
AAC Alida VB	6136	87	14.7	79.5	36.2	49	90	83	1.0
AAC Russell VB	5753	81	13.1	78.4	38.9	49	85	78	1.0
Rednet	6465	91	13.4	81.6	37.7	49	86	89	1.0
Resolve	4915	69	13.1	78.8	41.1	48	90	80	1.0
BW5031 VB	6823	96	13.9	80.4	43.3	49	90	77	1.0
Bolles	5425	76	16.2	78.5	40.5	51	92	75	1.0
SY Crossite	6222	88	13.4	79.2	37.8	48	90	82	1.0
Daybreak	6381	90	14.5	80.1	40.7	49	89	79	1.0
AAC Warman VB	6550	92	15.2	79.2	35.9	48	88	85	1.0
AAC Hodge VB	6105	86	15.1	79.1	35.5	49	89	74	1.0
Parata	6054	85	15.3	79.5	36.0	48	85	81	1.0
AAC Magnet	5772	81	14.8	77.7	37.1	48	90	76	1.0
PT5003	6224	88	13.8	77.6	37.0	48	84	77	1.0
AAC Tomkins	6023	85	14.6	77.9	37.2	48	88	74	1.0

AAC Wheatland VB	7040	99	14.2	81.2	38.2	49	90	76	1.0
BW5062	6853	97	14.2	77.7	36.9	49	89	74	1.0
BW1093	6005	85	14.6	78.1	35.3	49	88	76	1.0
SY Natron	6419	91	12.9	79.4	36.3	48	87	83	1.0
Ellerslie	5335	75	14.0	76.2	33.1	48	87	79	1.0
SY Chert VB	4599	65	14.1	79.9	36.8	49	91	83	1.0
PT598	6108	86	14.2	79.1	37.3	49	90	69	1.0
LSD (0.05)	6335		14.2	79.1	37.0	49	88	79	
CV (%)	7.7		6.5	0.9	3.4	1.4	2.6	3.2	

Table 2. Saskatchewan Variety Performance Group Irrigated Hex 2 Wheat Regional Variety Trial, ICDC Off-Station Pederson Site, 2021.

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)									
AAC Brandon	***7100***	***100***	***14.7***	***81.9***	***36.6***	***50***	***90***	***77***	1.0
Carberry	5459	77	15.6	79.2	36.6	49	93	74	1.0
Sheba	6179	113	13.6	80.6	34.5	50	90	79	1.0
Canada Prairie Spring – Red (CPSR)									
CDC Reign	7029	99	14.2	81.2	37.6	53	93	79	1.0
SY Rorke	7361	135	13.3	79.8	37.6	49	95	76	1.0
Accelerate	6752	109	14.2	79.0	34.7	48	90	69	1.0
Canada Western Special Purpose (CWSP)									
WPB Whistler	7755	109	11.4	77.0	41.3	53	97	75	1.0
Experimental Entries									
HY2095	5777	81	12.7	78.7	44.2	51	90	72	1.0
HY2082	7144	131	12.7	79.4	41.5	52	93	73	1.0
LSD (0.05)	6729		13.6	79.6	38.3	51	92	75	
CV (%)	4.2		2.3	0.9	2.8	0.6	1.8	3.7	

Table 3. Soft White Spring Wheat Irrigated Coop Variety Trial, ICDC Off-Station Pederson Site, 2021.

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	4926	54.0	13.5	79.3	36.9	48	90	67.4	1.0
AAC Brandon	6328.8	69.4	13.1	80.4	39.0	50	88	71.7	1.0
AC Andrew (SWS 241)	9116.9	100.0	11.2	77.0	39.5	51	94	77.8	1.0
Sadash (SWS 349)	7911.1	86.8	12.1	79.1	43.9	51	96	79.3	1.0
SWS499	8560.8	93.9	12.1	78.3	45.1	53	95	75.5	1.0
SWS505	7999.8	87.7	11.7	79.5	44.6	51	94	76.3	1.0
SWS484	9143.4	100.3	11.0	78.7	43.8	52	100	83.9	1.0
SWS500	8655.8	94.9	10.8	77.6	41.8	53	98	79.0	1.0
SWS488	8804.1	96.6	11.4	77.1	47.2	51	100	84.8	1.0
SWS501	8587.7	94.2	11.2	77.4	45.5	52	93	79.9	1.0
SWS496	8968.3	98.4	11.3	77.3	45.0	52	98	80.3	1.0
SWS503	7865.2	86.3	11.4	79.6	43.6	51	94	77.0	1.0
SWS502	8525.5	93.5	11.3	77.8	46.3	52	92	79.9	1.0
SWS490	9114.9	100.0	11.7	80.0	44.4	53	100	85.6	1.0
SWS504	7836.0	86.0	11.8	79.0	43.8	51	95	76.8	1.0
SWS427	9674.0	106.1	11.3	79.6	46.7	56	101	88.4	1.0
SWS497	8440.9	92.6	11.0	78.5	41.9	53	96	83.3	1.0
SWS498	8931.5	98.0	10.6	77.0	43.9	52	98	77.6	1.0
LSD (0.05)	0.0001		0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	
CV (%)	4.87		3.3	0.95	3.37	0.82	2.55	2.07	

Table 4. Saskatchewan Variety Performance Group Irrigated CWAD Wheat Regional Variety Trial, Off-Station Pederson Site 2021.

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
Pederson Site									
Carberry	4827.3	85.7	12.3	80.2	33.9	49	87	72.0	1.0
Strongfield	5634.0	100.0	15.2	80.1	38.3	52	92	83.3	1.0
AAC Brandon	6169.3	109.5	14.3	80.8	35.3	49	91	76.2	1.0
DT1014	7108.6	126.2	14.0	82.9	39.7	53	93	91.3	1.3

AAC Donlow	7100.5	126.0	13.7	81.9	39.0	52	94	86.7	1.3
DT2009	7144.1	126.8	14.2	81.8	42.1	53	94	90.3	1.3
CDC Precision	6465.6	114.8	15.2	80.8	42.4	52	96	86.7	1.3
AAC Succeed VB	6820.5	121.1	14.5	79.7	37.8	53	92	90.2	1.0
AAC Goldnet	6687.7	118.7	14.7	81.3	42.4	52	95	92.2	1.7
DT1011	6992.0	124.1	13.4	82.0	37.0	52	96	87.0	1.0
CDC Covert	6388.6	113.4	14.2	80.6	38.4	52	94	81.2	1.0
AAC weyburn VB	7270.0	129.0	13.4	81.2	38.9	53	95	90.0	1.3
DT1012	7215.6	128.1	13.3	80.2	41.1	57	98	85.7	1.0
AAC grainland	6191.1	109.9	15.2	79.0	39.9	52	97	89.5	1.0
CDC Flare	6412.3	113.8	14.2	78.3	36.7	50	93	85.3	1.0
CDC Defy	7240.6	128.5	13.3	81.9	38.2	50	93	95.3	1.0
LSD (0.05)	6604.2		14.1	80.8	38.8	51.9	93.8	86.4	1.1
CV (%)	7.7		4.6	1.0	4.1	0.8	1.6	4.5	29.6

NS = Not Significant

Table 5. Saskatchewan Variety Performance Group Irrigated CWAD Wheat Regional Variety Trial, ICDC Area 51 Site, 2021.

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**
ICDC Site									
Carberry	6582.7	104.0	15.6	79.3	38.1	NC	101	84.3	1.0
Strongfield	6331	100.0	13.8	81.2	44.5	NC	101	96.2	1
AAC Brandon	6553.7	103.5	15.1	80.3	38.2	NC	100	85.2	1.7
DT1014	7173.3	113.3	13.9	82.0	42.8	NC	100	105.5	1.0
AAC Donlow	7087.3	111.9	12.9	80.8	43.0	NC	103	101.8	1.7
DT2009	7321.7	115.6	13.7	81.1	45.8	NC	102	108.7	1.0
CDC Precision	6355	100.4	13.6	80.8	44.6	NC	102	95.5	1.0

AAC Succeed VB	6692.7	105.7	14.4	79.7	49.3	NC	101	100.0	1.3
AAC Goldnet	6831.3	107.9	14.0	80.8	43.6	NC	101	104.5	1.3
DT1011	7251	114.5	13.5	80.7	43.5	NC	103	101.5	1.0
CDC Covert	6628.7	104.7	13.4	80.5	41.0	NC	100	100.7	1.0
AAC Weyburn VB	6625.7	104.7	13.3	80.5	42.4	NC	100	103.5	1.0
DT1012	7543.7	119.2	12.9	78.3	40.0	NC	105	95.5	1.0
AAC grainland	6194.7	97.8	14.6	79.3	42.6	NC	101	102.7	1.3
CDC Flare	6912.7	109.2	13.9	79.3	46.3	NC	99	97.7	1.0
CDC Defy	7199.3	113.7	13.2	81.0	42.2	NC	100	109.5	1.0
LSD (0.05)	0.1989		0.0001	0.0002			0.0102	0.0001	0.7285
CV (%)	8.45		4.15	0.93	3.44		1.57	3.1	42.6

NS = Not Significant
NC = Observation not captured

Table 6. Saskatchewan Variety Performance Group Irrigated CWAD Wheat Regional Variety trial, Combined Site Analysis, 2021.

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
Pederson Site	6830.3	114.2	13.9	80.3	43.0	NA	101	99.9	1.1
Area 51	6604.2	110.4	14.1	80.8	38.8	NA	94	86.7	1.1
LSD (0.05)	NS		NS	NS	0.0001		0.0001	0.0010	NS
CV (%)	10.96		6.83	1.52	1.84		3	7.7	
Variety									
Carberry	5705	95.4	14.0	79.8	36.0	NA	94	78.5	1.0
Strongfield	5982.5	100	14.5	80.7	41.4	NA	97	90.2	1.0
AAC Brandon	6361.5	106.3	14.7	80.5	36.8	NA	95	80.8	1.0

DT1014	7140.9	119.4	14.0	82.4	41.2	NA	97	98.5	1.0
AAC Donlow	7093.9	118.6	13.3	81.4	41.0	NA	98	94.7	2.0
DT2009	7232.8	120.9	14.0	81.5	43.9	NA	98	99.8	1.0
CDC Precision	6410.3	107.2	14.4	80.8	43.5	NA	99	91.5	1.0
AAC Succeed VB	6756.6	112.9	14.5	79.7	43.6	NA	97	95.3	1.0
AAC Goldnet	6759.6	113.0	14.4	81.1	43.0	NA	98	98.5	1.0
DT1011	7121.5	119.0	13.5	81.4	40.3	NA	100	94.5	1.0
CDC Covert	6508.7	108.8	13.8	80.6	39.7	NA	97	91.2	1.0
AAC Weyburn VB	6947.8	116.1	13.3	80.9	40.6	NA	98	97.0	2.0
DT1012	7379.6	123.4	13.1	79.3	40.5	NA	101	90.8	1.0
AAC Grainland	6192.8	103.5	14.9	79.2	41.3	NA	99	96.5	1.0
CDC Flare	6662.6	111.4	14.0	78.8	41.5	NA	96	91.8	1.0
CDC Defy	7220.1	120.7	13.2	81.5	40.2	NA	97	102.7	1.0
LSD (0.05)	0.0001		0.0029	0.0015	0.0015		0.5695	0.0001	NS
Location x Variety Interaction									
LSD (0.05)	NS		NS	NS	S		S	S	NS

S = Significant
NS = Not Significant
NA = Observation not analysed

Table 7. Saskatchewan Variety Performance Group Irrigated 2-Row Barley Regional Variety Trial, ICDC Off-Station Pederson Site, 2021.

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	***8708***		***11.1***	***68.4***	***47.7***	***60***	***80***		***1.0***
AAC Synergy	9867	113	11.1	67.2	51.8	62	80		1.0
CDC Copeland	10119	116	10.4	66.2	49.0	61	80		1.0
AB BrewNet	9699	111	10.4	64.8	44.5	63	84		1.0
CDC Copper	9821	113	10.7	65.2	48.3	59	81		2.0
AAC Connect	9019	104	11.2	66.9	49.6	62	80		1.0
CDC Bow	9272	106	11.3	67.0	47.9	62	80		1.0
CDC Churchill	9834	113	10.4	67.5	49.7	65	80		1.0
CDC Fraser	9635	111	10.6	65.9	52.1	60	81		1.0
Feed-Hulled									
AB Advantage	8970	103	11.2	63.9	51.6	53	80		1.0
AB Cattlelac	9359	107	11.2	65.5	42.6	55	82		1.0
AB Tofield	11409	131	9.8	64.3	45.4	56	82		1.0
AB Wrangler	9743	112	10.4	65.9	48.7	56	80		1.3
Other (malting market may exist)									
CDC Goldstar	9263	106	10.9	67.0	48.2	62	79		1.0
KWS Coralie	9589	110	10.5	64.1	52.3	65	83		1.0
AB Hague	9857	113	10.0	68.1	47.7	61	82		1.0
AB Prime	8871	102	10.3	65.9	48.9	56	81		1.0
KWS Kellie	9340	107	10.0	66.1	52.8	67	81		1.0
Esma	9402	108	11.0	66.9	53.0	61	81		1.0
CDC Renegade	9302	107	10.6	66.7	56.5	57	82		2.3
RGT Planet	8956	103	10.5	66.6	49.6	60	81		1.0
Torbellino	9249	106	10.6	66.1	50.0	64	81		1.0
Experimental Entries									
TR19175	10260	118	11.0	68.7	51.3	65	82		1.0
TR18749	9780	112	10.5	68.2	52.3	61	81		1.0

TR19758	9861	113	10.2	68.5	49.8	57	81		1.0
TR18747	10345	119	10.2	68.9	52.7	57	81		1.0
TR17255	9147	105	11.1	67.1	48.5	63	78		1.0
TR18748	9765	112	10.5	67.4	50.0	56	80		1.0
LSD (0.05)	178.1		10.6	66.6	49.7	60.2	80.7		
CV (%)	5.88		2.74	1.33	3.69	3.88	1.03		

Table 8. Saskatchewan Variety Performance Group Irrigated Oats Regional Variety Trial, ICDC Off-Station Pederson Site, 2020.

Variety	**Yield (kg/ha)**	**Yield % of CS Camden**	**Protein (%)**	**Test weight (kg/hl)**	**1K Seed weight (gm)**	**Heading (days)**	**Maturity (days)**	**Height (cm)**	**Lodging 1=erect; 9=flat**
AAC Douglas	5644.8	94.6	12.9	48.8	37.9	52	80	76.3	1
Alka	6499.4	108.9	13.0	50.7	38.0	53	83	81.2	1
CDC Arborg	7143.9	119.7	12.8	51.2	38.0	53	81	89.0	1
CDC Endure	6090.1	102.1	12.4	50.1	37.8	53	80	83.7	1
CDC Skye	5581.6	93.5	13.1	51.9	35.3	52	83	82.3	1
CS Camden	**5966.8**	**100**	**13.8**	**48.8**	**39.4**	**52**	**78**	**79.8**	**1**
Kalio	6721.9	112.7	12.4	51.5	36.4	52	81	91.7	1
Kyron	4887.3	81.9	12.9	49.0	37.4	57	85	83.2	1
ORe Level 48	5117.8	85.8	12.9	51.4	38.3	53	84	76.8	1
ORe Level 50	5544.2	92.9	12.6	51.4	41.8	53	84	77.0	1
OT2129	5888	98.7	12.2	48.4	34.7	53	83	73.8	1
LSD (0.05)	0.0001		0.0001	0.0001	0.003	0.0001	0.0088	0.0001	
CV (%)	8.27		1.41	1.68	3.85	0.73	2.5	4.13	

Central Bread Wheat Irrigated Coop Trials

Funding

Funded by SeCan

Principal Investigators

- Garry Hnatowich, PAg, Research Director, ICDC
- Gursahib Singh, PhD, PAg, Co-Research Director, ICDC

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- AAFC Brandon – Dr. Santosh Kumar
- SeCan – Jim Downey

Objectives

The objectives of this study were to:

(1) Evaluate experimental CWRS wheat 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 Central Bread Wheat Irrigated Coop trial was seeded on May 17, 2021 at the ICDC Pederson off-station location. The trial was comprised of primarily experimental classes of bread wheat with 30 entries. The trial was arranged in a 5 x 6 lattice design with three replicates and plot size was 1.5 m x 4.0 m. The trial was conducted under both dryland and irrigated conditions.

Nitrogen fertilizer (urea, 46-0-0) was side-banded at a rate of 90 kg N/ha and phosphorous (monoammonium phosphate (MAP), 12-51-0) was seed-placed at a rate of 25 kg P_2O_5/ha. Weed control consisted of a post-emergence tank mix application of Simplicity™ (pyroxsulam; 28 g/ac) and Buctril® M (bromoxynil + MCPA ester; 0.4 L/ac). A foliar fungicide application of Priaxor (fluxapyroxad + pyraclostrobin) was applied July 8. The dryland trial was harvested on August 11, the irrigated on September 7, 2021. 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%. Harvested samples were cleaned and yields were adjusted to a moisture content of 14.5%.

In-season precipitation from mid-May through August was 106.5 mm (4.2”), in-season irrigation at Pederson was 208.3 mm (8.2”).

Results

The CBWC results are shown in Table 1.

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 varieties suited to irrigated 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 2021”*.

These trials will be discontinued in 2022.

Table 1. Central Bread Wheat Irrigated & Dryland Coop Trial, ICDC Off-Station Pederson Location, 2021.

Trt	Variety/Entry	Dryland				Irrigated			
		Yield (kg/ha)	Yield (bu/ac)	Days to Mature	Height (cm)	Yield (kg/ha)	Yield (bu/ac)	Days to Mature	Height (cm)
1	Unity	984	14.6	75	43	6532	97.1	88	87
2	Glenn	1072	15.9	75	45	6346	94.3	90	80
3	Carberry	1402	20.8	75	46	5677	84.4	91	80
4	AAC Viewfield	1099	16.3	75	39	7539	112.1	89	74
5	AAC Brandon	1569	23.3	75	44	7157	106.4	89	77
6	Faller	732	10.9	75	37	7387	109.8	90	81
7	BW1094	1041	15.5	75	38	6896	102.5	91	79
8	BW11103	1030	15.3	75	43	6151	91.4	90	82
9	BW1106	1014	15.1	75	44	6589	97.9	91	77
10	BW1111	1393	20.7	75	39	6827	101.5	90	75
11	BW1112	1286	19.1	75	39	7447	110.7	90	74
12	BW1113	963	14.3	75	41	7538	112.1	91	79
13	BW1116	914	13.6	75	39	7152	106.3	91	80
14	BW1117	1187	17.7	75	38	7217	107.3	91	76
15	BW1118	1208	17.9	75	36	6689	99.5	92	72
16	BW11125	1383	20.6	75	44	7142	106.2	91	77
17	BW1126	1621	24.1	75	43	7528	111.9	90	81
18	BW1127	1652	24.5	75	44	7672	114.1	91	76
19	BW1128	1367	20.3	75	43	7542	112.1	90	80
20	BW1129	1056	15.7	75	41	6987	103.9	91	75
21	BW1130	1150	17.1	75	42	6997	104.0	92	77
22	BW1131	1387	20.6	75	44	7168	106.6	89	82
23	BW1132	1180	17.6	75	40	7167	106.6	91	75
24	BW1133	1309	19.4	75	44	6943	103.2	91	76
25	BW1134	1095	16.3	75	42	7231	107.5	90	78
26	BW1135	916	13.6	75	41	6972	103.7	90	75
27	BW1136	939	14.0	75	40	6117	90.9	89	76
28	BW1137	998	14.9	75	39	6717	99.8	90	78
29	BW1138	1055	115.7	75	39	6931	103.0	91	69
30	ND Frohberg	718	10.7	75	40	5023	74.7	88	80
	LSD (0.05)	506	7.5	-	5.7	811	12.1	2.0	2.3
	CV (%)	26.8	26.8	-	8.4	7.2	7.2	1.3	3.7

Winter Wheat Variety Evaluation for Irrigation vs. Dryland Production

Funding

Funded by the Saskatchewan Winter Cereal Development Commission and ICDC

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Outlook
- Agriculture & Agri-food Canada (AAFC), Lethbridge

Project Lead

- Project Leads: Garry Hnatowich & Gursahib Singh (ICDC)
- AAFC-Lethbridge Lead: Dr. Robert Graf

Objectives

This project's objective is to identify the top producing or best adapted varieties of winter wheat for irrigated production. Until recently, winter wheat varieties had not been evaluated for their irrigation production potential for approximately 25 years. At that time, no variety 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. Robert Graf (AAFC-Lethbridge). On September 11, 2020, varieties were direct seeded into canola stubble on ICDC land rented from the Town of Outlook and adjacent to the federal CSIDC Research Station (Field 51). Winter wheat varieties were established in a complete randomized block design with 3 replicates. All varieties were evaluated under both irrigated and dryland production systems.

At seeding, each trial received 200 kg N/ha as side-banded urea (46-0-0), 30 kg P_2O_5/ha as side-banded monoammonium phosphate (MAP; 11-52-0), and an additional 30 kg P_2O_5/ha as seed-placed MAP. Weed control consisted of a post-emergence application of Buctril® M (bromoxynil + MCPA ester; 0.4 L/ac). Foliar fungicides were not applied for 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%. The dryland trial was harvested on July 22, irrigated on July 29, 2021. Harvest samples were cleaned and yields were adjusted to a moisture content of 14.5%.

Total in-season precipitation was 67.5 mm (2.7") and an additional 233.7 mm (9.2") of in-season irrigation was applied to the irrigated trial. The season was warmer than historic average and very, very dry.

Results

Irrigated Trial

Experimental line W563 yielded the highest and AAC Gateway yielded the lowest. Yields of the 12 varieties ranged from 5358 kg/ha to 6506 kg/ha (79.6 bu/ac to 96.7 bu/ac), with a mean yield of 6125 kg/ha (91.1 bu/ac). Grain protein content was highest in AAC Gateway (12.8%) and the lowest in W563 (10.5%), exhibiting an inverse relationship to yields obtained. Mean test weight was 80.8 kg/hl, with CDC Buteo the heaviest at 82.3 kg/hl and experimental line W563 the lightest at 79.7 kg/hl. For all evaluated varieties, mean seed weight was 29.0 g/1,000 seeds. Heading occurred over a 5-day period, with AAC Gateway being the earliest and AAC Icefield being the latest. By maturity there was only a 3-day difference between varieties, likely hastened by an extremely hot July.

CDC Buteo was the tallest variety (89 cm) and AAC Gateway the shortest variety (74 cm), while the mean height of all varieties was 82 cm. Plant height in 2021 was shorter than normal, again attributed to environmental conditions. There was no incidence of lodging in any plots.

Table 3. Winter Wheat Variety Evaluation, Irrigated 2021

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	6015	100	10.9	82.3	31.3	June 12	July 20	89	1.0
Moats	5987	100	12.3	80.0	26.8	June 13	July 20	88	1.0
AAC Gateway	5358	89	12.8	80.4	27.2	June 11	July 21	74	1.0
AAC Elevate	6375	106	10.7	80.2	31.0	June 12	July 19	81	1.0
Emerson	5950	99	12.1	80.8	25.7	June 12	July 21	83	1.0
Radiant	6399	106	10.9	81.7	29.8	June 12	July 21	88	1.0
AAC Icefield	6154	102	11.4	82.0	26.8	June 17	July 22	77	1.0
AAC Wildfire	6347	106	10.7	80.1	32.0	June 15	July 21	82	1.0
AAC Goldrush	5690	95	11.9	80.9	29.7	June 14	July 19	85	1.0
AAC Network	6424	107	10.8	81.1	29.1	June 12	July 22	76	1.0
W563	6506	108	10.5	79.7	29.2	June 12	July 21	82	1.0
W583	6299	105	11.3	80.2	29.3	June 12	July 19	81	1.0
LSD (0.05)	720		1.0	1.3	3.6	1.6 days	1.4 days	3.7	NS
CV (%)	6.9		5.4	1.0	7.3	0.6	0.4	2.7	-

* Yield not significant at $P \leq 0.05$ but significant at $P \leq 0.10$
NS = not significant

Dryland Trial

AAC Elevate yielded the highest and AAC Gateway yielded the lowest. Yields of the 12 varieties ranged from 2421 kg/ha to 3442 kg/ha (36.0 bu/ac to 51.2 bu/ac), with a mean yield of 2882 kg/ha (42.8 bu/ac). These yields are approximately half the expected yield and reflect the drought conditions of 2021.

Between varieties, differences in protein, test weight, seed weight, heading, maturity, and height were statistically significant (Table 4, ANOVA, $P \leq 0.05$). Grain protein content was highest in experimental W583 (16.2%) and the lowest in AAC Elevate (13.2%), while the average protein content of all varieties was 15.0%. The very high proteins obtained again reflect the very low drought induced yields achieved. For all evaluated varieties, mean test weight was 72.8 kg/hl and mean seed weight was 19.2 g/1,000 seeds. Seed size was very small and higher than typical combine losses were observed. Heading occurred over a 3-day period, with Emerson being the earliest and AAC Icefield being the latest. Similar to heading, maturity was spread over a narrow 2-day period, with AAC Elevate being the earliest and AAC Icefield being the latest. Moats was the tallest variety (82 cm) and AAC Gateway was the shortest variety (67 cm), while the mean height of all varieties was 76 cm. There was no incidence of lodging in any plots.

Table 4. Winter Wheat Variety Evaluation, Dryland 2021

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	**2825**	**100**	**15.1**	**74.9**	**18.8**	**June 14**	**July 11**	**81**	**1.0**
Moats	2756	98	15.8	70.9	18.3	June 12	July 11	82	1.0
AAC Gateway	2421	86	15.6	74.5	19.7	June 12	July 11	67	1.0
AAC Elevate	3442	122	13.2	74.4	22.0	June 12	July 11	75	1.0
Emerson	3085	109	14.9	75.4	17.1	June 12	July 11	79	1.0
Radiant	3094	110	14.8	73.2	20.2	June 14	July 13	81	1.0
AAC Icefield	2487	88	14.2	73.2	19.4	June 15	July 13	71	1.0
AAC Wildfire	2450	87	15.9	69.5	18.2	June 15	July 13	76	1.0
AAC Goldrush	2811	100	15.9	73.2	19.6	June 14	July 11	78	1.0
AAC Network	3397	120	14.4	73.4	19.5	June 13	July 13	73	1.0
W563	3285	116	14.2	70.9	19.7	June 14	July 12	78	1.0
W583	2528	89	16.2	70.6	18.4	June 13	July 11	76	1.0
LSD (0.05)	562		1.1	2.5	2.0	1.6 days	1.6 days	3.4	NS
CV (%)	11.5		4.3	2.1	6.1	0.6	0.5	2.6	-

NS = not significant

Irrigated vs. Dryland

Most measurements were statistically higher under irrigation as compared to dryland systems. The mean yield of all varieties grown under irrigated production were statistically higher yielding than the mean yield of those grown under dryland production (Table 5, ANOVA, $P \leq 0.05$). On average, the irrigated site produced 3243 kg/ha (48.2 bu/ac) more winter wheat grain yield, or greater than 2X the production compared to the dryland site. Protein content was statistically higher in dryland conditions by close to 4% points. Test weight was 8 kg/hl higher and seed size 51% higher. Irrigation required 8 days longer to mature and plants were taller.

Table 5. Winter Wheat Variety Evaluation, Irrigated vs Dryland 2021

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	6125	100	11.4	80.8	29.0	June 13	July 20	82	1.0
Dryland	2882	47	15.0	72.8	19.2	June 13	July 12	76	1.0
LSD (0.05)	783		0.4	0.9	0.7	NS		2.0	NS
CV (%)	8.5		4.8	1.5	7.1	0.6	0.5	2.7	-
Variety									
CDC Buteo	**4420**	**100**	**13.0**	**78.6**	**25.1**	**June 13**	**July 16**	**85**	**1.0**
Moats	4371	99	14.1	75.5	22.5	June 13	July 16	85	1.0
AAC Gateway	3889	89	14.2	77.5	23.5	June 12	July 16	70	1.0
AAC Elevate	4908	111	12.0	77.3	26.5	June 12	July 15	78	1.0
Emerson	4518	102	13.5	78.1	21.4	June 12	July 16	81	1.0
Radiant	4746	107	12.9	77.5	25.0	June 13	July 17	84	1.0
AAC Icefield	4321	98	12.8	77.6	23.1	June 16	July 18	74	1.0
AAC Wildfire	4399	100	13.3	74.8	25.1	June 15	July 17	79	1.0
AAC Goldrush	4250	96	13.9	77.1	24.7	June 14	July 15	81	1.0
AAC Network	4910	111	12.6	77.2	24.3	June 13	July 17	75	1.0
W563	4896	111	12.4	75.3	24.4	June 13	July 17	80	1.0
W583	4413	100	13.8	75.4	23.9	June 12	July 15	79	1.0
LSD (0.05)	444		0.7	1.4	2.0	1.1 days	1.0 days	2.4	-
Production System x Variety Interaction									
LSD (0.05)	NS		S	S	NS	S	NS	NS	-

S = significant at $P < 0.05$
NS = not significant

Acknowledgements

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Fall Rye Variety Evaluation for Irrigation vs. Dryland

Funding

Funded by the Saskatchewan Winter Cereal Development Commission and ICDC

Organizations

- Saskatchewan Ministry of Agriculture (SMOA), Outlook
- Irrigation Crop Diversification Corporation (ICDC), Outlook
- Agriculture & Agri-Food Canada (AAFC), Lethbridge

Project Lead

- Project Leads: Garry Hnatowich & Gursahib Singh (ICDC)
- AAFC-Lethbridge Lead: Raja Ragupathy

Objectives

This demonstration provided local producers a yield 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 seven fall rye (2 conventional and 5 hybrid) varieties were acquired from fall rye breeder Dr. Raja Ragupathy (AAFC-Lethbridge). On September 11, 2020, varieties were direct seeded into canola stubble on ICDC land rented from the Town of Outlook and adjacent to the federal CSIDC Research Station (Field 51). Fall rye varieties were established in a complete randomized block design with 3 replicates. All varieties are evaluated under both irrigated and dryland production systems. At seeding, each trial received 200 kg N/ha as side-banded urea (46-0-0), 30 kg P_2O_5/ha as side-banded monoammonium phosphate (MAP; 11-52-0), and an additional 30 kg P_2O_5/ha as seed-placed MAP.

Weed control consisted of a post-emergence application of Buctril® M (bromoxynil + MCPA ester, 0.4 L/ac) on May 26. 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. The dryland trial was harvest on July 29, the irrigated the following day, July 30, 2021. Harvested samples were cleaned and yields were adjusted to a moisture content of 14.5%.

Total in-season precipitation was 67.5 mm (2.7") and an additional 233.7 mm (9.2") of in-season irrigation was applied to the irrigated trial. The season was warmer than historic average and very, very dry.

Results

Irrigated Trial

Under irrigated production, varietal differences in yield, seed weight, and days to maturity were statistically significant (Table 3, ANOVA, $P \leq 0.05$). Grain protein and test weight (not shown) were statistically significant at $P \leq 0.10$. The hybrid variety KWS Serafino yielded the highest and the conventional variety Prima yielded the lowest. Yields of the 7 varieties ranged from 6799 kg/ha to 8922 kg/ha (108.3 bu/ac to 142.1 bu/ac), with a mean yield of 8347 kg/ha (132.9 bu/ac). All hybrid varieties were statistically higher yielding than the two open-pollinated conventional varieties. Hazlet was statistically higher yielding than Prima. On average, the hybrid varieties were approximately 26%

higher yielding than the conventional varieties. Grain protein content was highest in KWS Gatano (10.8%), the lowest in Prima (10.0%), and averaged 10.4% across all varieties. Mean test weight was 72.8 kg/hl, with Prima the heaviest at 74.3 kg/hl and KWS Serafino the lightest at 71.9 kg/hl (data not shown). For all evaluated varieties, mean seed weight was 33.0 g/1,000 seeds. Maturity was spread over a 4-day period, with Prima being the earliest and KWS Daniello being the latest. KWS Gatano was the shortest variety, Prima the tallest. No plant lodging or presence of ergot occurred in 2021.

Table 3. Fall Rye Variety Evaluation, Irrigation Site, 2021.

Variety	**Yield (kg/ha)**	**Yield (bu/ac)**	**Protein (%)**	**Seed Weight (mg)**	**Date of Maturity**	**Height (cm)**	**Lodging 1=erect; 9=flat**	**Ergot (%)**
Open-Pollinated Conventional Varieties								
Hazlet	7293	116.2	10.2	35.6	July 24	104	1.0	0
Prima	6799	108.3	10.0	28.8	July 20	121	1.0	0
Hybrid Varieties								
Bono	8907	141.9	10.4	33.8	July 22	96	1.0	0
KWS Gatano	8896	141.7	10.8	33.2	July 24	96	1.0	0
KWS Serafino	8922	142.1	10.5	33.1	July 23	98	1.0	0
KWS Daniello	8790	140.0	10.6	32.0	July 24	97	1.0	0
KWS Trebiano	8821	140.5	10.3	34.8	July 21	105	1.0	0
LSD (0.05)	428	6.8	NS	1.9	2.4 days	5.3	NS	NS
CV (%)	2.9	2.9	2.9	3.2	0.7	2.9	-	-

NS = not significant

Dryland Trial

Under dryland production, varietal differences in yield, maturity and plant height were statistically significant (Table 4, ANOVA, $P \leq 0.05$). KWS Gatano yielded the highest and Hazlet yielded the lowest. Yields of the 7 varieties ranged from 4356 kg/ha to 5462 kg/ha (69.3 bu/ac to 87.0 bu/ac), with a mean yield of 498979.5 kg/ha (102.2 bu/ac). Fall rye dryland yields in 2021 were substantially lower than historic at ICDC. On average, the hybrid varieties were approximately 19% higher yielding than the conventional varieties. Grain protein content was highest in KWS Sarafino (11.9%), the lowest in KWS Trebliano and KWS Gatano (11.5%), and averaged 11.3% across all varieties. Mean test weight was 71.6 kg/hl, with Hazlet the heaviest at 72.2 kg/hl and KWS Gatano the lightest at 71.1 kg/hl. For all evaluated varieties, mean seed weight was 21.8 g/1,000 seeds. Maturity was spread over a 11-day period, with Prima being the earliest and KWS Gatano being the latest. No plant lodging or presence of ergot occurred in 2021.

Table 4. Fall Rye Variety Evaluation, Dryland Site, 2021.

Variety	Yield (kg/ha)	Yield (bu/ac)	Protein (%)	Seed Weight (mg)	Date of Maturity	Height (cm)	Lodging 1=erect; 9=flat	Ergot (%)
Open-Pollinated Conventional Varieties								
Hazlet	4356	69.3	11.9	22.9	July 22	101	1.0	0
Prima	4426	70.7	11.9	20.0	July 13	118	1.0	0
Hybrid Varieties								
Bono	4931	78.7	11.9	21.3	July 23	98	1.0	0
Gatano	5462	87.0	11.5	21.5	July 24	95	1.0	0
Serafino	5233	83.3	11.9	20.7	July 24	102	1.0	0
Daniello	5151	82.0	11.6	23.6	July 23	97	1.0	0
Trebiano	5366	85.7	11.5	22.5	July 23	103	1.0	0
LSD (0.05)	727	11.9	NS	NS	1.2 days	5.4	NS	NS
CV (%)	8.2	8.2	3.4	1.5	0.3	3.0	-	-

NS = not significant

<u>Irrigated vs. Dryland</u>

The mean yield of all varieties grown under irrigated production were statistically higher yielding than the mean yield of those grown under dryland production (Table 5, ANOVA, $P \leq 0.05$). On average, the irrigated site produced 3358 kg/ha (53.5 bu/ac) more fall rye grain yield, or 67% greater production, than the dryland site, under drought conditions. Protein content was higher under the dryland, drought conditions. Test weight and seed weights statistically higher with irrigated vs dryland systems. Interesting varieties matured similarly under both moisture regimes and were similar in plant height.

When data from both the irrigated and dryland sites were combined, the hybrid varieties had a clear yield advantage - averaging a yield increase of 21.2 bu/ac - over the conventional varieties.

Table 5. Fall Rye Variety Evaluation, Irrigation versus Dryland, 2021.

System / Variety	Yield (kg/ha)	Yield (bu/ac)	Protein (%)	Seed Weight (mg)	Date of Maturity	Height (cm)	Lodging 1=erect; 9=flat	Ergot (%)
Production System								
Irrigated	8347	133.0	10.4	33.0	July 22	102	1.0	0
Dryland	4989	79.5	11.7	21.8	July 22	102	1.0	0
LSD (0.06)	385	6.0	0.6	4.2	NS	NS	NS	NS
CV (%)	5.0	5.0	3.2	5.5	0.5	3.0	-	-
Varieties								
Open-Pollinated Conventional Varieties								
Hazlet	5824	92.8	11.1	29.3	July 22	102	1.0	0
Prima	5613	89.5	10.9	24.4	July 17	119	1.0	0
Hybrid Varieties								
Bono	6919	110.3	11.1	27.5	July 22	97	1.0	0
Gatano	7179	114.4	11.2	27.3	July 24	95	1.0	0
Serafino	7077	112.7	11.2	26.9	July 24	100	1.0	0
Daniello	6971	111.0	11.1	27.8	July 24	97	1.0	0
Trebiano	7093	113.1	10.9	28.7	July 22	104	1.0	0
LSD (0.05)	399	6.5	NS	1.8	1.3 days	3.6	NS	NS
Production System x Variety Interaction								
LSD (0.05)	S	S	NS	NS	S	NS	NS	NS

S = significant at $P < 0.05$
NS = not significant

Discussion

This project showed irrigators in Saskatchewan that fall rye benefits greatly from irrigation and the newer hybrid varieties have a yield advantage. Despite the high cost of hybrid fall rye seed at approximately $69.60/acre (Government of Saskatchewan, 2020a), its 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.

This trial was continued with 7 fall rye entries seeded in October 2021.

Saskatchewan Dry Bean Wide and Narrow Row Regional Variety Trial

Funding

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

Project Lead

- Garry Hnatowich & Gursahib Singh
- 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 (10 inch) and Wide Row (20 inch) Regional variety trial was conducted in the spring of 2021 at ICDC off-station Pederson location. The trial was seeded May 27. Eight 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 20 kg P_2O_5/ha during the seeding operation. Granular inoculant was unavailable, so nitrogen requirements were met by supplemental side banding urea, applied and irrigated immediately, for a total application of 35 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.
No foliar fungicides were applied for either powdery mildew, mycosphaerella, downy mildew and white mold. Individual plots measured 0.8 m x 4 m with six rows in narrow row spacing and three rows in wide row spacing. 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 106.5 mm and in-season irrigation at Pederson was 208.3 mm (8.2”)

General observations of the 2021 growing season are warranted. The 2021 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.

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	55	60	91.7
June	317	242	131.0
July	677	510	132.7
August	922	754	122.3
September	1054	821	128.4

Results

Pederson

Results of the trials are shown in Table 1 for Pederson under wide and 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. The mean yield, protein, test weight and seed weight among wide row and narrow row production system were not statically different.

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 and Wide Row Regional Variety Trial, ICDC Off-Station Pederson Site, 2021.

Variety	Yield (kg/ha)	Yield (lb/ac)	Protein (%)	Test weight (kg/hl)	Seed weight (g/1000)	Flower (days)	Maturity (days)	Lodge rating 1=upright 5=flat	Height (cm)
Wide row									
Black									
CDC Blackstrap	4572.9	4078.8	24.9	79.5	293.5	46	93	1	43.5
Pinto									
CDC WM-3	3575.9	3189.5	24.3	78.8	379.9	46	91	1	45.2
Yellow									
CDC Sunburst	5256.9	4688.9	21.2	83.3	335.5	43	88	1	45.0
Cranberry									
OAC Racer	3969.7	3540.7	21.7	83.7	160.9	49	91	1	51.5
OAC Candycane	5358.9	4779.8	22.2	78.1	329.8	44	83	1	38.0
OAC Fusion	4318.8	3852.2	22.8	79.2	298.8	45	86	1	45.2
4767CBB-6-2	4701.3	4193.3	22.1	79.9	248.6	45	90	1	47.7
4910CBB-2	3355.7	2993.1	23.6	80.5	363.7	46	92	1	44.3

Flor de Junio									
CDC Ray	4246.8	3787.9	26.8	81.0	230.0	47	89	1	50.5
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS		NS
CV (%)	19.54		18.87	4.22	51.68	5.81	7.41		10.04
Narrow row									
Black									
CDC Blackstrap	3648.9	3254.6	30.9	79.8	189.5	48	89	1	48.3
Pinto									
CDC WM-3	4332.8	3864.6	22.3	80.0	394.3	44	87	1	49.0
Yellow									
CDC Sunburst	3324.2	2965.0	22.4	76.6	435.7	43	84	1	42.8
Cranberry									
OAC Racer	3324.2	2965.0	22.4	76.6	435.7	43	84	1	42.8
OAC Candycane	3785.6	3376.5	22.6	79.3	386.7	47	92	1	48.2
OAC Fusion	4676.6	4171.3	21.5	82.2	298.3	45	92	1	46.3
4767CBB-6-2	3852.3	3436.1	22.1	79.2	338.9	45	92	1	47.2
4910CBB-2	3486.9	3110.1	22.6	83.2	172.5	50	95	1	53.2
Flor de Junio									
CDC Ray	3766.4	3359.4	25.1	79.1	264.6	48	92	1	43.5
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS		NS
CV (%)	19.18		14.9	3.25	43.15	6.2	7.07		8.62

Herbicide Tolerant Soybean Regional Variety Trial

Funding

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

Project Lead

- Garry Hnatowich & Gursahib Singh
- 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 Pederson Site (NE17-28-07-W3): Bradwell fine sandy loam to loam (NW quadrant)

Soybean varieties were received through the Saskatchewan Pulse Growers for evaluation under irrigation production assessment. The trialing was divided into two separate trials based on maturity – a short season and a long season evaluation. Both short season trial and long season trial had 32 entries. These trials were established at the ICDC Pederson off-station location. Plot size was 1.2 m x 4 m. All plots received 20 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 7, under irrigated production. Weed control consisted of a pre-plant soil incorporated application of granular Edge (ethalfluralin). Weed pressure was low in the research site so no post-emergence herbicide was applied but plots were regularly hand weeded. 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 September 29. In-season precipitation from mid-May through September was 218 mm, in-season irrigation at Rudy Agro 274 mm.

Results

Short Season Herbicide Tolerant Variety Trial

Thirty-two Roundup Ready soybean varieties were evaluated. In both trails plant emergence and seedling development was poor. Seed yield, quality and agronomic data collected for the irrigated soybean are shown in Table 1. Yields were normal in 2021, with range of 2854.3 kg/ha (42.4 bu/ac) to

4978.5 kg/ha (74 bu/ac) and the median yield of all thirty-two entries of 3758 kg/ha (55.9 bu/ac). Oil content varied among entries with a 2.7% content difference between the lowest and highest % oil entries. Median protein content was 28.8%, very low. Protein concentration ranged from 27.5 – 33.1%. Seed weight also exhibited a wide variance between entries. All varieties were able to reach physical maturity and the plots were harvested on September 29. Average maturity for all the thirty variety was 121 days; NSC Dauphin RR2X was the earliest maturing (110 days) entry. Plant height varied among entries with the shortest at 69 cm to the tallest at 91 cm, median plant height of all varieties was 82 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)	Height (cm)	Maturity (days)	Lodge (1-5)
1	TH 33003R2Y	3519.1	17.2	31.2	75.1	156.1	85	124	1
2	Amirani R2	3304.5	17.4	31.9	75.3	174.7	86	121	1
3	B0012RX	4301.9	18.5	29.1	75.1	150.1	82	121	1
4	C4M17226 R2	4289.9	17.5	30.5	75.8	146.4	85	116	1
5	C4M19343 XT	3757.0	18.3	27.8	76.4	133.8	75	115	1
6	CP000521RX	3890.2	19.0	29.9	75.0	141.7	79	117	1
7	CP000621WPRX	4050.4	17.7	31.5	75.2	146.7	80	120	1
8	D1701-12	4525.8	17.6	30.5	76.3	164.8	88	117	1
9	Dextro R2X	4469.0	17.8	30.4	75.9	141.4	91	122	1
10	DKB0003-24	3320.4	18.5	29.4	73.7	145.3	80	118	1
11	DKB0008-87	4343.4	17.4	29.1	75.0	139.9	84	124	1
12	DKB0009-89	3737.2	17.2	29.4	76.5	158.8	89	123	1
13	EXP0005-21	3483.0	18.2	28.9	74.3	140.4	81	122	1
14	Fresco R2X	2881.3	17.1	33.1	76.1	172.4	84	121	1
15	Major R2X	3936.4	17.5	29.6	74.5	135.9	88	121	1
16	Mynarski R2X	3633.1	18.3	31.6	76.0	131.0	77	116	1
17	NSC Dauphin RR2X	3596.3	18.9	31.5	75.0	130.4	73	110	1
18	NSC EXP0007X	3470.5	17.0	29.7	76.0	172.2	75	121	1
19	NSC Watson RR2Y	3355.6	19.4	27.9	74.8	142.2	72	112	1
20	P001A48X	4210.2	18.5	28.6	75.3	146.8	78	118	1
21	PR159003Z	3165.8	17.4	29.2	74.9	116.3	75	156	1
22	PV 15s0009 R2X	4345.7	17.2	31.2	75.3	100.3	90	123	1
23	PV 20S0006 R2X	2854.3	17.0	31.3	74.4	161.0	80	124	1
24	PV 22s002 R2X	3981.3	16.8	28.4	75.7	151.3	84	124	1
25	PV EXP 21-C1	3759.4	17.9	30.7	74.7	157.1	70	120	1
26	PV EXP 21-C2	4871.2	18.1	28.4	75.4	131.8	89	121	1

27	PV EXP 21-C3	3400.2	16.7	30.4	75.4	159.0	87	124	1
28	S0009-F2X	3847.2	18.8	27.6	75.1	140.2	80	119	1.3
29	S0009-M2	4978.5	19.2	29.8	74.9	139.8	82	115	1
30	S001-D8X	4681.3	18.0	27.5	74.1	133.8	89	121	1
31	SV175069Z-01-06-11	3144.2	19.0	30.3	75.9	120.3	69	115	1
32	Young R2X	3236.7	17.2	30.3	74.9	166.8	85	122	1.7
LSD (0.05)		0.0145	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	NS
CV (%)		11.3	2.52	4.02	0.65	10.57	12.62	8.59	22.62

NS = not significant

Long Season Herbicide Tolerant Variety Trial

Thirty-two Roundup Ready soybean varieties were evaluated. Plant emergence and seedling development was again an issue. Seed yield, quality and agronomic data collected for the irrigated soybean are shown in Table 1. Yields were normal with a median yield of all thirty-nine entries of 4177 kg/ha (62.1 bu/ac). Yields ranged from a low of 2715 kg/ha (40.4 bu/ac) to a high of 4958 kg/ha (73.7 bu/ac). Oil content varied among entries with a 3% content difference between the lowest and highest % oil entries. Median protein content was 28.9%, very low. Protein concentration ranged from 27.4 – 31.3%. Seed weight also exhibited a wide variance between entries. All varieties were able to reach physical maturity and the plots were harvested on September 29. Average maturity for all the thirty variety was 121 days; NSC Watson RR2Y was the earliest maturing (113 days) entry. Plant height varied among entries with the shortest at 71 cm to the tallest at 100 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 result 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 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	4195.7	18.2	29.7	75.4	144.4	125	100	1
2	Akras R2	4371.5	16.3	28.9	76.1	144.6	124	100	1
3	Amirani R2	4073.5	18.2	30.0	75.6	159.4	119	85	1
4	B0012RX	4657.4	19.0	28.3	74.6	140.2	119	89	1
5	B0041RX	4958.9	17.7	30.6	73.9	135.8	125	95	1
6	C4M17226 R2	3669.1	18.1	29.6	74.7	135.5	118	75	1
7	C4M19343 XT	4056.6	17.6	30.3	75.5	134.7	118	86	1
8	C4M21433 XT	2715.8	18.1	28.6	74.8	134.7	117	72	1
9	CP000521RX	3716.8	19.2	29.5	74.6	138.4	117	79	1
10	CP000621WPRX	3918.6	18.1	29.9	74.9	136.9	118	80	1
11	CP001WPRX	4315.9	17.2	28.8	75.0	145.6	125	83	1
12	CW1760277	4741.8	19.1	28.9	74.4	138.4	118	79	1
13	D1701-12	3917.1	18.7	28.2	75.3	145.0	115	75	1

14	Dextro R2X	3921.3	18.2	29.1	75.7	125.5	122	88	1
15	DKB002-32	4476.2	17.2	31.3	74.8	132.2	125	77	1
16	Hart R2X	4280.6	18.2	28.0	74.9	156.6	124	89	1
17	Mahoney R2	4083.3	18.4	28.7	74.1	145.2	124	82	1
18	NSC EXP001LX	4027.4	18.9	30.2	74.6	147.5	118	79	1
19	NSC EXP001PX	3848.1	18.3	27.4	75.2	136.4	121	71	1
20	NSC Redvers RR2X	3341.3	18.1	27.6	74.3	119.4	123	80	1
21	NSC Watson RR2Y	4525.3	19.3	28.6	74.5	145.5	113	80	1
22	P001A48X	4467.9	18.6	29.0	75.0	149.5	121	83	1
23	P003A97X	4199.7	18.2	30.3	74.0	145.7	124	86	1
24	P005A27X	4812.0	17.5	30.6	74.6	162.8	124	86	1
25	P006A37X	4212.1	18.9	27.4	74.7	154.2	123	79	1
26	PR159000Z	4314.9	18.3	28.2	75.3	165.7	124	86	1
27	PV 22s002 R2X	4145.7	16.8	29.7	75.7	147.4	124	94	1
28	PV EXP 21-C3	4146.7	17.5	28.9	75.4	146.7	123	90	1
29	S001-D8X	4300.8	18.4	28.9	74.1	136.1	119	79	1
30	S003-Z4X	4170.0	18.3	28.2	74.9	137.6	121	80	1
31	S007-Y4	3315.7	17.1	30.3	75.2	152.2	124	90	1
32	Sunna R2X	4184.1	17.1	30.0	75.2	145.4	125	83	1
LSD (0.05)		0.033	0.001	0.0497	0.001	0.001	0.001	0.003	NS
CV (%)		11.75	2.61	4.69	0.52	5.13	1.07	9.83	

NS = not significant

Conventional Soybean Variety Trial

Funding

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

Project Lead

- Garry Hnatowich & Gursahib Singh
- 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

Fourteen conventional soybean varieties were received through the Saskatchewan Pulse Growers for evaluation under irrigation production assessment. Plot size was 1.2 m x 4 m. All plots received 20 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 18.

Weed control consisted of a pre-plant soil incorporated application of granular Edge (ethalfluralin). Weed pressure was low in the research site so no post-emergence herbicide was applied but plots were regularly hand weeded. The plots were harvested on September 28. 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%. In-season precipitation from mid-May through September was 106.5 mm, in-season irrigation at Pederson was 208.3 mm (8.2")

Results

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 NSC Watson RR2Y, the highest was PR130077Z-28. The median yield of all entries was 3542 (52.7 bu/ac). Median oil content was 17.4% and protein was not statically different between entries. Median Test weight was 75.8 kg/hl and median thousand seed weights was 143 g. All varities reached physical maturity; NSC Watson RR2Y was the earliest maturing (118 days) and OAC Prudence was late maturing (125 days). Lodging was not an issue in 2021.

The result 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 2021 Soybean Regional Variety Trial – Irrigated conventional season Varieties.

#	Variety	Yield (kg/ha)	% Oil	% Protein	Test weight (kg/hl)	Seed weight (g/1000)	Height (cm)	Maturity (days)	Lodge (1-5)
1	TH 33003R2Y	3542.3	17.6	32.2	75.4	141.6	77	123	1
2	AAC Edward	3061	17.6	32.9	76.3	131.4	62	118	1
3	AAC Halli	3927.3	17.4	33.9	75.7	158.7	74	123	1
4	CM 26	3316.3	17.7	34.2	76.5	129.2	59	118	1
5	CM 39	3199.7	17.9	33.6	76.0	128.9	59	116	1
6	Liska	3670.7	17.0	33.7	75.6	146.7	79	124	1
7	NSC Watson RR2Y	2859	18.4	31.4	74.6	139.7	56	115	1
8	OAC Prudence	3753.7	16.4	33.4	75.7	181.6	88	125	1
9	PR130077Z-28	3996.4	17.4	34.1	76.0	134.4	76	120	1
10	Siberia	3778.7	17.0	32.7	75.7	144.5	74	120	1
11	X6029- 6- S1- S1-1	3190.7	16.9	32.6	76.5	174.6	65	118	1
12	X6029- 6- S1- S1-27	3879.3	16.4	33.4	76.3	149.2	64	118	1
13	X6034-4-S1-S1-15	3560.7	18.2	31.7	75.2	146.7	69	116	1
14	X6035- 5- S1- S1-3	3405	17.0	31.0	76.1	137.1	71	118	1
LSD (0.05)		NS	0.001	NS	0.0001	0.0001	0.004	0.0001	NS
CV (%)		14.4	3.05	4.48	0.38	7.99	12.47	1.31	

AGRONOMIC TRIALS

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 Leads: Garry Hnatowich & Gursahib Singh

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	AAC Viewfield (A)	Certified
2	Untreated	AAC Viewfield (A)	Farm-Saved Seed
3	Untreated	Cardale (B)	Certified
4	Untreated	Cardale (B)	Farm-Saved Seed
5	Untreated	AAC Brandon (C)	Certified
6	Untreated	AAC Brandon (C)	Farm-Saved Seed
7	Treated	AAC Viewfield (A)	Certified
8	Treated	AAC Viewfield (A)	Farm-Saved Seed
9	Treated	Cardale (B)	Certified
10	Treated	Cardale (B)	Farm-Saved Seed
11	Treated	AAC Brandon (C)	Certified
12	Treated	AAC Brandon (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 %	Total Fusarium %	1K Seed weight (gm)
AAC Viewfield (A)	Certified	94	92	1	5	1	38.54
AAC Viewfield (A)	Farm-Saved	96	95	3	1	1	35.40
Cardale (B)	Certified	95	95	2	3	9	36.02
Cardale (B)	Farm-Saved	97	93	1	2	0.5	28.04
AAC Brandon (C)	Certified	99	98	1	0	2	38.68
AAC Brandon (C)	Farm-Saved	99	96	1	0	0	27.74

This trial was established on ICDC rented land approximately 16 km south of Broderick, SK. All varieties were seeded into potato stubble at a seeding rate of 300 viable seeds/m^2, adjusted for % vigor and seed weight, on May 17. 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 90 kg N/ha as 46-0-0 and 25 kg P_2O_5/ha as 11-52-0, N fertilizer was side-banded at seeding, P fertilizer was seed placed. Spring soil test results indicated the site had 76 kg/ha available NO3 in the top 60 cm and 25 kg available P in the top 15 cm. 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 Buctril M (bromoxynil + MCPA ester) at recommended rates on June 8. A foliar fungicide application of Priaxor (fluxapyroxad + pyraclostrobin) occurred on July 8. Lodging was evaluated when recording date of maturity and rated using the Belgian Lodging System [= lodged area of plot (1-10, 1 being no lodging, 10 being entire plot) x lodging intensity (1-5, 1 being no lodging, 5 indicating plants flat to soil surface) x0.2]. 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 August 17. 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 August 17 was 84.1 mm (3.3”). Total in-season irrigation applied was 208.3 mm (8.2”).

Results

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

Despite above average temperatures and below average seasonal precipitation overall yields obtained were excellent. Seed treatment had no influence on seed yield in 2021 (Table 3). This result is not surprizing given the early season environmental conditions experienced in 2021. Precipitation during April was much less than the 30-year average, May precipitation was close to normal. The trial was established on worked potato stubble, soil moisture at seeding was good but certainly not excessive. Therefore, seedling disease, particularly root diseases, were not observed and no benefit obtained for seed treatment. The Cardale variety was significantly lower yielding than either AAC Viewfield or AAC Brandon. Farm saved seed lots yielded numerically less than certified seed, this difference was not statistically significant at a 5% confidence level but was statistically significant at 10%. Certified seed provided a 5% yield benefit over farm saved seed in this season. Statistical interactions were generally not obtained between any of the three factors evaluated: seed treatment, variety pairing or seed type. Seed treatment had no effect on remaining seed quality parameters of seed protein, test weight or seed weight nor in-season agronomic observations. Differences between variety pairing were found between variety pairings and deemed due to inherent genetic differences. Farm saved seed produced lighter test weight compared to certified seed but did not differ in % protein or seed weight.

In general, neither seed treatments, varieties or seed type had any significant influence on in-season agronomic observations in 2021, as shown in Table 4.

This is the third and final year of a multi-site, multi-year trial. Results from ICDC will be combined with those of other participating sites and a final report completed by the East Central Research Foundation and submitted and made available through ADF.

A 3-year summary of the ICDC irrigated results obtained from this study is included below.

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 producers for donation of farm-saved seed used in this trial;

- Mr. Kelly Farden, Outlook SK.
- Mr. Jeff Ewen, Riverhurst SK.
- Mr. Aaron Williams, Macrorie SK.

Table 3. Influence of Treatments on Yield and Seed Quality Parameters.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

Treatment	Yield (kg/ha)	Yield (bu/ac)	% Protein	Test weight (kg/hl)	Seed weight (g/1000)
Seed Treatment					
Untreated	6579 a	97.8 a	12.5 a	82.5 b	34.6 a
Treated	6460 a	96.0 a	12.4 a	82.9 a	34.1 a
LSD (0.05)	NS	NS	NS	0.3	NS
CV (%)	10.0	10.0	6.9	0.6	5.0
Variety Pairing					
AAC Viewfield (A)	6789 a	100.9 a	12.0 b	83.7 a	34.2 b
Cardale (B)	5894 b	87.6 b	12.6 a	81.8 c	33.1 b
AAC Brandon (C)	6876 a	102.2 a	12.7 a	82.5 b	35.7 a
LSD (0.05)	468	7.0	NS*	0.3	1.2
Seed Type					
Certified	6686 a	99.4 a	12.5 a	82.9 a	34.1 a
Farm-Saved Seed	6353 a	94.4 a	12.3 a	82.5 b	34.5 a
LSD (0.05)	NS*	NS*	NS	0.3	NS
Seed Treatment x Variety Pairing Interaction					
LSD (0.05)	NS	NS	NS	S	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	NS	NS	NS
Seed Treatment x Variety Pairing x Seed Type Interaction					
	NS	NS	NS	NS	NS

S = significant at P<0.05

NS = not significant at P<0.05

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

Table 4. Influence of Treatments on Agronomic Observations.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

Treatment	Plant Emergence (plant/m^2)	Plant Vigor (1 – 10)	Days to Heading	Days to Mature	Plant Height (cm)	Lodging Belgian Scale
Seed Treatment						
Untreated	290 a	9 a	47 a	85 a	71.8 a	0.2 a
Treated	302 a	9 a	47 a	84 a	73.8 a	0.2 a
LSD (0.05)	NS	NS	NS	NS*	NS	NS
CV (%)	10.3	-	0.9	1.6	3.5	-
Variety Pairing						
AAC Viewfield (A)	293 a	9 a	47 a	85 a	69.1 b	0.2 a
Cardale (B)	306 a	9 a	46 b	83 b	75.1 a	0.2 a
AAC Brandon (C)	289 a	9 a	47 a	85 a	74.2 a	0.2 a
LSD (0.05)	NS	NS	0.3	1.0	NS*	NS
Seed Type						
Certified	298 a	9 a	46 b	84 a	72.5 a	0.2 a
Farm-Saved Seed	294 a	9 a	47 a	84 a	73.1 a	0.2 a
LSD (0.05)	NS	NS	0.3	NS	NS	NS
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	NS		NS	NS
Seed Treatment x Variety Pairing x Seed Type Interaction						
LSD (0.05)	NS	NS	NS		NS	NS

S = significant at P<0.05

NS = not significant at P<0.05

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

Summary Results from Irrigated Trails, 2019-2021

The objectives and methodology of this study has been discussed in the proceeding section.

The assessed influence of seed treatments, varieties and certified or farm saved seed on yield and seed quality is outlined in Table 5. Not surprisingly yield and seed quality differed by years during the time of the study. Seed treatments offered no yield benefit during the 3-year's trialing. Varieties, as would be expected, did differ in yield and seed quality. Of importance was the summary results obtained between certified and farm saved seed lots. During each individual year of the trial, grain yield did not statistically differ between certified and farm saved at a 5% confidence level (certified seed did yield higher than the farm saved seed in 2021 at a 10% confidence level). Numerically in each individual year of the study was higher for certified seed lots used compared to farm saved lots. On combination of years, these numerical yield advantages did show to be statistically significant upon analyses. Seed yield of certified and farm saved seed for each year, and averaged over years, is illustrated in Figure 1. On average certified seed resulted in an average yield advantage of 152 kg/ha (2.3 bu/ac) compared to farm saved seed. Whether this yield gain is worth the additional cost would be dependant on the commodity sales price of wheat, and the price of certified seed vs the price of farm saved seed (storage, cleaning, handling, disease/quality testing, etc.).

Table 5. Influence of Treatments on Yield and Seed Quality Parameters, 3-year Summary 2019-2021. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

Treatment	Yield (kg/ha)	Yield (bu/ac)	% Protein	Test weight (kg/hl)	Seed weight (g/1000)
Year					
2019	4296 c	63.9 c	12.6 a	79.3 b	39.8 a
2020	6080 b	90.4 b	12.7 a	79.2 b	37.3 b
2021	6520 a	96.9 a	12.4 a	82.7 a	34.3 c
LSD (0.05)	183	2.7	NS	0.4	0.7
CV (%)	8.0	8.0	5.2	1.2	4.5
Seed Treatment					
Untreated	5639 a	83.8 a	12.6 a	80.3 a	37.4 a
Treated	5624 a	83.6 a	12.5 a	80.5 a	36.9 a
LSD (0.05)	NS	NS	NS	NS	NS
Variety Pairing					
A	5634 b	83.8 b	12.6 a	80.8 a	37.3 a
B	5419 c	80.6 c	12.6 a	80.3 b	37.9 a
C	5842 a	86.9 a	12.6 a	80.1 b	36.3 b
LSD (0.05)	183	2.7	NS	0.4	0.7
Seed Type					
Certified	5708 a	84.9 a	12.7 a	80.4 a	36.9 b
Farm-Saved Seed	5556 b	82.6 b	12.5 a	80.4 a	37.4 b
LSD (0.05)	149	2.2	NS	NS	0.6

NS = not significant at P<0.05

The 3-year influence of these factors on in-season agronomic parameters (emergence, vigor, maturity, plant height and lodging) are shown in Table 6. In general, yields differed between years and occurred within variety pairings. These results would not be unexpected. Seed treatments had no influence on plant growth. Only 2-site years of plant emergence information was obtained, results indicate that certified seed did obtain higher plant populations compared to farm saved seed. Though seed planting rate was adjusted to account for seed vigor, results suggest that seed/seedling vigor is superior with certified seed. Certified seed also developed and matured earlier than farm saved seed, possibly also a function of seedling vigor. Plant height was taller and exhibited less lodging with certified seed, however, results are not agronomically significant in terms of crop management.

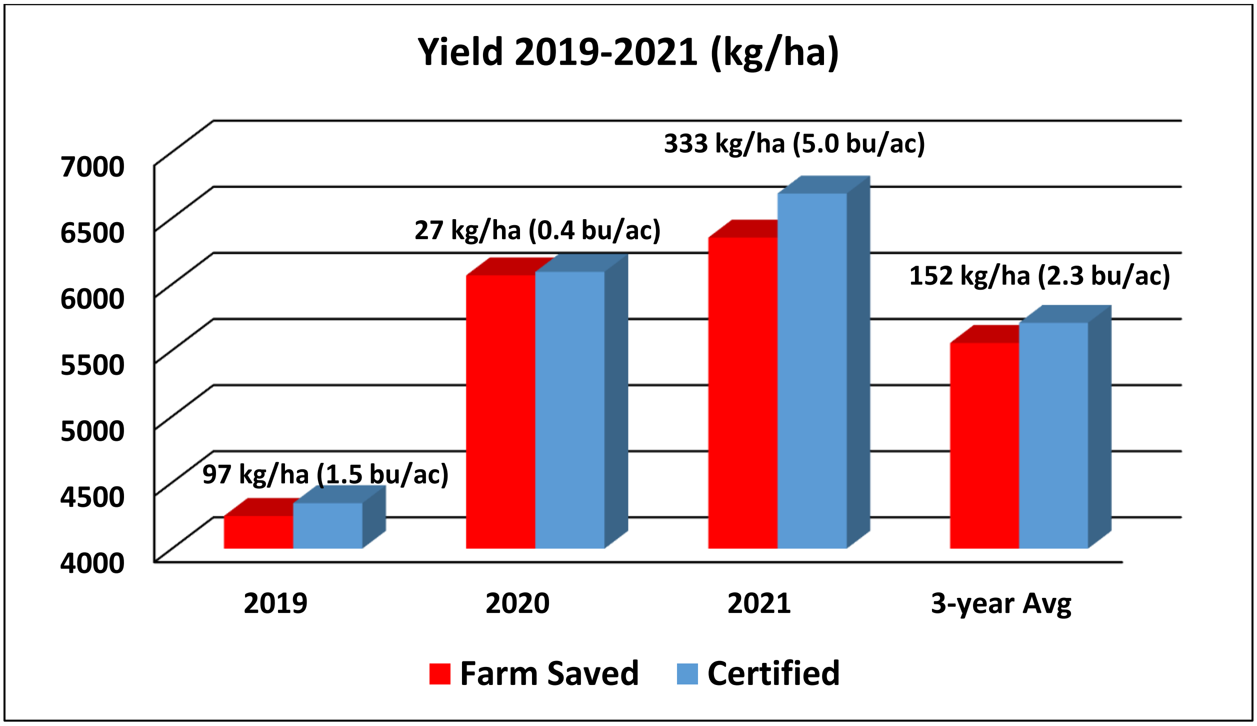
As previously indicated, this is the third and final year of a multi-site, multi-year trial. Results from ICDC will be combined with those of other participating sites and a final report completed by the East Central Research Foundation and submitted and made available through ADF.

Table 6. Influence of Treatments on Agronomic Observations, 3-year Summary 2019-2021.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

Treatment	**Plant Emergence (plant/m²)***	**Plant Vigor (1 – 10)**	**Days to Heading**	**Days to Mature**	**Plant Height (cm)**	**Lodging Belgian Scale**
Year						
2019	204 b	9.0 b	62 a	101 a	90 a	0.2 b
2020		9.7 a	51 b	91 b	87 b	0.3 a
2021	296 a	9.0 b	47 c	84 c	73 c	0.2 b
LSD (0.05)	20	0.2	0.3	1.0	1.3	0.05
CV (%)	19.4	6.4	1.2	2.7	3.8	52.0
Seed Treatment						
Untreated	251 a	9.3 a	53 a	92 a	83 a	0.2 a
Treated	249 a	9.4 a	53 a	92 a	83 a	0.2 a
LSD (0.05)	NS	NS	NS	NS	NS	NS
Variety Pairing						
A	256 a	9.0 b	54 a	92 a	80 c	0.2 a
B	237 a	9.5 a	53 b	92 a	86 a	0.3 a
C	256 a	9.4 a	53 b	92 a	83 b	0.2 a
LSD (0.05)	NS	0.2	0.3	NS	1.3	NS
Seed Type						
Certified	262 a	9.3 a	53 b	91 b	84 a	0.2 b
Farm-Saved Seed	238 b	9.3 a	54 a	93 a	82 b	0.3 a
LSD (0.05)	20	NS	0.2	0.8	1.0	0.04

*Plant Emergence – data not obtained in 2020, 2-site year analyses.
NS = not significant at P<0.05

Figure 1. 3-Year Yield Irrigated Summary 2019-2021: Farm Saved vs Certified Seed.



Fungicide timing to mitigate Fusarium head blight in cereal crops and temperature effects on chemotypes

Funding

Funded by the Saskatchewan Wheat Development Commission, Western Grains Research Foundation, and Alberta Wheat Commission

Project Lead

- Project P.I: Randy Kutcher/ Gursahib Singh
- ICDC Lead: Garry Hnatowich/Gursahib Singh

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- University of Saskatchewan (U of S)

Objectives

Fusarium head blight (FHB), is the most serious disease affecting bread and durum wheat (Triticum aestivum L. and T. turgidum L.) across Canada. This disease was contained to the south-east portion of the province during the 1990s and much of the 2000s, but in recent years, the disease has become prevalent in all wheat growing areas of Saskatchewan. It causes yield and quality losses in all classes of wheat, as well as in barley, oats, and canary seed. An integrated disease management approach is suggested by pathologists for adequate control of FHB, because no single control strategy provides a high level of disease control (Gilbert and Haber 2013). Amongst these, the most important are: selection of wheat varieties with the best genetic resistance available, use of cultural control practices (crop rotation with other non-host crops, and practices that increase residue decomposition), and under high risk conditions, fungicide application at flowering.

One of the most challenging issues for all wheat and barley growers is to determine the correct timing of a fungicide application due to variability in growth stage among the cereal spikes of each plant in terms of heading and anthesis. Generally, a single fungicide application to wheat at the beginning of anthesis (BBCH 61 - 65) is recommended for managing the disease as wheat is most susceptible to FHB during anthesis when anthers are extruded from the florets (Fernandez et al. 2012). This primary management practice (fungicide application at BBCH 61 - 65) is a narrow window that lasts for 2-3 days, depending on the weather conditions. In years with high rainfall, wet weather during this critical period restricts fungicide application. Normally, it is thought that if this narrow window of opportunity is missed, infection will occur, and later applications will not control the disease. However, we recently completed a fungicide timing study in durum wheat (ADF project #20150176), in which we found a wider window of fungicide application (BBCH 61 to BBCH 69) controlled FHB by reducing FDK and mycotoxin content of the grain (Gursahib Singh unpublished data). With subtle differences in crop physiology within wheat classes, we think that this window of application may also apply to spring wheat, winter wheat, and barley.

While the timing of fungicide application has been compared in winter wheat, spring wheat, and barley in the Atlantic region of Canada (Caldwell et al. 2017) and the United States, it has not been conducted in Saskatchewan. In the absence of detailed information, Saskatchewan farmers have to depend on anecdotal evidence regarding appropriate fungicide timing to control FHB in cereals. Therefore, we propose a comprehensive study to address this knowledge gap under Saskatchewan conditions.

The objectives of the proposed project are to compare fungicide application timing in wheat and barley to provide recommendations for improving FHB control by reducing FDK and DON toxin.

Research Plan

A field demonstration with four cereal crops (winter wheat, bread wheat, durum and barley) was established in the fall of 2020 and spring of 2021 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. Five treatments of metconazole fungicide (trade name, Caramba® by BASF) were applied at four crop growth stages:

- BBCH 59, (End of heading: inflorescence fully emerged)
- BBCH 61, (Beginning of flowering: first anthers visible)
- BBCH65 (Full flowering: 50% of anthers mature)
- BBCH69 (End of flowering),
- Unsprayed check

Individual seeded plot size was 10 m in length and 1.5 m wide. Winter wheat was seeded on September 11, 2020 and received 85 kg N/ha as urea (46-0-0) side banded, 30 kg P2O5/ha side banded and an additional 50 kg N/ha in the spring (broadcast). All spring cereals (bread wheat, durum and barley) were seeded on May 6, 2021 and received 135 kg N/ha as urea (46-0-0) side banded and 30 kg P2O5/ha was side banded. 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. All plots were sprayed three-times with liquid *Fusarium graminearum* incoulant approximately one week before flowering. Fusarium head blight was assessed using the FHB index [FHB index = (FHB severity * FHB incidence)/100] (Stack and McMullen, 1995). For each plot, 50 wheat heads were assessed visually to estimate the severity and incidence of FHB within each plot using the Horsfall-Barratt scale (Horsfall and Barratt, 1945). The harvested grain was weighed after cleaning to calculate the final yield, later adjusted to 14.5% moisture content. Test weight (TW, kg hl-1), thousand kernel weight (TKW; g), number of Fusarium Damaged Kernel (FDK; %), protein content (%) were measured for each plot.

Results

This project focused on examining the optimum window of fungicide application for FHB control, the impact on FDK, and the quantity of toxins that result in the harvested grain. All plots were rated for FHB disease symptoms (severity and incidence) in 50 heads per plot. The 2021 growing season experienced very low precipitation and high temperatures. Even though the research plots were irrigated and sprayed with inoculant, the disease pressure was very low in all four cereal crops and the FHB index was zero for all plots. The harvested grains were also examined for fusarium damaged kernels, but the crop samples were free of any fusarium damage.

The mean effect of treatments on yield and seed quality are tabulated in Table 1. Fungicide treatments did not have any significant impact on yield. Yield varied among treatments in all four cereals The difference in yield between treatments was very low, and no trend was detected. Like yield, seed quality parameters (test weight, TKW and protein) were also not affected by fungicide treatments.

This is the first year of an intended three-year study, it will be repeated in 2022. Results from this ICDC trial will be combined with those of other participating sites for an interim report of results for 2021.

Acknowledgements

Financial support was provided by Saskatchewan Wheat Development Commission, Western Grains Research Foundation, and Alberta Wheat Commission. All funding is gratefully acknowledged.

Table 2. Impact of fungicide treatments on yield, protein, test weight and thousand kernel weight (TKW)

Crop	Treatments	Yield (kg/ ha)	Protein (%)	Test weight (kg/hl)	TKW (g)
Winter wheat	BBCH 59	6903.8	13.7	80.1	31.6
	BBCH 61	6621.5	13.8	80.0	29.0
	BBCH 65	6573.2	13.7	79.6	31.0
	BBCH 69	6775.6	13.7	80.1	31.7
	Unsprayed	6937.3	13.8	80.2	31.5
	LSD (0.05)	NS	NS	NS	NS
	CV	7.01	1.94	0.47	6.12
Durum	BBCH 59	5753.3	14.6	82.1	38.3
	BBCH 61	5450.9	14.7	81.9	38.0
	BBCH 65	5326.5	14.7	81.5	36.9
	BBCH 69	5637.7	14.7	81.8	37.5
	Unsprayed	5409.2	14.9	82.0	36.8
	LSD (0.05)	NS	NS	NS	NS
	CV	5.28	1.81	0.7	4.7
Bread wheat	BBCH 59	6067.5	14.3	84.4	32.5
	BBCH 61	6142.9	14.4	84.3	32.2
	BBCH 65	6073.5	14.4	84.0	32.7
	BBCH 69	6162.9	14.1	84.2	32.4
	Unsprayed	6057.5	14.2	84.3	32.5
	LSD (0.05)	NS	NS	NS	NS
	CV	1.7	2.15	29.0	4.3
Barley	BBCH 59	7302.1	11.7	70.3	51.6
	BBCH 61	7404.2	11.5	69.1	51.8
	BBCH 65	7131.4	11.7	68.4	52.1
	BBCH 69	7284.7	11.6	68.9	52.2
	Unsprayed	7450.4	11.8	69.1	52.0
	LSD (0.05)	NS	NS	NS	NS
	CV	4.5	1.33	2.0	1.7

NS = not significant

Topdressing Nitrogen Fertilizer on Frozen or Snow-Covered Soils in Saskatchewan

Funding

Funded by the Strategic Field Program (SFP)

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Outlook

Project Lead

- Principal Lead: Kim Stonehouse, MOA
- ICDC Leads: Garry Hnatowich & Gursahib Singh

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Northeast Agriculture Research Foundation (NARF)
- East Central Research Foundation (ECRF)
- South East Research Farm (SERF)
- Indian Head Research Foundation (IHARF)
- Wheatland Conservation Area Inc. (WCA)
- Conservation Learning Center (CLC)
- Western Applied Research Corporation (WARC)

Objectives

The use of nitrogen (N) fertilizers has a large impact on crop production in western Canada. It is often the largest single bulk nutrient that is applied annually to crops such as wheat, barley, canola, etc. High rates of nitrogen being applied at seeding can significantly slow down operations due to the extra time required to haul and fill seeder tanks. As well, there are added labour requirements and increased capital investment for trucks to haul the product and seeders capable of banding. In response to these logistical issues, producers have looked at ways to apply nitrogen fertilizer at different times of the year. One of these practices involves the broadcasting granular nitrogen fertilizer onto cold or frozen soils often covered with snow. This practice has started to be utilized more in many regions across the province. Some producers have opted to use products that can help to reduce losses associated with broadcasting nitrogen fertilizers such as urease inhibiters (ANVOL) and/or nitrification inhibitors (Super U) while other do not.

To date there is very little Saskatchewan specific independent information or research available to agronomist or producers that directly measures the potential losses (crop yield and economic cost) for nitrogen broadcast onto frozen or snow-covered ground with or without the use of a nitrification and/or urease inhibitors. Furthermore, there is potential to have regional differences in nutrient losses within the province of Saskatchewan, due to significant differences in soil type and growing season moisture. In order to account for some of the regional variability this project will be conducted on multiple sights across the province to determine if nitrogen losses and crop responses are different due to environmental factors as well as soil types.

The objectives of the project are to develop Saskatchewan specific data showing the loss of production and economic risks associated with broadcast applications of nitrogen fertilizers on frozen and snow-covered soils.

Research Plan

The trial was established on the ICDC land base at Outlook. The trial was established in a Randomized Complete Block Design with four replications. Individual plots were seeded 4 m wide by 10 m in length and later trimmed to 8 m harvest lengths. Treatments were as follows,

Treatments:

1. 1x Urea broadcast mid-November
2. 1x Super U (urease + nitrification inhibitor) broadcast mid-November
3. 1X ANVOL (urease inhibitor) treated Urea mid-November
4. 1x Urea broadcast early February
5. 1x Super U broadcast early February
6. 1X ANVOL treated Urea early February
7. 1x Urea broadcast early April
8. 1x Super U broadcast early April
9. 1X ANVOL treated Urea early April
10. Spring side band 1x urea at seeding

The trial was established on a level area such that terrain would not influence the lateral movement of N fertilizer. Three N fertilizer sources were evaluated; bare untreated urea (46-0-0) and two nitrogen stabilizer products; SuperU (46-0-0) and ANVOL (46-0-0). All fertilizer sources were applied at 155 kg N/ha as determined by soil sampling analyses conducted in October 2020. In the fall of 2021, the trial area received a blanket band application of 30 kg P_2O_5/ha and an additional 30 kg P_2O_5/ha side banded at seeding. Broadcast N applications occurred on November 17, 2021; February 16 and April 15, 2021. The trial was seeded to AAC Wheatland VB spring wheat on May 5, 2021, at a 300 viable seeds/m^2 seeding rate. The side band N applications occurred at this time. A pre-emergent glyphosate herbicide burn-off was applied May 6 and post-emergent tank mix application Simplicity (pyroxsulam) and Buctril M (bromoxynil + MCPA ester) at recommended rates on June 7, 2021. A foliar fungicide application of Priaxor (fluxapyroxad + pyraclostrobin) occurred on July 8, 2021. Yields were estimated by direct cutting a 1.5 m x 8.0 m center section of each 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 August 16, 2021. 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 August 16 was 72.7 mm (2.9”). Total in-season irrigation applied was 259.1 mm (10.2”).

Results

At each date of broadcast N fertilizer applications snow depth was measured at 4 random locations within each plot and averaged. Additionally, soil temperatures were recorded at five depths with buried thermocouples. Results of these observations are show in Table 1.

Soil was snow-covered by the time of the first broadcast application but had melted by the April application. No run-off of melted snow was observed, it is suggested that most snow water infiltrated the soil while a portion would have evaporated. Surface soil temperatures were positive at both the November and April application timings, such that gaseous N losses from fertilizer sources may have been possible.

Table 1. Recorded snow depth and soil temperatures at times of broadcast N fertilizer application.

Date of N Application	Snow Depth (cm)	Soil Temperature at Soil Depth (°C)				
		5 cm	10 cm	20 cm	50 cm	100 cm
November 17	26	1.76	2.23	2.78	4.33	5.8
February 16	24	-10.47	-9.62	-8.17	-4.14	-0.61
April 15	0	3.97	3.69	3.36	3.13	2.79

Yield, seed quality and plant agronomic observations are provided in Table 2. In general, the November and February broadcast applications of N were lower yielding compared to the April broadcast applications. The greater amount of time the N fertilizers were applied prior to seeding likely provided greater over-winter N losses. Measuring gaseous N losses was beyond the scope of this demonstration but lower yields indirectly suggest N fertilizer loses did occur with broadcast November and February applications. April broadcast timing yields were higher than prior application timings. The lack of snow at this timing resulted in N sources being applied to bare, and thawing soil. The side band urea application resulted in the highest yields, suggesting this time and placement method was more efficient than other treatments. Mean effects of time of N application and N source is illustrated in Figure 1. Results suggest, that if a producer was intending to float N fertilizer onto fields, as a time management strategy, they would be advised to delay application until early spring, preferably as close to seeding as possible. A delayed broadcast application appears to minimize potential over-winter N losses. Yield losses of the November and February compared to the urea side band at seeding were >10%, while the April broadcast was 3%. Stabilizer N products did not statistically yield more than urea but yields were numerically higher and resulted in grain yields 6% higher than untreated urea when N sources are broadcast.

All broadcast N treatments resulted in lower seed protein compared to the side band urea treatment which was the only treatment with protein content at a desired level. Test weight and seed weight was not influenced by the various N treatments. When urea was side banded at seeding the days to both heading and maturity were increased, plant height varied with N treatments but, in general the April and side band applications resulted in taller plants. Plant heights also tended to be higher with SuperU as opposed to ANVOL or untreated urea. Plant lodging was not influenced by N fertilizer treatments in 2021 (data not shown).

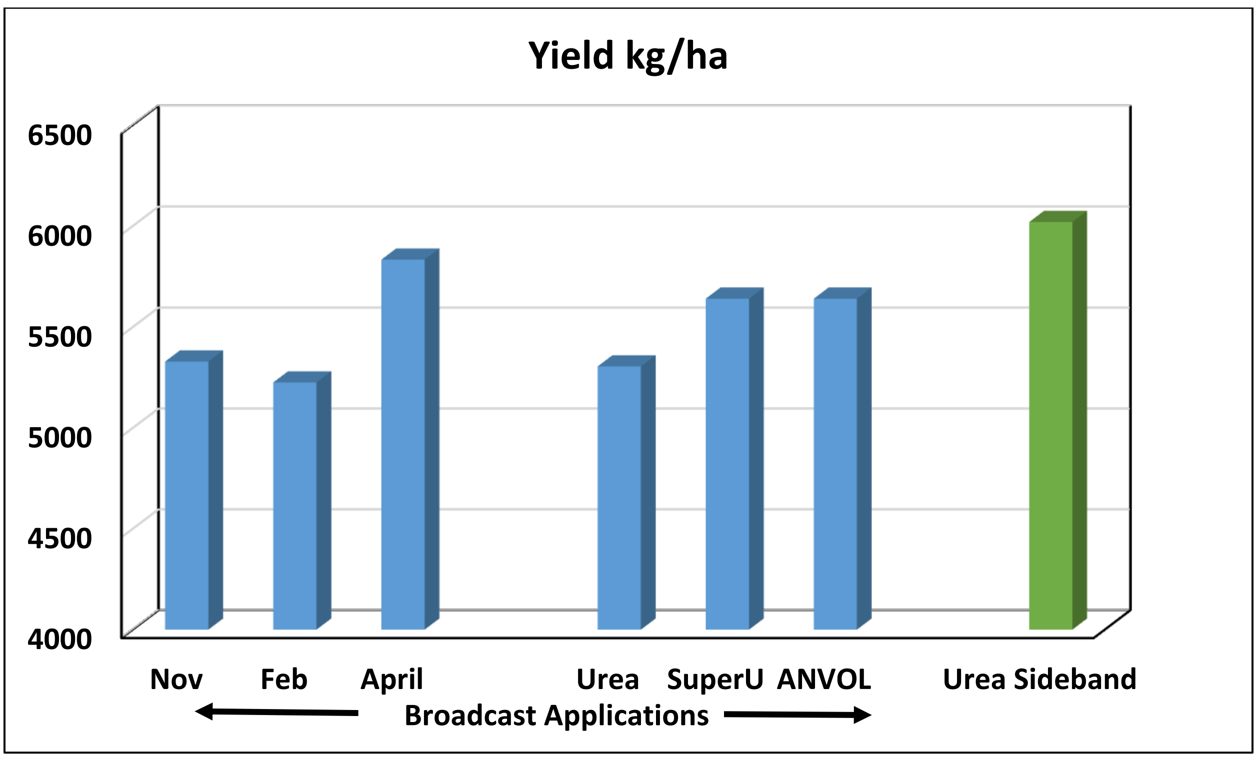
Results from this trial will be tabulated to the results of the other co-operating test locations and an interim report prepared by the Principal Investigator.

This study will be repeated in 2022.

Table 2. Wheat yield, seed quality and agronomic observations by N source, time and placement. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

N Rate	Yield (kg/ha)	% Protein	Test Weight (kg/hl)	Seed Weight (g/1000)	Days to Heading	Days to Mature	Plant Height (cm)
Urea – Nov	4939 c	10.6 d	83.9 a	31.3 a	50 b	93 b	82.5 cd
SuperU – Nov	5561 abc	12.6 ab	83.8 a	33.2 a	50 b	95 b	85.4 bcd
ANVOL - Nov	5488 abc	11.3 bcd	84.4 a	32.4 a	50 b	94 b	82.4 cd
Urea – Feb	5182 bc	11.1 cd	84.4 a	31.8 a	50 b	93 b	83.4 bcd
SuperU – Feb	5466 abc	10.9 d	84.3 a	32.6 a	50 b	93 b	84.9 bcd
ANVOL - Feb	5031 c	10.9 d	84.4 a	32.1 a	50 b	93 b	81.1 d
Urea – Apr	5796 ab	12.0 bcd	84.4 a	32.3 a	50 b	94 b	86.6 abc
SuperU – Apr	5895 a	12.6 ab	84.8 a	33.6 a	50 b	95 b	89.9 a
ANVOL - Arp	5811 ab	12.5 ab	84.2 a	33.9 a	50 b	95 b	87.3 ab
Urea – side band	6020 a	13.6 a	83.7 a	33.2 a	52 a	98 a	86.3 abc
LSD (0.05)	665	1.4	NS	NS	0.2	2.1	2.1
CV (%)	8.3	8.3	0.5	4.9	0.4	1.5	3.5

Figure 1. Mean wheat yield effects of time of N application and N source.



Influence of Potassium Fertilizer on Yield and Seed Quality of Malt Barley & Spring Wheat

Funding

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

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Outlook

Project Lead

- ICDC Leads: Garry Hnatowich & Gursahib Singh

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- East Central Research Foundation (ECRF)
- South East Research Farm (SERF)
- Indian Head Research Foundation (IHARF)
- Wheatland Conservation Area Inc. (WCA)
- Conservation Learning Center (CLC)

Objectives

Dozens of potassium (K) fertilizer field trials have been conducted in Saskatchewan since the 1960's, however, the majority failed to provide a grain yield response. In Saskatchewan, soils tend to have abundant soil available K, and therefore its application in cereals is typically restricted to the Grey soil zone or very light textured soils. Yield responses tend to be limited when K is applied to soils deemed adequate in soil test K (Karamanos et al., 2013; Holzapfel, C, 2016). However, yield responses can and have occurred. A summary of 124 barley trials conducted by Westco from 1989 to 1998 suggested that the probability of observing a yield response in barley to seed-placed K could be expected in 2 of 5 years. In wheat (52 sites) trials the probability of observing a yield response to seed-placed K was 1 year in 5 (data summary presentation in possession of G. Hnatowich). In yield responsive trials, the influence of K fertilizer additions may have been an indirect response to disease suppression and an overall healthier plant stand. Although yield responses can be variable on typical soils in western Canada, K fertilization may provide other agronomic and market-enhancing attributes.

Vasey & Soper (1966) found that K fertilization increased the plumpness of malting barley in soils high in available K. Similarly, low levels of K fertilization elevated the percentage of plump kernels in malt barley grown on soils testing from 248 to 1060 kg K/ha in North Dakota (Zubriski et.al., 1970). As 2-row malt barley varieties require $\geq$ 80% plump kernels to meet grading criteria, the potential to increase plumpness with K fertilizer additions is highly desirable and would provide a direct monetary benefit to producers. There may be other agronomic factors that respond to K fertilization (i.e., higher test weight in spring wheat) that could benefit producers and increase the profitability of either malt barley or spring wheat.

Lodging is a concern for high yielding varieties, particularly under irrigation. Lodging reduces yield, influences seed quality, and can create logistical challenges at harvest. Increased stem strength and enhanced lodging resistance is attributed to sufficient K availability (Yuan et. al., 2010). However, McKenzie et. al. (2005) conducted field trials in southern Alberta and failed to relate barley lodging resistance to K fertilization as lodging only occurred at one of fourteen sites over a three-year period. In high yielding or irrigated environments where lodging is more prevalent, additional K fertilizer supplementation might be beneficial.

The objectives of this project are to conduct trials with typical soil testing potassium (K) levels to:
(1) Evaluate the effects of K fertilizer rate and placement on yield of malt barley and spring wheat;
(2) Evaluate the influence of K fertilization on seed quality characteristics, and to;
(3) Assess the impact of K fertilization on crop lodging.

Research Plan

Small plot trials were established at Indian Head (IHARF), Yorkton (ECRF), Redvers (SERF), Prince Albert (CLC), Swift Current (WCA) and Outlook (ICDC). Seven potassium (K) fertilizer treatments were established in a Randomized Complete Block Design with four replications. Both spring wheat and malt barley were evaluated as separate and individual trials. Plot size varied in accordance to seeding equipment at each site. Wheat variety selection will be on a site-by-site preference to a regionally suitable variety. However, the barley will be a high yielding malt variety such as AAC Synergy or CDC Churchill. K fertilizer rates and positional placement were:

1. 0 kg K_2O/ha – seed placed
2. 10 kg K_2O/ha – seed placed
3. 20 kg K_2O/ha – seed placed
4. 30 kg K_2O/ha – seed placed
5. 10 kg K_2O/ha – side banded
6. 20 kg K_2O/ha – side banded
7. 30 kg K_2O/ha – side banded
8. 20 kg K_2O/ha – seed placed + 40 kg K_2O/ha – side banded

Prior to seeding all sites obtained soil samples for nutrient analyses. Samples were sampled and submitted to Western Ag according to their sampling and shipping protocols for ion exchange resin membrane available K. Additionally, sites also obtained a conventional soil test as per standard testing procedures at AgriArm locations. Conventional soil testing measured ammonium acetate exchangeable K. As wheat and barley trials were adjacent a single composite soil sample was obtained from the trialing area. Soil test results and recommendations are shown in Table 1. In general, Cropcaster recommendations were higher than conventional soil test procedures in the study. Operational dates and inputs applied at each site are shown in Table 2.

Table 1. Soil analysis results, 2021

Trial Location	Western Ag PRS Cropcaster		Agvise	
	Soil K_2O kg/ha	Fertilizer K2O Recommendation kg/ha	Soil K_2O kg/ha	Fertilizer K2O Recommendation kg/ha
ICDC	106.4	0	426	11
ECRF	58.2	29	764	11
SERF	29.8 Wheat 27.2 Barley	40 Wheat 35 Barley	364 Wheat 312 Barley	Not provided
IHARF	26.9	56	1316	0
WCA	260.3	0	834	11

CLC	121.2	28 Wheat, 67 Barley	490	10

Table 2. Operational dates and inputs used in wheat/barley, 2021.

Activity	Location					
	ICDC	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Pre-seed Herbicide	May 7 glyphosate	none		May 11 glyphosate	May 3 glyphosate	none
Variety	Wheat – AAC Wheatland VB Barley – AAC Synergy	Wheat – AAC Brandon Barley – AAC Synergy	Wheat – AAC Brandon Barley – AAC Connect	Wheat – CDC Alida VB Barley – AAC Synergy	Wheat - Adamant Barley – AAC Synergy	Wheat – AAC Cameron VB Barley – CDC Churchill
Seeding	May 14	Wheat – May 7 Barley – May 13	May 6	May 6	May 11	May 27
N-P-S (kg nutrient/ha) Fertilizer	Wheat 135-25-0 Barley 135-25-0	Wheat 125-30-0 Barley 100-30-0	Wheat 65-25-0 Barley 65-25-0	Wheat 145-40-0 Barley 125-40-0	Wheat 133-30-0 Barley 105-30-0	Wheat 126-39-0 Barley 98-45-0
In-crop Herbicide	June 18 Buctril M / Simplicity	June 7 Prestige June 16 Axial		Wheat June 7 Prestige/Simplicity Barley June 16 Prestige /Axial	June 7 Buctril M / Achieve	June 15 Dyvel
In-crop Fungicide	none	Wheat July 9 Prosaro XTR Barley June 28 Trivepro A+B		Wheat July 6 Prosaro XTR Barley July 1 Trivepro B	none	July 13 Folicur
Harvest	Aug 26	Wheat – Aug 13 Barley – Aug 27	Wheat – Aug 14 Barley – Aug 10	Wheat – Aug 30 Barley – Aug 15	Wheat – Aug 31 Barley – Aug 30	Wheat – Sept 22 Barley – Sept 9

Results

Growing Season Weather

Mean monthly temperatures and precipitation amounts for 6 locations are listed in Tables 3 and 4. The 2021 growing season was a historic event with temperatures higher than long-term averages and seasonal precipitation much below typical precipitation levels at most locations. The Outlook site received only 49.6% of historic precipitation but was irrigated. Irrigation applied to the Outlook consisted of 15 mm in May, 110 mm in June, 110 mm in July and no applications in August, total irrigation applied was 235 mm. All other remaining trial locations were dryland production and adversely influenced by heat and or drought, particularly at Yorkton, Swift Current and Prince Albert where only 54%, 75% and 73% historic precipitation was received, respectively. Indian Head and Redvers received precipitation close to long-term averages.

Table 3. Mean monthly temperatures at sites for 2021 compared to long-term (30 years) averages.

Location	Year	May	June	July	August	Avg. / Total
		------------------------------*Mean Temperature (°C)* -------------------				
ICDC Outlook	2021	10.1	18.8	21.6	17.9	17.1
	Long-term	***11.3***	***16.0***	***18.6***	***17.8***	***15.9***
ECRF Yorkton	2021	8.9	19.1	21.0	17.3	16.5
	Long-term	***10.4***	***15.5***	***17.9***	***17.1***	***15.2***
SERF Redvers	2021	10.0	18.7	20.8	17.5	16.8
	Long-term	***11.1***	***16.2***	***18.7***	***18.0***	***16.0***
IHARF Indian Head	2021	9.0	17.7	20.3	17.1	16.0
	Long-term	***10.8***	***15.8***	***18.2***	***17.4***	***15.6***
WCA Swift Current	2021	*9.5*	*18.4*	*21.7*	*18.0*	*16.9*
	Long-term	***10.9***	***15.3***	***18.2***	***17.6***	***15.5***
CLC Prince Albert	2021	10.1	18.3	20.3	17.0	16.4
	Long-term	***11.4***	***15.9***	***18.5***	***17.1***	***15.7***

Table 4. Precipitation received at sites during 2021 compared to long-term (30 years) averages.

Location	Year	May	June	July	August	Avg. / Total
		--------------------------------- *Precipitation (mm)* ---------------------				
ICDC Outlook	2021	44.5	10.3	13.8	37.7	106.3
	Long-term	***43.2***	***69.3***	***57.6***	***44.2***	***214.3***
ECRF Yorkton	2021	24.6	18.1	35.2	69.7	147.6
	Long-term	***51***	***80***	***78***	***62***	***272***
SERF Redvers	2021	41.4	95.2	38.4	72.1	247
	Long-term	***60.0***	***95.2***	***65.5***	***46.6***	***267***
IHARF Indian Head	2021	81.6	62.9	51.2	99.4	295.1
	Long-term	***51.7***	***77.4***	***63.8***	***51.2***	***244.1***
WCA Swift Current	2021	35.0	29.6	38.9	55.8	159.3
	Long-term	***44.1***	***74.5***	***51.9***	***43.2***	***213.7***
CLC Prince Albert	2021	29.8	84.0	9.6	57.0	180.4
	Long-term	***40.4***	***79.6***	***84.6***	***42.9***	***247.5***

Wheat Results

Results gathered for wheat seed yield, quality and other agronomic characteristics from all trial locations are shown in Tables 1 through 7. Potassium fertilization had little or no effect in wheat under the trial conditions. Results from the ECRF and WCA sites had higher than acceptable coefficients of variation with respect to yield. At both locations the high degree of variability within grain yield was attributed to drought conditions. Seed yield at the remaining four trial locations, while acceptable with respect to statistical analysis, where lower than might "normally" be expected. For example, under irrigation at ICDC average yield was 4412 kg/ha (65.6 bu/ac) where expected yields on this field are typically in the 6000-6200 kg/ha range (89.2-92.2 bu/ac) range. Therefore, although irrigated, the adverse environmental conditions experienced unquestionably had a negative influence on wheat growth and development. This probably may also apply to all dryland locations. Therefore, it is not possible to determine if spring wheat is nonresponsive to K fertilizer additions or if the absence of response is due to environmental conditions.

Table 1. Wheat Grain Yield Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Yield kg/ha**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		4436 a	3822 a	3795 a	3965 a	1414 a	3715 a
10		4409 a	3735 a	3578 a	3905 a	1431 a	3246 a
20		4325 a	3312 a	3714 a	3910 a	1428 a	3559 a
30		4344 a	3398 a	3847 a	3956 a	1311 a	3405 a
	10	4413 a	3029 a	3313 a	3917 a	1429 a	3239 a
	20	4362 a	3087 a	3679 a	3931 a	1520 a	3449 a
	30	4522 a	2985 a	3438 a	3949 a	1603 a	3425 a
20	40	4489 a	3049 a	3789 a	3882 a	1543 a	3545 a
	LSD (0.05)	NS	NS	NS	NS	NS	NS
	CV (%)	5.2	21.7	7.7	1.9	15.6	13.5

NS = not significant

Table 2. Wheat Grain Protein Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Protein %**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		10.7 a	15.9 a	14.1 a	15.03 ab	17.3 a	ND
10		10.8 a	16.1 a	14.6 a	15.05 a	17.2 a	ND
20		10.6 a	16.4 a	14.3 a	14.85 cd	17.1 a	ND
30		10.8 a	16.1 a	14.6 a	14.95 abc	17.1 a	ND
	10	10.8 a	16.4 a	14.8 a	14.93 abc	17.3 a	ND
	20	10.6 a	16.4 a	14.4 a	14.75 de	17.1 a	ND
	30	10.9 a	16.6 a	15.2 a	14.90 bc	17.0 a	ND
20	40	10.5 a	16.5 a	14.6 a	14.70 e	17.3 a	ND
	LSD (0.05)	NS	NS	NS	0.15	NS	
	CV (%)	4.4	2.8	4.5	0.7	1.2	

NS = not significant
ND = not determined

Table 3. Wheat Grain Test Weight Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Test Weight (kg/hL)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		78.5 a	78.6 a	81.0 a	78.1 a	77.9 a	74.9 a
10		78.3 a	78.5 a	81.0 a	78.3 a	78.6 a	75.4 a
20		78.5 a	77.6 a	81.4 a	78.3 a	78.0 a	75.6 a
30		78.9 a	78.7 a	81.4 a	78.3 a	78.0 a	75.5 a
	10	78.4 a	78.5 a	81.5 a	78.3 a	78.0 a	75.4 a
	20	78.0 a	77.9 a	81.8 a	77.9 a	78.5 a	75.3 a

	30	77.9 a	77.6 a	81.5 a	78.2 a	78.2 a	75.2 a
20	40	78.2 a	78.4 a	81.9 a	78.2 a	77.5 a	76.0 a
	LSD (0.05)	NS	NS	NS	NS	NS	NS
	CV (%)	0.8	1.1	0.8	0.4	0.9	1.0

NS = not significant

Table 4. Wheat Seed Weight Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).

K Placement & Rate (kg/ha)		**Seed Weight (TKW)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA***	**CLC**
Control - 0		37.2 a	34.4 a	33.3 a	35.1 a	27.38 c	31.0 a
10		37.5 a	31.6 a	32.4 a	35.4 a	29.38 a	32.4 a
20		37.6 a	32.7 a	32.8 a	35.1 a	27.70 bc	31.6 a
30		37.7 a	33.8 a	33.9 a	35.6 a	27.93 abc	30.9 a
	10	38.1 a	33.2 a	32.3 a	35.2 a	27.45 c	31.3 a
	20	37.9 a	32.1 a	33.8 a	35.7 a	29.03 ab	31.0 a
	30	37.2 a	31.6 a	33.4 a	34.8 a	28.45 abc	31.3 a
20	40	37.7 a	33.7 a	33.6 a	34.1 a	27.53 bc	32.7 a
	LSD (0.05)	NS	NS	NS	NS	1.55	NS
	CV (%)	2.4	4.7	3.9	2.7	3.8	4.2

* = significant at P<0.10
NS = not significant

Table 5. Wheat Days to Maturity Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).

K Placement & Rate (kg/ha)		**Days to Mature**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		94 a	88 a	87 a	93.0 b	87 a	ND
10		94 a	88 a	88 a	93.3 ab	86 a	ND
20		94 a	87 a	88 a	93.0 b	86 a	ND
30		94 a	88 a	88 a	93.4 a	87 a	ND
	10	94 a	87 a	87 a	93.3 ab	87 a	ND
	20	94 a	87 a	88 a	93.0 b	86 a	ND
	30	94 a	86 a	86 a	93.1 ab	88 a	ND
20	40	94 a	88 a	88 a	93.0 b	87 a	ND
	LSD (0.05)	NS	NS	NS	0.27	NS	
	CV (%)	-	1.4	1.3	0.2	1.2	

NS = not significant
ND = not determined

Table 6. Wheat Plant Height Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Plant Height (cm)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		79 a	71 a	76 a	77 a	46 a	ND
10		79 a	71 a	79 a	76 a	44 a	ND
20		79 a	71 a	73 a	75 a	48 a	ND
30		79 a	70 a	77 a	77 a	45 a	ND
	10	81 a	68 a	72 a	74 a	47 a	ND
	20	79 a	67 a	76 a	75 a	46 a	ND
	30	80 a	70 a	76 a	75 a	46 a	ND
20	40	79 a	66 a	73 a	74 a	47 a	ND
	LSD (0.05)	NS	NS	NS	NS	NS	
	CV (%)	2.4	6.5	4.2	2.5	7.4	

NS = not significant
ND = not determined

Table 7. Wheat Plant Lodging Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Lodging (Belgian Scale)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		0.2 a	0.5 a	0.2 a	0.2 a	0.2 a	0.2 a
10		0.2 a	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a
20		0.2 a	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a
30		0.2 a	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a
	10	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a
	20	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a
	30	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a	0.2 a
20	40	0.2 a	0.3 a	0.2 a	0.2 a	0.2 a	0.2 a
	LSD (0.05)	NS	NS	NS	NS	NS	NS
	CV (%)	-	38.6	-	71.0	-	-

NS = not significant

Barley

Results gathered for barley seed yield, quality and other agronomic characteristics from all trial locations are shown in Tables 1 through 7. Like wheat, dryland barley trials failed to respond in any meaningful manner to fertilizer K additions. Correspondingly, unfavourable environmental conditions may have adversely influenced findings. However, results for the irrigated barley trial differed. At ICDC all fertilizer K applications resulted in numerically higher grain yield compared to the unfertilized control treatment. Mean yield response to K application was 17%. Seed-placed K additions were highest with the 10 kg K_2O/ha rate and declined with additional seed-placed K rates. This suggests that though the K fertilizer was beneficial, the higher rates may have caused some seedling damage from fertilizer salt, particularly in the dry seed bed conditions prevalent in 2021. Once fertilizer K was positioned away from the seed, in a side band application, all treatment rates produced statistically higher grain yield compared to the control treatment. Protein at ICDC decreased with K fertilizer applications, this is attributed to a dilution effect because of higher yields obtained. Generally, it appears that at ICDC the 10 kg K_2O/ha rate provided optimal barley yield, aligning with the conventional soil test K fertilizer recommendation for this location. At IHARF, some K additions did tend to increase the % plump seed fraction, thought results were variable both within K rates and between K fertilizer positional placement. No other results from K fertilizer treatments were obtained.

Table 8. Table 1. Barley Grain Yield Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).

K Placement & Rate (kg/ha)		**Yield kg/ha**					
Seed	**Side band**	**ICDC***	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		4706 b	2737 a	4000 a	4162 a	1554 a	3581 a
10		5425 a	2116 a	3890 a	4258 a	1448 a	4392 a
20		5360 ab	2988 a	3786 a	4226 a	1675 a	4178 a
30		5266 ab	2305 a	3959 a	4199 a	1471 a	4221 a
	10	5555 a	2417 a	4058 a	4270 a	1555 a	3785 a
	20	5446 a	2984 a	4221 a	4185 a	1706 a	4118 a
	30	5821 a	2589 a	4089 a	4264 a	1483 a	3902 a
20	40	5760 a	2280 a	4048 a	4241 a	1651 a	3532 a
	LSD (0.05)	695	NS	NS	NS	NS	NS
	CV (%)	8.7	27.0	6.3	3.4	10.9	16.4

* = significant at P<0.10
NS = not significant

Table 9. Barley Grain Protein Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).

K Placement & Rate (kg/ha)		**Protein %**					
Seed	**Side band**	**ICDC***	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		9.2 a	15.9 a	13.9 a	12.3 a	16.38 ab	ND
10		8.8 ab	15.8 a	13.6 a	12.2 a	16.43 ab	ND
20		9.0 ab	14.7 a	14.2 a	12..3 a	16.00 c	ND
30		9.0 ab	16.0 a	14.1 a	12.3 a	16.45 a	ND
	10	8.6 b	15.3 a	14.1 a	12.4 a	16.43 ab	ND
	20	8.8 ab	14.8 a	13.7 a	12.2 a	16.18 bc	ND
	30	8.6 b	15.8 a	13.6 a	12.3 a	16.28 ab	ND
20	40	8.6 b	15.7 a	13.9 a	12.4 a	16.20 abc	ND
	LSD (0.05)	0.4	NS	NS	NS	0.26	
	CV (%)	3.4	5.5	3.7	1.0	1.1	

* = significant at P<0.10
NS = not significant
ND = not determined

Table 10. Barley Grain Test Weight Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Test Weight (kg/hL)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		68.4 a	55.3 a	55.3 a	60.8 a	64.9 a	57.2 a
10		64.8 a	55.0 a	55.8 a	61.3 a	65.1 a	57.5 a
20		63.8 a	55.2 a	54.4 a	61.6 a	64.5 a	56.7 a
30		64.0 a	55.3 a	54.8 a	61.2 a	65.2 a	56.4 a
	10	64.7 a	55.6 a	54.3 a	60.9 a	65.4 a	58.9 a
	20	63.7 a	55.1 a	55.2 a	60.7 a	65.1 a	57.2 a
	30	64.8 a	55.6 a	55.4 a	60.9 a	64.8 a	57.2 a
20	40	64.6 a	55.3 a	55.5 a	61.2 a	64.7 a	56.9 a
	LSD (0.05)	NS	NS	NS	NS	NS	NS
	CV (%)	5.2	1.4	2.7	1.0	0.9	2.0

NS = not significant

Table 11. Barley Seed Weight Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Seed Weight (TKW)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF***	**WCA**	**CLC**
Control - 0		47.6 a	43.3 a	41.3 a	41.7 c	64.9 a	43.0 a
10		47.1 a	44.1 a	41.3 a	42.3 abc	65.1 a	42.1 a
20		47.7 a	45.0 a	42.0 a	42.8 a	64.5 a	42.4 a
30		47.4 a	43.3 a	41.3 a	42.4 abc	65.2 a	40.9 a
	10	47.4 a	44.4 a	41.1 a	42.5 ab	65.4 a	41.7 a
	20	47.0 a	43.5 a	41.9 a	41.8 bc	65.1 a	42.0 a
	30	47.6 a	44.3 a	41.6 a	42.1 abc	65.1 a	42.3 a
20	40	47.2 a	44.7 a	42.1 a	42.8 a	64.7 a	42.9 a
	LSD (0.05)	NS	NS	NS	0.8	NS	NS
	CV (%)	2.1	5.0	6.8	1.3	2.2	5.4

* = significant at $P<0.10$
NS = not significant

Table 12. Barley Plump Seed Percentage Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**% Plump Seed**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		98.5 a	97.0 a	ND	97.18 cd	ND	ND
10		98.2 a	97.9 a	ND	97.24 bcd	ND	ND
20		98.4 a	98.2 a	ND	97.75 a	ND	ND
30		98.1 a	97.7 a	ND	97.24 bcd	ND	ND
	10	98.0 a	98.7 a	ND	96.96 d	ND	ND
	20	98.1 a	97.4 a	ND	97.35 abcd	ND	ND

	30	98.0 a	98.4 a	ND	97.59 abc	ND	ND
20	40	98.2 a	98.2 a	ND	97.72 ab	ND	ND
	LSD (0.05)	NS	NS		0.48		
	CV (%)	0.3	1.2		0.3		

NS = not significant
ND = not determined

Table 13. Barley Thin Seed Percentage Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**% Thin Seed**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		1.6 a	0.3 a	ND	0.12 a	ND	ND
10		1.8 a	0.2 a	ND	0.15 a	ND	ND
20		1.6 a	0.2 a	ND	0.10 a	ND	ND
30		1.9 a	0.2 a	ND	0.11 a	ND	ND
	10	2.0 a	0.2 a	ND	0.14 a	ND	ND
	20	1.9 a	0.3 a	ND	0.11 a	ND	ND
	30	2.0 a	0.2 a	ND	0.10 a	ND	ND
20	40	1.8 a	0.2 a	ND	0.09 a	ND	ND
	LSD (0.05)		NS		NS		
	CV (%)		48.9		24.8		

NS = not significant
ND = not determined

Table 14. Barley Days to Maturity Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Days to Mature**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		83 a	77 a	80 a	87 a	87 a	ND
10		83 a	78 a	81 a	87 a	87 a	ND
20		83 a	78 a	81 a	87 a	87 a	ND
30		83 a	77 a	81 a	87 a	87 a	ND
	10	83 a	77 a	81 a	87 a	86 a	ND
	20	83 a	77 a	82 a	87 a	87 a	ND
	30	83 a	78 a	81 a	87 a	87 a	ND
20	40	83 a	78 a	82 a	87 a	87 a	ND
	LSD (0.05)	NS	NS	NS	NS	NS	
	CV (%)	-	1.8	1.2	0.3	1.6	

NS = not significant
ND = not determined

Table 15. Barley Plant Height Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Plant Height (cm)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		72 a	69 a	63 a	60 a	55 a	ND
10		70 a	66 a	63 a	60 a	53 a	ND
20		69 a	73 a	65 a	59 a	55 a	ND
30		69 a	66 a	64 a	59 a	54 a	ND
	10	71 a	65 a	67 a	59 a	52 a	ND
	20	70 a	71 a	66 a	60 a	56 a	ND
	30	71 a	67 a	64 a	60 a	53 a	ND
20	40	72 a	66 a	66 a	59 a	52 a	ND
	LSD (0.05)	NS	NS	NS	NS	NS	
	CV (%)	3.1	7.5	3.4	3.0	7.2	

NS = not significant
ND = not determined

Table 16. Barley Plant Lodging Response to Fertilizer K Applications.
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

K Placement & Rate (kg/ha)		**Lodging (Belgian Scale)**					
Seed	**Side band**	**ICDC**	**ECRF**	**SERF**	**IHARF**	**WCA**	**CLC**
Control - 0		0.2 a	1.0 a	0.2 a	0.4 a	0.2 a	0.2 a
10		0.2 a	0.5 a	0.2 a	0.5 a	0.2 a	0.2 a
20		0.2 a	0.6 a	0.2 a	0.5 a	0.2 a	0.2 a
30		0.2 a	0.4 a	0.2 a	0.7 a	0.2 a	0.2 a
	10	0.2 a	0.6 a	0.2 a	0.4 a	0.2 a	0.2 a
	20	0.2 a	0.9 a	0.2 a	0.4 a	0.2 a	0.2 a
	30	0.2 a	0.7 a	0.2 a	0.4 a	0.2 a	0.2 a
20	40	0.2 a	0.8 a	0.2 a	0.8 a	0.2 a	0.2 a
	LSD (0.05)	NS	NS	NS	NS	NS	NS
	CV (%)	-	51.2	-	63.3	-	-

NS = not significant

Conclusions

K fertilizer additions failed to influence seed yield, seed quality or any measured agronomic parameter measured for both wheat and barley grown under dryland conditions in 2021. Irrigated spring wheat also did not respond to K fertilizer additions under irrigated production. Irrigated barley responded to K fertilizer additions with increased grain yield to all K applications. Mean yield response to K application was 17%. K fertilizer yield response was greatest where K fertilizer was side banded.

Fertilizer salt damage may have reduced the seed placed K fertilizer addition yield response. Optimal rate of K fertilizer for irrigated barley was 10 kg K_2O/ha.

Acknowledgements

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Developing Target Yield Nitrogen Fertilizer Recommendations for Silage and Grain Corn Under Irrigated & Dryland Production

Funding

Funded by the Agriculture Development Fund (ADF) and the Saskatchewan Cattlemen's Association

Project Lead

- ICDC Lead: Garry Hnatowich & Gursahib Singh

Objectives

Corn, either silage or grain, is presently considered a specialty crop within Saskatchewan and present acreage is limited. However, with the continued improvements in reduced Corn Heat Unit hybrids with earlier maturity and higher yields there is the potential for dramatically increased acreage. Estimates by Bayer Crop Science anticipate western Canadian corn acreage to be 7 million acres by 2027 (Dan Wright –personnel communication). Corn has high nitrogen (N) demand requirements to obtain high silage or grain yields. The SK Ministry of Agriculture's publication *Nitrogen Fertilization in Crop Production* indicates that a 100 bu/ac corn crop will require an N uptake of 138 – 168 lbs. N/ac. (1.38 – 1.68 lbs N/bu). However, in its *Crop Planning Guide 2019* it advises that corn be fertilized with 106 lbs. N/ac to achieve 99.1 bu/ac in all soil zones (1.07 lbs N/ac). I have been unable to locate any Saskatchewan data that actually evaluated fertilizer N rate responses of yield to soil test N levels and N uptake by corn. A recent ADF study conducted by PAMI did evaluate 3 N fertilizer rates with silage corn, with variable results, but did not attempt to define fertilizer N recommendations.

Across the major corn growing regions of Canada and the United States corn N recommendations have been based around yield goals. Reliable N fertilizer recommendations are critical to obtain maximum economic return, and as public concern and scrutiny builds, to minimize potential negative impacts of fertilizer N on the environment. Manitoba's N recommendations for corn were developed in 1985 and provide N recommendations for varying target grain or silage yields based on initial soil test N levels. Manitoba's present fertilizer N recommendations range from 0 to 260 lbs N/ac depending on soil test N levels in 0 – 24".

This study is intended to develop specific N fertilizer application rates to obtain specific target yields for both silage and grain corn production. Trials will be established under both irrigated and dryland production.

Research Plan

Six corn trials were established in the South Saskatchewan River Irrigation District (SSRID) in 2021. Three of these trials (CSIDC, ICDC, Peterson) where established under irrigated production and three (ICDC, Larson, Sommerfeld) established relying on rainfed (dryland) conditions. At each trial location both silage and grain corn trials were conducted. However, silage and grain corn were assessed independently, irrigated and dryland production assessed independently. The silage hybrid used at all sites was P7527AM, commonly grown in the SSRID, considered a dual-purpose silage or grain hybrid with a 2150 corn heat unit rating. The grain corn hybrid used was P7213R with a heat unit rating of

2050. The SSRID region accumulates 2200-2400 corn heat units annually. Irrigated trials were seeded to obtain final plant stands of 32,000 plants/acre and dryland 28,000 plants/acre. typically

Each trial was established in a randomized complete block design replicated four times. Plots consisted of 4 rows of corn at 75 cm row spacing. Soil samples from each control plot (0 fertilizer N, 4 plots for each silage and grain trial) were taken prior to seeding. Soil samples were obtained for the 0 – 15, 15 – 30, 30 – 60, 60 – 90 and 90 – 120 cm depths. Two soil samples were obtained from each plot and material composited for nutrient analyses. Total number of soil samples obtained was 240. A general composite for each site was also obtained from 0 – 15, 15 – 30, 30 – 60 cm depths. Samples were collected using a Giddings hydraulic soil sampler. Soil samples were submitted to Agvise Laboratories for nitrate ($N0_3$-N) analyses. Nitrogen fertilizer, as urea (46-0-0), was banded at 25 cm spacings across the width of plots at time of seeding. Nitrogen fertilizer was applied at the following rates to both silage and grain and irrigated and dryland trials:

N Treatments:

kg N/ha

1. 0
2. 50
3. 100
4. 150
5. 200
6. 250

All plots also received supplemental additions of monoammonium phosphate (11-52-0) seed-placed a rate of 30 kg P2O5/ha. Soil testing indicated adequate availability of sulphur, potassium, and micro-nutrients. Weed control was provided by pre-burn and in-season glyphosate applications. Biomass samples for %N and N Uptake determinations were obtained for both silage and grain corn trials at approximately the R3 growth stage. Samples were obtained by cutting down whole plants close to the soil surface. Biomass sample size was 1m length of each of the two center corn rows. Final yield harvest was obtained from the same center 2 corn rows and adjusted for the removed biomass area. Silage yield was obtained at approximately ½ milk line stage (target plant moisture 65-70%), grain corn yield was taken when kernels were hard (<12% moisture). Silage yields were obtained with a Hege small plot forage combine equipped with a mulching header, grain yields by hand picking all ears within the harvest area, ears were then dried and then thrashed through a stationary Wintersteiger plot combine.

Seasonal rainfall precipitation at all harvested locations was 109.5mm. The 30-year rainfall expectation is 247mm for the trialing region. Irrigation amounts at CSIDC was 218.4mm, at ICDC 259.1mm and at Pederson 208.3mm. Cumulative corn heat units (CHU) for the region in 2021 was 2683 CHU verses the 30-year average off 2350 CHU.

Trial Locations included:

1. CSIDC – Irrigated Silage and Grain Trials, Elstow loam, previous crop wheat.
2. ICDC – Irrigated Silage and Grain Trials, Elstow loam, previous crop canola.
3. Pederson – Irrigated Silage and Grain Trials, Asquith sandy loam, previous crop potato.
4. Larson – Dryland Silage and Grain Trials, Bradwell loam, previous crop canola.
5. Sommerfeld - Dryland Silage and Grain Trials, Bradwell loam, previous crop wheat.
6. ICDC - Dryland Silage and Grain Trials, Elstow loam, previous crop canola.

Results

Silage Corn – Irrigated

Composite soil test results from each irrigated silage corn trial are shown in Table 1. A high degree of variability was associated with soil sample NO_3-N at the CSIDC location. This location has had a history of small plot potato trials on the field and the variability found is attributed to the high fertilizer N rates used in prior studies. Consequently, soil analysis results from this location will not be used later when discussing N suppling capability and corresponding corn N uptake.

Table 1. Irrigated Silage Corn Control Treatment Soil Test Results, Spring 2021 Sample Timing.

		NO_3-N (kg N/ha) by Depth					
Location	0 kg N/ha treatments	0-15 cm	15-30 cm	30-60 cm	60-90 cm	90-120 cm	Total 0-120 cm
CSIDC	Rep 1	20.2	14.6	49.3	51.6	38.1	173.8
	Rep 2	46.0	69.5	109.9	87.4	60.5	373.3
	Rep 3	33.6	48.2	71.7	47.1	33.6	234.3
	Rep 4	21.3	10.1	9.0	17.9	31.4	89.7
ICDC	Rep 1	12.3	10.1	17.9	15.7	9.0	65.0
	Rep 2	12.3	10.1	15.7	11.2	13.5	62.8
	Rep 3	15.7	11.2	17.9	11.2	11.2	67.3
	Rep 4	13.5	7.8	13.5	11.2	11.2	57.2
Pederson	Rep 1	47.1	7.8	15.7	13.5	26.9	111.0
	Rep 2	33.6	15.7	35.9	15.7	20.2	121.1
	Rep 3	34.8	10.1	17.9	15.7	20.2	98.6
	Rep 4	39.2	9.0	15.7	20.2	24.7	108.7

Agronomic data collected for each of the irrigated silage corn trials are outlined in Tables 2, 3 and 4. Silage yield at CSIDC increased with N fertilizer additions up to 100 kg N/ha, at ICDC silage yield increased to 150 kg N/ha and at Pederson fertilizer N additions resulted in no yield response. Moisture content at time of silage harvest (approximately 1/2 milk line) ranged from mid-60% ICDC and Pederson to low-70% at CSIDC. Tissue N content did trend to numerically increase with N fertilizer rate additions at CSIDC and ICDC but were not statistically different at Pederson. Biomass tended to be variable at all three locations. Total N uptake increased at CSIDC to the 100 kg N/ha fertilizer rate then leveled at ICDC N uptake leveled at 150 kg N /ha while at Pederson no difference occurred. The lack of yield, tissue N and N uptake at the Pederson location is attributed, in part, to its establishment on potato stubble. It is believed that high rates of mineralization occurred at all sites due to the climatic conditions experienced through the growing season. This was particularly the case with potato stubble and tubers remaining after harvest at the Pederson location. In general, days to tassel and silking were not influenced by N fertilizer applications. Plants populations were not affected by N fertilizer rate, plant populations where higher than anticipated and attributed to excellent emergence and seedling survival.

Table 2: CSIDC Irrigated Silage Corn Trial Agronomics, 2021
Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).

N Rate	Dry Wt Yield (kg/ha)	Harvest Silage Moisture (%)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	10223 b	73.1 a	1.55 bc	6242 a	98 c	77 a	80 a	82692 a
50 kg N/ha	12264 ab	72.4 a	1.43 c	7887 a	112 bc	75 a	78 a	76099 a
100 kg N/ha	14581 a	71.3 a	1.74 ab	9946 a	173 ab	74 a	78 a	78297 a
150 kg N/ha	14178 a	70.9 a	1.69 ab	10368 a	168 ab	75 a	78 a	85165 a
200 kg N/ha	14335 a	72.4 a	1.65 ab	10061 a	165 ab	75 a	78 a	82143 a
250 kg N/ha	14259 a	72.2 a	1.84 a	10417 a	191 a	75 a	78 a	85165 a
LSD (0.05)	2845	NS	0.19	NS	65	NS	NS	NS
CV (%)	13.5	1.7	7.7	26.8	27.1	1.9	1.5	11.1

NS = not significant at P<0.05

Table 3: ICDC Irrigated Silage Corn Trial Agronomics, 2021
Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).

N Rate	Dry Wt Yield (kg/ha)	Harvest Silage Moisture (%)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	14305 c	68.1 a	0.92 e	10969 c	101 d	74 a	78 a	92583 a
50 kg N/ha	17148 b	67.0 a	1.09 d	13148 bc	141 cd	73 a	77 ab	85715 a
100 kg N/ha	18178 b	67.9 a	1.26 c	13063 bc	164 bc	73 a	76 bc	90385 a
150 kg N/ha	20459 a	66.7 a	1.47 a	17930 a	260 a	73 a	76 bc	93956 a
200 kg N/ha	22263 a	66.1 a	1.38 ab	13358 bc	182 bc	73 a	75 c	87912 a
250 kg N/ha	22465 a	65.9 a	1.34 bc	15416 ab	206 ab	73 a	76 bc	91484 a
LSD (0.05)	2258	NS	0.12	4036	56	NS	1.3	NS
CV (%)	7.8	1.9	6.2	19.2	21.0	0.8	1.3	8.5

NS = not significant at P<0.05

Table 4: Pederson Irrigated Silage Corn Trial Agronomics, 2021
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

N Rate	Dry Wt Yield (kg/ha)	Harvest Silage Moisture (%)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	23142 a	64.7 a	1.33 a	16916 a	225 a	75	79	81594 a
50 kg N/ha	24197 a	64.7 a	1.29 a	11889 a	154 a	75	79	82143 a
100 kg N/ha	21416 a	66.8 a	1.43 a	12907 bc	184 a	75	79	82143 a
150 kg N/ha	24252 a	65.5 a	1.42 a	15842 ab	224 a	75	79	84890 a
200 kg N/ha	23323 a	65.6 a	1.57 a	12907 bc	206 a	75	79	79945 a
250 kg N/ha	23234 a	65.4 a	1.48 a	13211 bc	196 a	75	79	84616 a
LSD (0.05)	NS	NS	NS	3476	NS	NS	NS	NS
CV (%)	8.9	2.8	11.1	16.5	24.3	-	-	9.3

NS = not significant at P<0.05

Silage dry matter yields vs fertilizer N applied from each site are illustrated in Figure 1. The relationship between dry matter yield and plant N uptake combined from all irrigated corn silage trials is illustrated in Figure 2. This uses an assumption that the line will derive from the axis transects whereby 0 N uptake produces 0 silage yield. In 2021 the best fit relationship between dry matter yield and N uptake is described by a polynomial relationship with an r^2 value of 0.5, it is anticipated the relationship will become stronger with additional site years of testing.

Figure 1. Irrigated Silage Dry Matter Yield vs N Fertilizer Applied by Location, 2021.

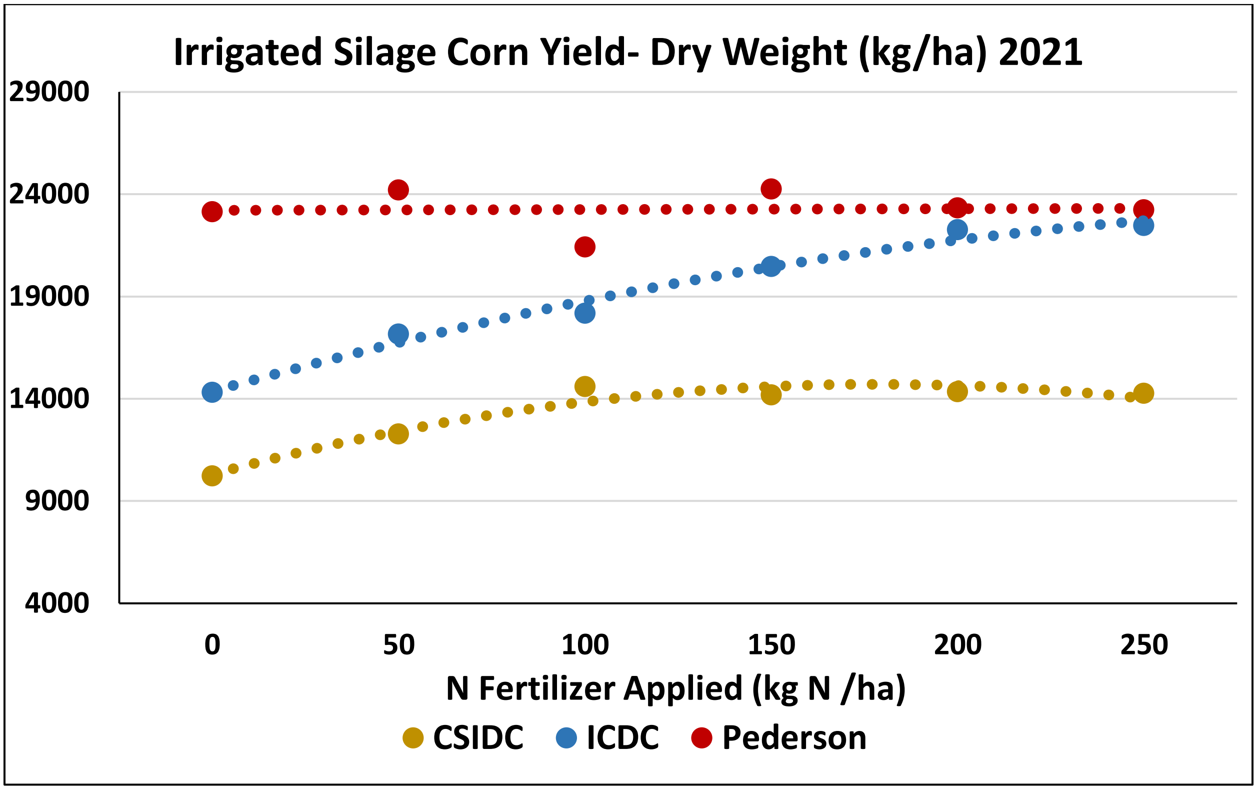
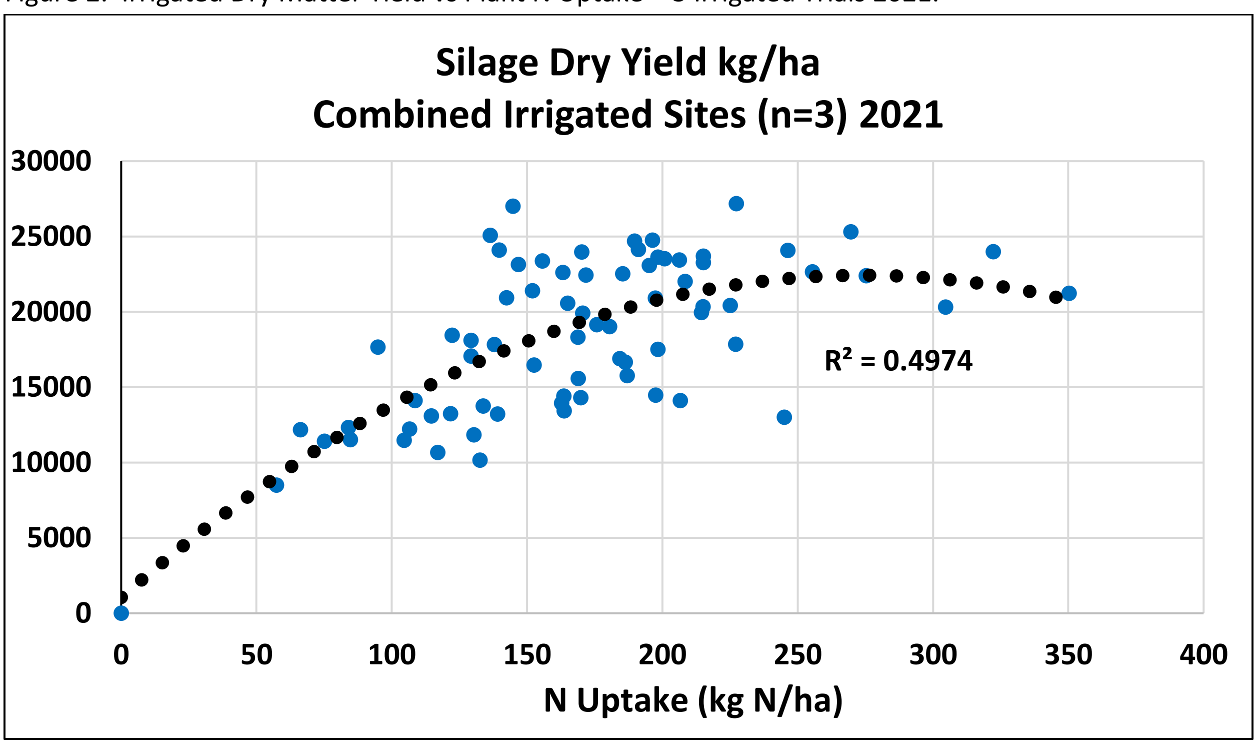


Figure 2. Irrigated Dry Matter Yield vs Plant N Uptake – 3 Irrigated Trials 2021.



Silage Corn – Dryland

Composite soil test results from each dryland silage corn trial is shown in Table 5. Unfortunately, dryland trials suffered from the consequence of the severe drought experienced in 2021. As previously indicated the South Saskatchewan Region Irrigation District in which all dryland trials (silage and grain) where located received only 44% of long-term average rainfall. Average temperature was also much higher than normal. Within the trial region daily maximum temperatures exceeded 30 °C 9 days in June, 17 days in July and 7 days in August. The dryland silage and grain corn trials located at both the Larson and Sommerfeld locations were abandoned by mid-July due to abnormal, atypical growth and development (picture 1). The only dryland silage and grain corn location to obtain harvest yields was at the ICDC location. These trials did not receive supplemental irrigation applications during the growing season but were located on irrigation land and undoubtably survived on subsoil moisture reserves from previous years irrigation applications.

Consequently, only results from the ICDC location will be discussed. Agronomic results obtained for the single dryland silage corn trial is shown in Table 6. Dry matter silage yield is illustrated in Figure 3. Silage yield increased to the 100 kg N/ha rate then generally leveled. Silage moisture content was higher with N rates of 150 kg N/ha and higher. Tissue N increased with increasing rates of fertilizer up to 150 kg N/ha then stabilized. Fertilizer N was not found to influence biomass yield at V2-3 growth stage, this result may be related to the corn simply surviving on limited soil moisture reserves from prior irrigation seasons. However, total N uptake did respond to fertilizer N applications. Neither days to tassel and silk nor plant population was influenced by N fertilizer rate.

With only a single dryland location the relationship between N uptake and yield will not be discussed. Once additional site years of data is collected this relationship will be explored.

Table 5. Dryland Silage Soil Sample NO_3-N Summary Results, Spring 2021 Sample Time.

Soil Depth	NO_3-N (kg N/ha) by Location		
	Larson	Sommerfeld	ICDC
0-15 cm (0-6”)	16.5	34.8	13.2
15-30 cm (6-12”)	14.3	31.4	7.3
30-60 cm (12-24”)	13.5	32.5	8.4
60-90 cm (24-36”)	6.7	19.6	6.7
90-120 cm (36-48”)	7.3	14.6	9.5
Total 0-120 cm (0-48”)	58.3	132.8	45.1

Table 6: ICDC Dryland Silage Corn Trial Agronomics, 2021

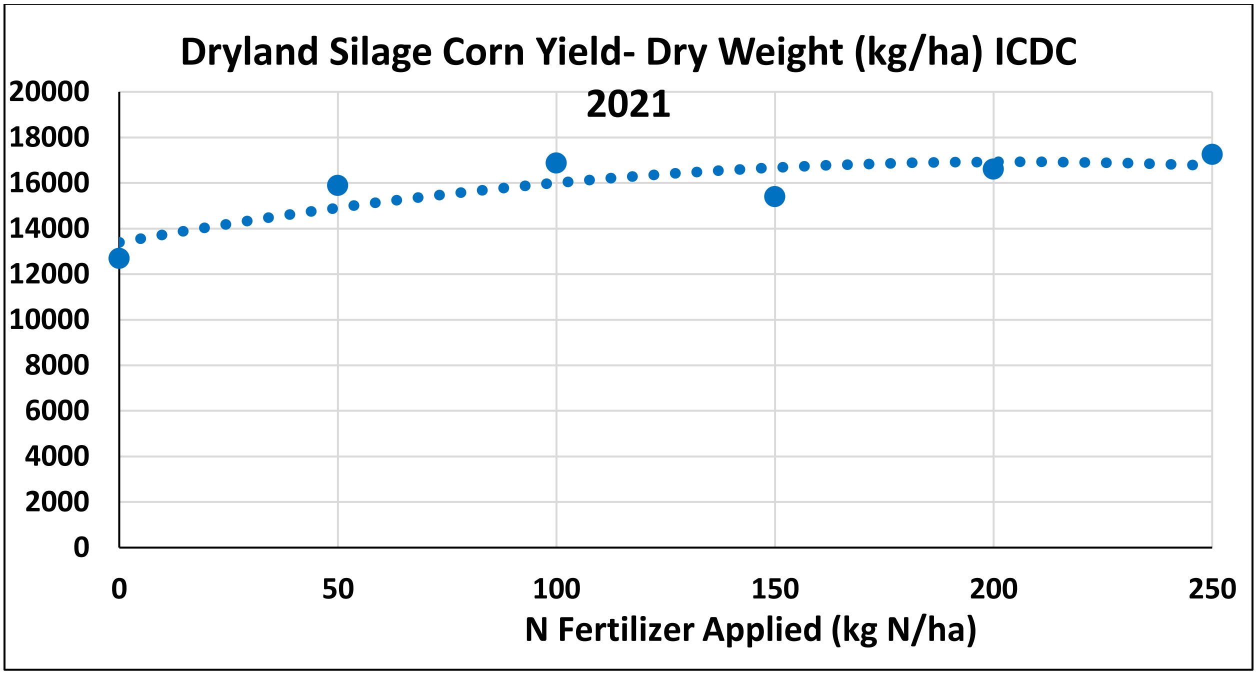
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

N Rate	Dry Wt Yield (kg/ha)	Harvest Silage Moisture (%)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	12678 d	61.9 b	1.0 c	10886 a	110 c	72 a	76 a	75549 a
50 kg N/ha	15891 bc	61.6 b	1.2 c	10214 a	121 c	72 a	76 a	80769 a
100 kg N/ha	16861 ab	61.8 b	1.4 b	9556 a	138 bc	73 a	76 a	76099 a
150 kg N/ha	15386 c	65.1 a	1.7 a	10605 a	179 a	73 a	77 a	78572 a

200 kg N/ha	16598 abc	65.6 a	1.8 a	9672 a	161 ab	73 a	76 a	71154 a
250 kg N/ha	17251 a	64.8 a	1.7 a	9822 a	167 ab	73 a	77 a	82143 a
LSD (0.05)	1310	2.5	0.19	NS	30	NS	NS	NS
CV (%)	5.5	2.6	8.9	12.3	13.5	0.7	1.2	10.2

NS = not significant at P<0.05

Figure 3. Dryland Silage Dry Matter Yield vs N Fertilizer Applied, ICDC 2021.



Grain Corn – Irrigated

Composite soil test results from each irrigated grain corn trial are shown in Table 7. Similar to the silage trial, a high degree of variability was associated with soil sample NO3-N at the CSIDC location. Consequently, soil analysis results from this location will not be used later when discussing N suppling capability and corresponding corn N uptake.

Agronomic data collected for each of the irrigated grain corn trials are outlined in Tables 8, 9 and 10. Grain corn yield at both CSIDC and ICDC increased with N fertilizer additions up to 100 kg N/ha, at Pederson fertilizer N additions resulted in no yield response. Grain starch content ranged from 70-72% at CSIDC, 70-71% at ICDC and maintained a consistent 71% at Pederson, N fertilizer rate had no or little impact on grain starch content (data not shown). Grain corn protein at CSIDC increased as N fertilizer rate increased, ranging from 8.7% protein at 0 kg N/ha to 10.3% protein at 250 kg N/ha. Grain protein at ICDC was lowest at 8.4% for the 0 kg N/ha rate and maximized at 10.2% at the 200 kg N/ha application. At Pederson grain protein was lowest at 9.3% for the 0 kg N/ha application and highest at 9.7% for the 150 kg N/ha rate (data not shown). Grain corn oil content was generally not affected by N fertilizer applications (data not shown).

Tissue N content did trend to numerically increase with N fertilizer rate additions at CSIDC and ICDC but were not statistically different at Pederson. Biomass tended to increase as N fertilizer rate increased at CSIDC and ICDC but did not respond to N fertilizer additions at Pederson. Total N uptake at CSIDC and

ICDC was highest at the 250 kg N/ha rate while at Pederson no difference occurred. The lack of yield, tissue N and N uptake at the Pederson location is attributed, in part, to its establishment on potato stubble. In general, days to tassel and silking were not influenced by N fertilizer applications. Plants populations were not affected by N fertilizer rate, plant populations where higher than anticipated and attributed to excellent emergence and seedling survival.

Table 7. Irrigated Grain Soil Sample NO_3-N Summary Results, Spring 2021 Sample Time.

Soil Depth	NO_3-N (kg N/ha) by Location		
	CSIDC	ICDC	Pederson
0-15 cm (0-6”)	17.4	10.1	19.3
15-30 cm (6-12”)	12.6	6.7	14.3
30-60 cm (12-24”)	31.4	5.0	12.9
60-90 cm (24-36”)	68.9	3.9	12.3
90-120 cm (36-48”)	70.1	3.1	18.5
Total 0-120 cm (0-48”)	200.4	28.9	77.3

Table 8: CSIDC Irrigated Grain Corn Trial Agronomics, 2021

Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

N Rate	Yield (kg/ha)	Yield (bu/ac)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	5014 c	79.9 c	1.4 c	6878 c	97 c	69 a	75 a	85440 a
50 kg N/ha	6090 bc	97.0 bc	1.6 b	9419 b	149 b	69 a	74 b	82967 a
100 kg N/ha	7361 a	117.2 a	1.6 b	9864 ab	159 b	69 a	73 b	92308 a
150 kg N/ha	6882 ab	109.6 ab	1.6 b	9972 ab	162 b	69 a	73 b	86813 a
200 kg N/ha	6829 ab	108.8 ab	1.7 ab	9045 bc	152 b	69 a	73 b	81868 a
250 kg N/ha	6704 ab	106.8 ab	1.8 a	12070 a	216 a	69 a	73 b	91484 a
LSD (0.05)	1076	17.1	0.16	2355	45	NS	0.5	NS
CV (%)	11.0	11.0	6.5	16.4	19.0	-	0.5	9.5

NS = not significant at P<0.05

Table 9: ICDC Irrigated Grain Corn Trial Agronomics, 2021
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

N Rate	Yield (kg/ha)	Yield (bu/ac)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	4016 c	63.9 c	0.8 c	7148 b	60 c	71 a	76 a	90660 a
50 kg N/ha	5867 b	93.5 b	1.1 b	10174 ab	112 b	69 a	75 a	90660 a
100 kg N/ha	6809 a	108.5 a	1.2 b	12726 a	149 ab	68 a	75 a	92033 a
150 kg N/ha	7197 a	114.7 a	1.4 a	11245 a	151 ab	69 a	76 a	94780 a
200 kg N/ha	7474 a	119.0 a	1.4 a	9699 ab	131 ab	68 a	75 a	95879 a
250 kg N/ha	6917 a	110.2 a	1.5 a	11375 a	165 a	68 a	76 a	83517 a
LSD (0.05)	967	15.4	0.14	3464*	43	NS	NS	NS
CV (%)	9.5	9.5	7.3	21.0	21.0	2.2	1.7	9.1

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

Table 10: Pederson Irrigated Grain Corn Trial Agronomics, 2021
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

N Rate	Yield (kg/ha)	Yield (bu/ac)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	9731 a	155.0 a	1.3 a	16487 a	204 a	67 a	72 a	82143 a
50 kg N/ha	9709 a	154.7 a	1.4 a	15880 a	217 a	67 a	72 a	82143 a
100 kg N/ha	10226 a	162.9 a	1.4 a	15333 a	212 a	67 a	72 a	87912 a
150 kg N/ha	9459 a	150.7 a	1.5 a	13479 a	204 a	67 a	72 a	85165 a
200 kg N/ha	9450 a	150.5 a	1.4 a	13138 a	189 a	67 a	72 a	82143 a
250 kg N/ha	10218 a	162.7 a	1.5 a	15129 a	222 a	67 a	72 a	85165 a
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	7.9	7.9	8.8	14.8	16.6	-	-	12.9

NS = not significant at P<0.05

Grain corn seed yield vs fertilizer N applied from each site are illustrated in Figure 4. The relationship between dry matter yield and plant N uptake combined from all irrigated corn silage trials is illustrated in Figure 5. In 2021 the best fit relationship between dry matter yield and N uptake is described by a polynomial relationship with an r2 value of 0.6, it is anticipated the relationship will become stronger with additional site years of testing.

Figure 4. Irrigated Grain Corn Seed Yield vs N Fertilizer Applied by Location, 2021.

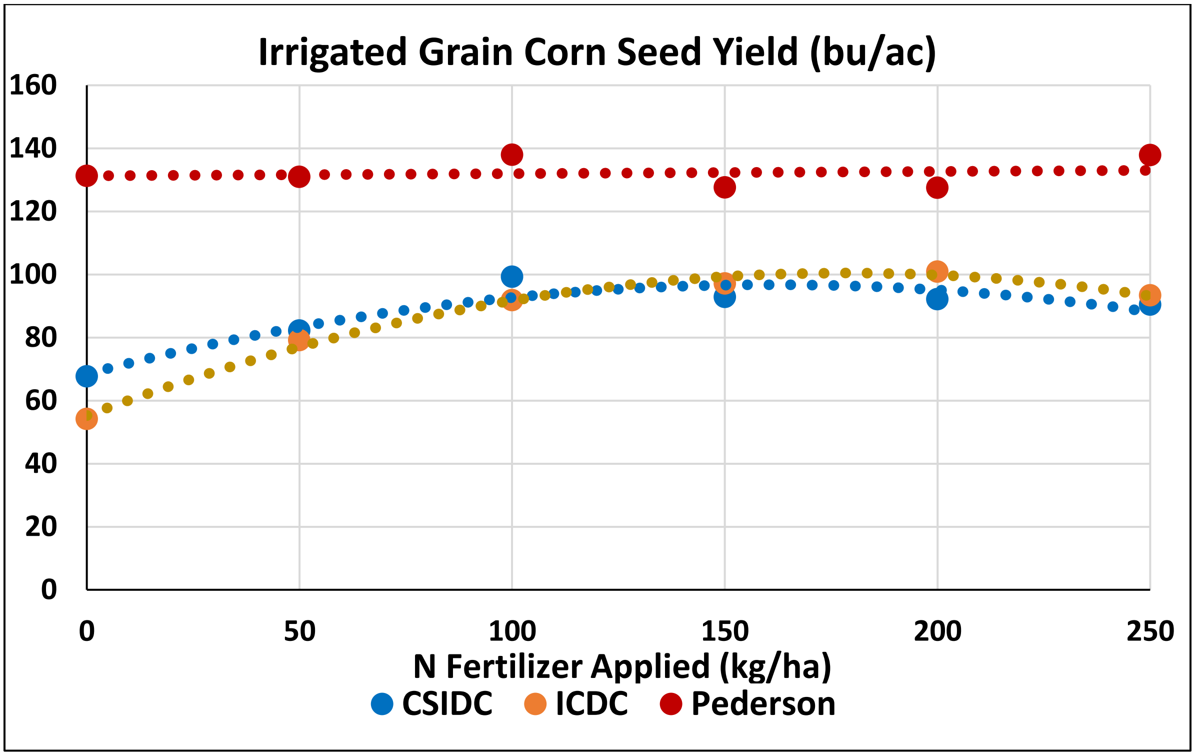
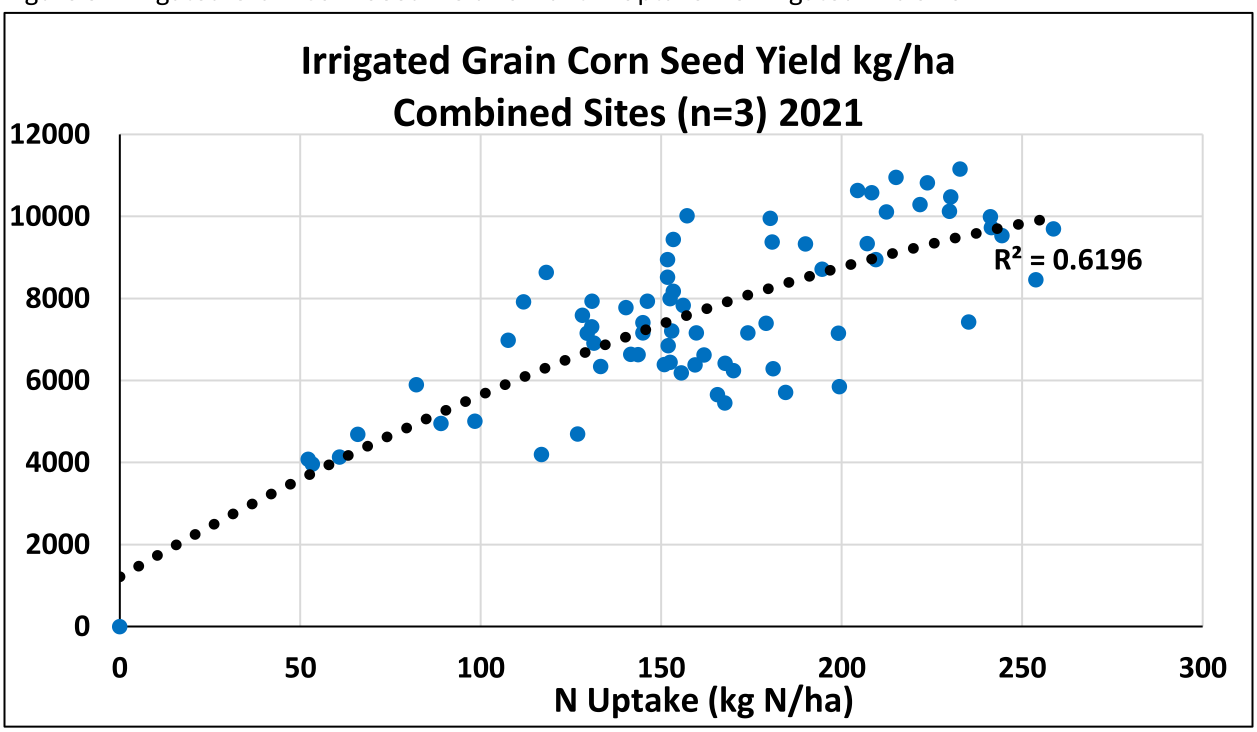


Figure 5. Irrigated Grain Corn Seed Yield vs Plant N Uptake – 3 Irrigated Trials 2021.



Grain Corn – Dryland

Composite soil test results from each dryland grain corn trial are shown in Table 11. As was the case with silage corn trials the dryland grain corn suffered from the consequence of the severe drought experienced in 2021. The dryland grain corn trials located at both the Larson and Sommerfeld locations were abandoned by mid-July due to abnormal, atypical growth and development (picture 1). The only dryland grain corn location to obtain harvest yields was at the ICDC location. This trial did not receive supplemental irrigation applications during the growing season but was located on irrigation land and undoubtably survived on subsoil moisture reserves from previous years irrigation applications.

Consequently, only results from the ICDC location will be discussed. Agronomic results obtained for the single dryland grain corn trial is shown in Table 12. Grain yield is illustrated in Figure 6. Corn grain yield increased to the 150 kg N/ha rate then began declining. Starch content of grain declined significantly as N fertilizer rates increased, with a high of 71.7% at the 0 kg N/ha rate to 70.0% at the 250 kg N/ha rate (data not shown). Conversely, seed protein content tended to increase with N fertilizer rate increases. At the 0 kg N/ha rate grain protein was 8.5% and maximized with the 200 kg N/ha treatment at 10.6% protein (data not shown). Fertilizer N applications had no effect on grain oil content. Tissue N also increased with increasing rates of fertilizer up to 150 kg N/ha then stabilized. Fertilizer N was not found to influence biomass yield at V2-3 growth stage, this result may be related to the corn simply surviving on limited soil moisture reserves from prior irrigation seasons. However, total N uptake did respond to fertilizer N applications greater than 50 kg N/ha. Neither days to tassel and silk nor plant population was influenced by N fertilizer rate.

With only a single dryland grain corn location the relationship between N uptake and yield will not be discussed. Once additional site years of data is collected this relationship will be explored.

Table 11. Dryland Grain Soil Sample NO_3-N Summary Results, Spring 2021 Sample Time.

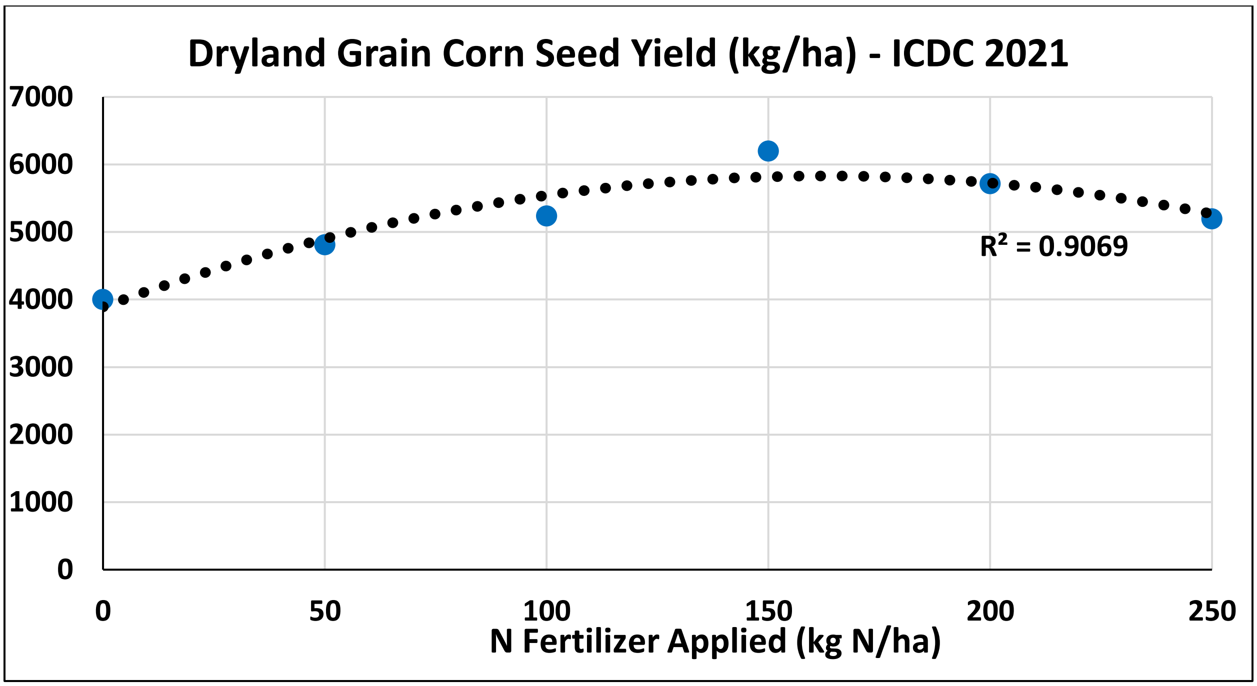
Soil Depth	NO_3-N (kg N/ha) by Location		
	Larson	Sommerfeld	ICDC
0-15 cm (0-6”)	14.0	23.8	17.9
15-30 cm (6-12”)	17.4	18.8	7.3
30-60 cm (12-24”)	23.5	25.8	11.8
60-90 cm (24-36”)	22.4	17.9	7.3
90-120 cm (36-48”)	10.1	16.8	6.7
Total 0-120 cm (0-48”)	87.4	103.1	51.0

Table 12: ICDC Dryland Grain Corn Trial Agronomics, 2021
Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

N Rate	Yield (kg/ha)	Yield (bu/ac)	Tissue N (%)	Dry Tissue Biomass (kg/ha)	N Uptake (kg/ha)	Days to Tassel	Days to Silk	Plant Population (plants/ha)
0 kg N/ha	4002 c	63.8 c	0.9 d	9867 a	91 c	68 a	74 a	81044 a
50 kg N/ha	4809 bc	76.6 bc	1.2 c	9361 a	108 bc	68 a	73 ab	74725 a
100 kg N/ha	5234 b	83.4 b	1.3 b	9666 a	128 b	68 a	73 ab	76923 a
150 kg N/ha	6196 a	98.7 a	1.5 ab	9035 a	132 ab	68 a	73 ab	78022 a
200 kg N/ha	5716 ab	91.0 ab	1.5 ab	11143 a	162 a	68 a	72 b	71978 a
250 kg N/ha	5191 b	82.7 b	1.5 a	9234 a	138 ab	68 a	73 ab	81044 a
LSD (0.05)	892	14.2	0.13	NS	33	NS	0.8	NS
CV (%)	10.8	10.8	6.6	17.8	17.3	-	0.7	13.2

NS = not significant at P<0.05

Figure 6. Grain Corn Seed Yield vs N Fertilizer Applied, ICDC 2021.



Soil Nitrogen Supplying Ability

To develop N fertilizer recommendations, it is required to assess the soil N availability to plants during the growing season. As indicated previously, detailed soil sampling, at numerous soil depths, were obtained from all control plots (0 kg N/ha treatments) for both silage and grain corn at all test locations.

The CSIDC irrigated location (silage & grain) demonstrated a high degree of variability and is therefore excluded from the following illustration. The relationship between spring soil test N analyses and N uptake by plants is shown in Figure 7.

Figure 7 demonstrates the soil test N relationship to N uptake for the total soil test N availability from the 0 – 60 cm (0-24") depth. Soil samples were obtained for the 0 – 15, 15 – 30, 30 – 60, 60 – 90 and 90 – 120 cm depths. Therefore, similar correlations can be conducted for differing soil analysis depths. As the study progresses through years 2 & 3 these will be evaluated.

The illustration indicates that in 2021 if a producer obtained a soil sample from 0 – 60 cm and it indicated soil N available levels of 30 kg N then during the growing season further mineralization would result in 100 kg N/ha being absorbed by the corn.

This correlation between soil test N and plant N uptake will continue to be built upon.

Fertilizer N Recovery

Fertilizer Use Efficiency (FUE) or Fertilizer-N Recovery Efficiency was defined as,

$$\%FUE = \frac{\text{Plant Nf} - \text{Plant } N_0}{\text{Fertilizer N Applied}} \times 100$$

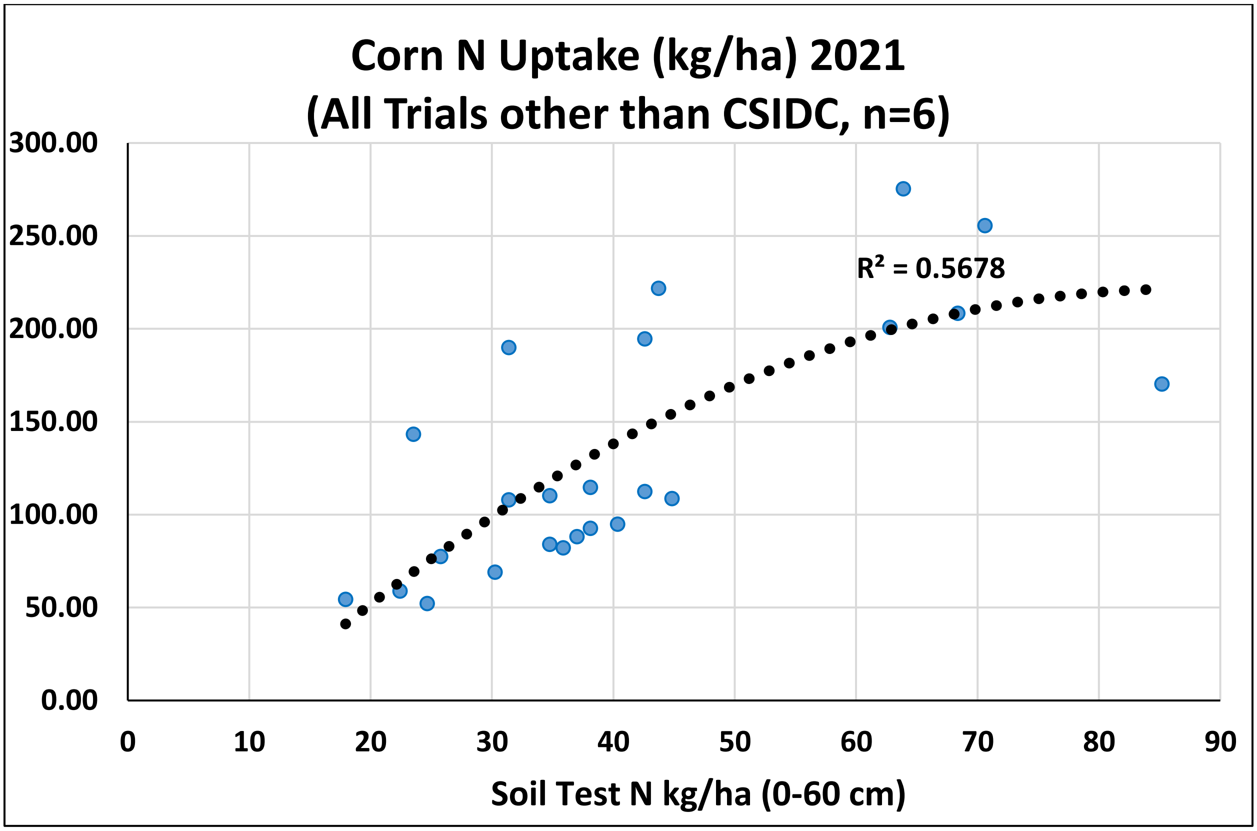
Where Plant Nf is the value of plant N uptake obtained at each rate of N fertilizer applied and N_0 is the plant N uptake from the 0 kg N/ha treatment. The plant N_0 value obtained from each rep was subtracted from each fertilizer treatment within that respective rep (i.e. if the value of N_0 in rep 1 was 117 kg N/ha this value was subtracted from the N uptake of all fertilized treatments within rep 1, if N_0 was 135 kg N/ha in rep 2 this value was subtracted from the N uptake of all fertilized treatments within rep 2, etc).

This formula was used to determine FUE for both irrigated silage and grain corn trials excluding the following.

1. If the calculation resulted in a negative value or a value > 100 the data point was not included. Such values are deemed due to sampling error or random experimental variation.
2. As Pederson was a nonresponsive yield site this location was not included.

Results indicated that %FUE for irrigated silage corn was 50.9% and for irrigated grain corn 48.1%. As these results are remarkably similar combining both silage and grain trials results in an overall FUE of 49.5%. In other words, approximately 50% of the fertilizer applied was used by the plant for growth and development. The remaining 50% would remain in the soil (mineralizable N and immobilized N) or have been lost (denitrification, leaching). FUE data is not shown but this information will be further calculated in subsequent years.

Figure 7. Relationship Between Soil Test N and Plant N Uptake, 2021.



Picture 1. Larson Dryland Corn, July 2021. The corn is starting to tassel, height <90 cm!

Demonstrating Spring Wheat Phosphorous Fertilizer Response on a Severely Phosphorous Deficient Irrigated Field

Year 2 – Canola Planted on Previous Wheat Plots

Funding

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

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Outlook

Project Lead

- Principal Investigators: Wheatland Conservation Area (WCA), Swift Current
- ICDC Leads: Garry Hnatowich & Gursahib Singh

Objectives

The objective of this project was to evaluate the yield response of spring wheat to varying rates, time, and placement of phosphorus (P) fertilizer on a deficient P soil under irrigated production. The importance of appropriate P fertilization in Saskatchewan has been demonstrated amply since the 1950s. Yet, many Saskatchewan soils continue to decline in soil test available P, with P exported in grain exceeding annual P inputs from fertilizer additions. This trial demonstrates the influence of P fertilization and its importance on spring wheat yield on land where years of under-fertilization has resulted in very low soil test available P.

Saskatchewan soils are among the lowest in North America with respect to available P levels (Fixen et al., 2010). Reasoning for this include uncontrollable factors such as soil parent material. However, present agricultural practices have contributed to low soil P values. These factors include cultural factors such as unwillingness to invest fertilizer dollars on rented land and risk aversion (short or long term) in terms of input investment, markets, or to yield limiting growing season precipitation. In 2017, ICDC acquired a rental agreement with the Town of Outlook for a 14-acre parcel of land immediately adjacent to the AAFC-Outlook Research Station. Prior to 2017, this land was annually cropped under dryland conditions on a rental agreement with local producers. Upon acquiring the land base, soil testing indicated levels of soil test available P of 2 ppm. ICDC bought and installed a linear irrigation system on this field and converted it to irrigation production.

This field offers a unique opportunity to demonstrate the importance of P fertilization to Saskatchewan producers. In accordance with defining Best Management Practices (BMPs), we will evaluate the influence of P application timing, rate, and placement. This trial will also strengthen the Ministry of Agriculture's memorandum of understanding with Fertilizer Canada to demonstrate and develop 4R fertilizer strategies in Saskatchewan.

Research Plan

<u>2020</u>

In the fall of 2019, a field demonstration with spring wheat was established on ICDC land rented from the Town of Outlook and adjacent to the federal CSIDC Research Station (Field 51). The trial was established in a randomized complete block design and each treatment was replicated 4 times. The trial was direct seeded into canola stubble on May 14, 2020. A composite soil sample was collected from the study area and submitted to AgVise Laboratories for analysis. Total soil NO_3^-- N in the 0 to 60 cm profile was 7.8 kg N/ha and residual soil P was relatively low at 2 ppm (4.5 kg P/ha).

Nitrogen fertilizer (urea, 46-0-0) was side-banded in either the spring or fall at a rate of 120 kg N/ha. Phosphorous fertilizer (monoammonium phosphate, 12-51-0) was either side-banded in the fall, side-banded in the spring, or seed-placed in the spring at rates of 20 kg P_2O_5/ha (20P), 40 kg P_2O_5/ha (40P), and 60 kg P_2O_5/ha (60P). Treatments 1 and 5 (spring and fall control treatments) did not receive any P fertilizer additions (0P). Fertilizer treatments are shown in Table 1.

Table 1. Nitrogen and phosphorous fertilizer treatments established in 2019/2020.

Trt	N Rate (kg N/ha)	N Placement	P Rate (kg P_2O_5/ha)	P Placement
1	120	Fall Side-Band	0	-
2	120	Fall Side-Band	20	Fall Side-Band
3	120	Fall Side-Band	40	Fall Side-Band
4	120	Fall Side-Band	60	Fall Side-Band
5	120	Spring Side-Band	0	-
6	120	Spring Side-Band	20	Spring Side-Band
7	120	Spring Side-Band	40	Spring Side-Band
8	120	Spring Side-Band	60	Spring Side-Band
9	120	Spring Side-Band	20	Spring Seed-Placed
10	120	Spring Side-Band	40	Spring Seed-Placed
11	120	Spring Side-Band	60	Spring Seed-Placed

2021

In May of 2021 canola was seeded onto existing wheat stubble plots. No additional P fertilizer was applied, the only P available to plants would derive from native soil reserves and initial P fertilizer applications. Canola was seeded on May 7, 2021. All plots received a side band application of nitrogen fertilizer at 135 kg N/ha as urea. A heavy flea beetle population resulted in an application of Matador (lambda-cyhalothrin; 35 ml/ac). Weed control consisted of a post-emergence tank mix application of Liberty 150 SN (glufosinate; 1.6 L/ac) and Centurion (clethodim; 50 ml/ac) plus Amigo adjuvant (250 ml/ac) applied June 4. Control of sclerotinia, black spot and blackleg was with an application of Priaxor (fluxapyroxad + pyraclostrobin; 180 ml/ac) on July 8. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh. Harvest plot size was 8 m x 1.5 m. The trial was harvested August 13, 2021. Harvested samples were cleaned, and yields were adjusted to a moisture content of 10%.

Total in-season rainfall (May-August 13) was 76.3 mm (4.7”) and total in-season irrigation was 151 mm (9.2”).

Results & Discussion

The 2021 growing season was much warmer and extremely dry in comparison to the 30-year region average. During canola flowering the average daily temperature was 30.3 °C. Flowering duration was shortened, and flower abortion noticeable. Environmental conditions are believed to have limited treatment effects in 2021 as average yields were much lower than typical for irrigation.

Rate Response

Canola seed yield, seed quality and measured agronomic observations to prior P fertilizer additions are shown in Table 2. Differences in oil content, test weight, 1,000 kernel weight, days to maturity plant height and lodging were driven by the rate of P fertilizer applied and were not influenced by timing (spring vs. fall) or placement (side-band vs. seed placed) (ANOVA, $P \leq 0.05$). Yield significantly increased with increasing P fertilizer rate (Table 2, illustrated in Figure 1). Canola incremental additions of 20 kg P_2O_5 increased yield by 6%, 4% and 4%. This yield response is considerably less than the response obtained with wheat to P fertilizer rate. In 2020 with wheat the incremental additions of 20 kg P_2O_5 increased yield by 78%, 16%, and 11%. However, these results indicate that original P fertilizer additions were still contributing to canola 15 to 22 months after application. As previously reported in the 2020 interim report, on a typical fertilizer response curve (Figure 2), (A) yield increases with increasing fertilizer rate (nutrient supply is limiting) until maximum efficiency is reached, (B) yields are unaffected by increasing fertilizer rate (nutrient supply is non-limiting) and finally, (C) yields decrease with increasing fertilizer rate (nutrient supply is in excess) due to nutrient and salt toxicities (McKenzie et al., 2003). In this experiment, it is possible that the highest application rate of 60P was still in the deficient range and maximum potential yield was not realized even in the second year after fertilizer applications (Figure 1).

Canola seed oil content increased at each 20 kg P_2O_5 addition, which would benefit the crushing industry. Although seed protein was not measured it is suspected that protein would decrease with each incremental P fertilizer addition, given the inverse relationship usually occurring between % oil and % protein. P fertilizer rates did not influence canola test weight or seed weight. Days to flower and maturity decreased as P rates increased. The difference in maturity between the 0 kg P_2O_5 and the 60 kg P_2O_5 rates was 3 days – an agronomically important difference in crop and harvest management. Increasing P rates increased plant height but reduced lodging, another important crop management factor.

Time/Placement Response

Time and placement of fertilizer P application did influence canola yield in year 2 (Figure 3). The seed placed P produced less yield compared to the band P applications. This might be attributable to more P used by wheat in year 1 (highest yielding treatment) and/or soil surface soils rapidly drying due to intensive heat between irrigation scheduling stranding residual P in the seed placed position. Time/placement of P fertilizer applications had little or no impact on any other seed or plant growth characteristic.

Table 2. Canola yield, seed quality and agronomic observations at each application rate and timing/placement. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

P Rate/Timing/ Placement	Yield (kg/ha)	Oil (%)	Test Weight (kg/hl)	TKW (g/1000)	Flower (days)	Maturity (days)	Height (cm)	Lodging (1-10)
Rate (kg/ha)								
0	2100 *c*	47.2 *c*	65.9 *a*	3.9 *a*	45.8 *a*	87.8 *a*	74 c	1.7 *a*
20	2233 b	48.0 *bc*	62.9 a	3.8 *a*	45.6 *a*	85.7 *b*	81 *b*	1.1 *b*
40	2316 a*b*	48.5 *ab*	62.7 *a*	3.9 *a*	45.5 *a*	85.1 *b*	89 a	1.1 *b*
60	2401 *a*	49.0 *a*	62.8 *a*	3.8 *a*	44.7 b	84.9 *b*	89 a	1.0 *b*
LSD (0.05)	124	1.0	NS	NS	0.5	1.0	7	0.4
CV (%)	5.8	2.3	6.0	3.4	1.2	1.2	9.7	37.0
Timing/Placement								
Fall Side-Band	2301 *a*	47.7 *a*	62.9 *a*	3.8 *a*	45.2 *b*	85.8 *a*	82 a	1.2 a
Spring Side-Band	2326 *a*	48.6 *a*	64.2 *a*	3.8 *a*	45.2 *b*	85.5 *a*	83 a	1.2 *a*
Spring Seed-Placed	2161 b	48.2 *a*	63.6 *a*	*3.9 a*	45.7 *a*	86.4 *a*	84 *a*	1.3 *a*
LSD (0.05)	107	NS	NS	NS	0.4	NS	NS	NS
Rate x Timing/Placement								
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Figure 1. Mean effect if P fertilizer rates (applied Sept. 2019 or May 2020) on canola yield.

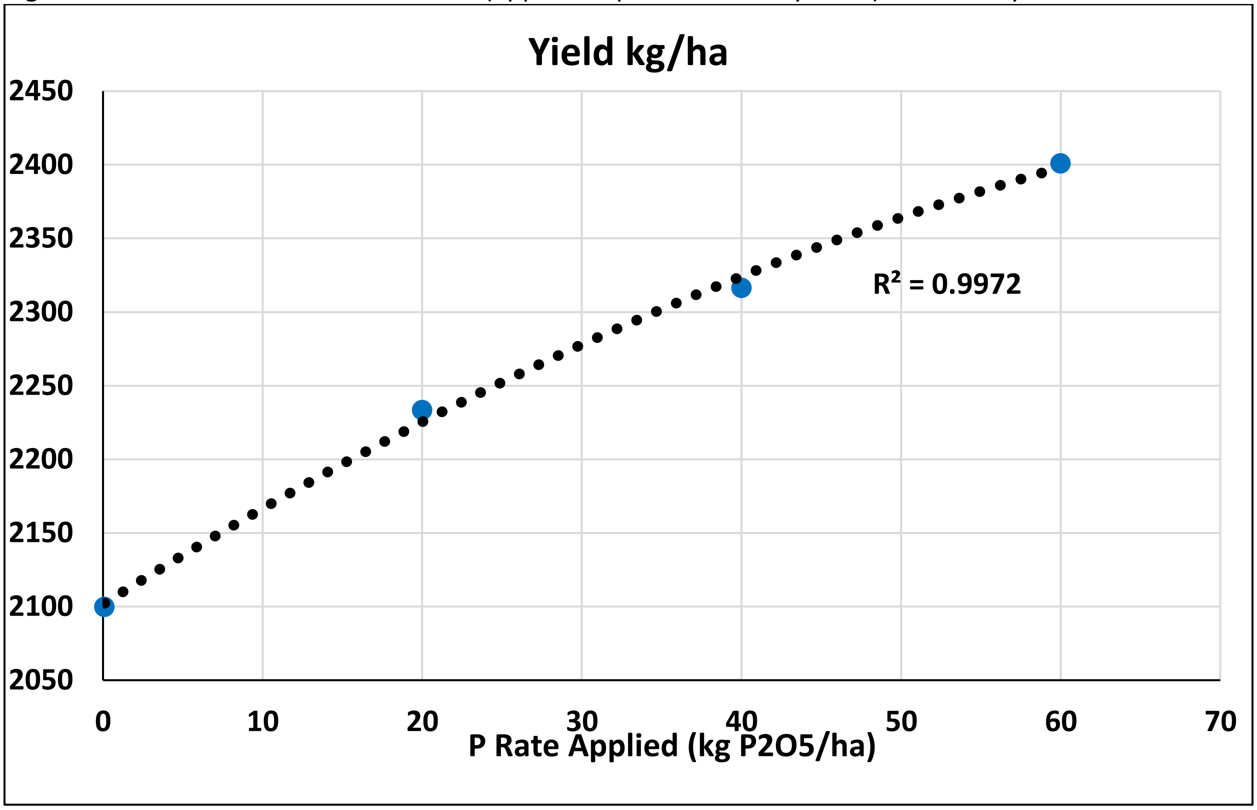


Figure 2. Typical fertilizer response curve (McKenzie et al., 2003).

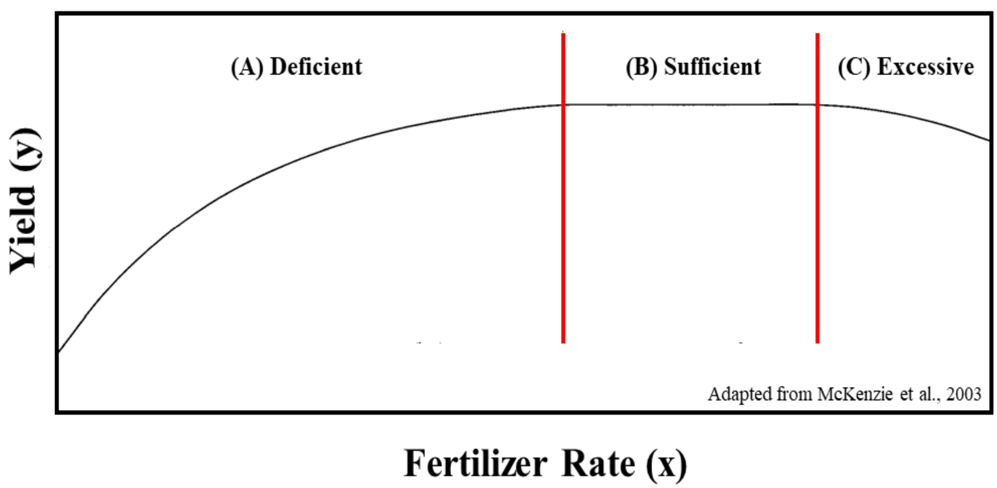
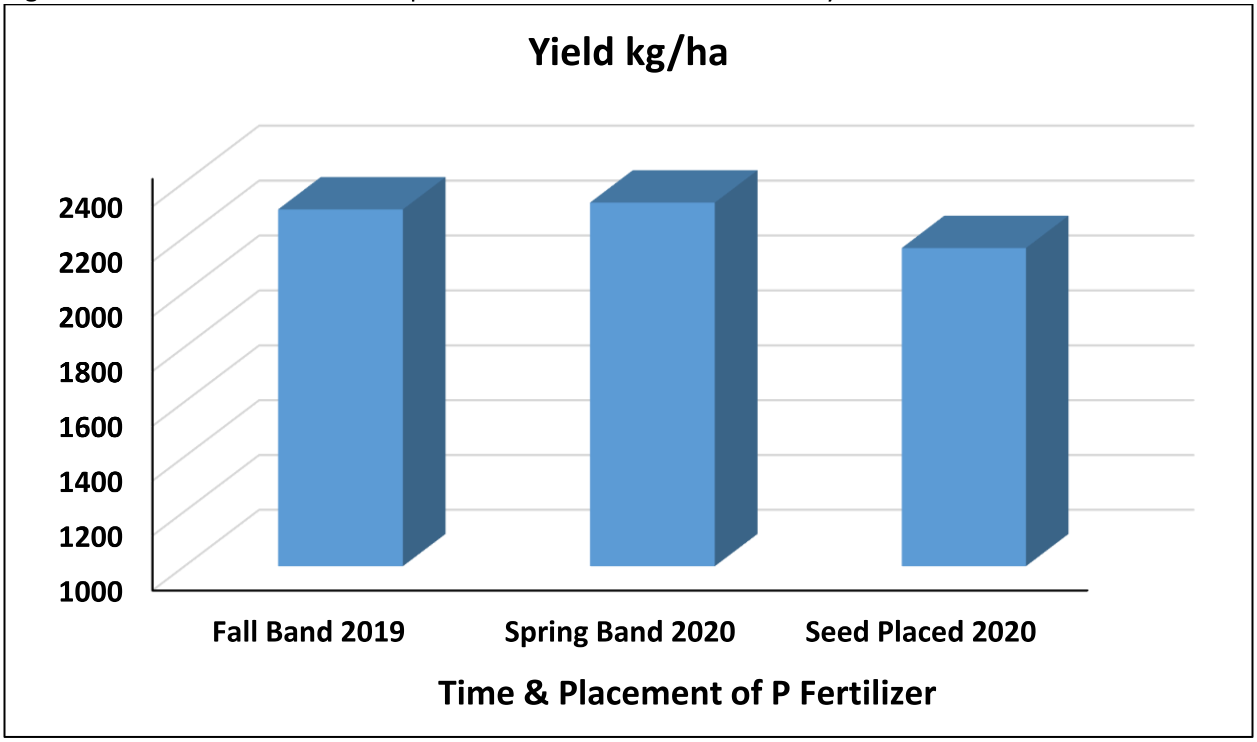


Figure 3. Mean effect of time and placement of P fertilizer on canola yield.



Conclusions

In this study, the rate of P fertilizer applied was the most signifcant factor driving differences in most agronomic observations when applied to a soil with very low soil testing P. Time and placement were less important, only resulting in marginal differences. In this study, the 60P application rate generated the highest yield in both spring wheat produced in year-1 and canola produced in year-2. There was no evidence of fertilizer toxicity or detrimental effects to any seed quality or plant growth parameters. Based on a low soil test results, producers should be able to gain crop benefits from applying P fertilizer whether it is side-banded in the fall, side-banded in the spring, or placed with the seed. The greatest benefit occurred from application of the first 20 kg P_2O_5/ha increment, with additional 20 kg P_2O_5/ha increments still providing yield gains that would be economically viable. This study also demonstrated that on a low testing P soil the addition of P fertilizer provides residual P availablity beyond the year of application. Typically, many agronomists advise producers that available fertilizer P quickly beomes less available and residual benefit small. This advise may apply to soils with medium to high levels of soil P but the benefit should not be overlooked on low P soils. The study clearly demonstrated the agronomic benefit and importance of adequate P plant nutrition and it's importance to yield and plant development. A fertilizer P management strategy which builds available soil P is highly recommended on these low testing P soils.

Acknowledgements

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Canola Seed Safety and Yield Response to Novel Phosphorus Sources in Saskatchewan Soils

Funding

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

Organizations

- Indian Head Agricultural Research Foundation (IHARF), Indian Head
- Irrigation Crop Diversification Corporation (ICDC), Outlook
- Wheatland Conservation Area (WCA), Swift Current
- East Central Research Foundation (ECRF), Yorkton
- South East Research Farm (SERF), Redvers
- Western Applied Research Corporation (WARC), Scott

Project Lead

- IHARF Lead: Chris Holzapfel
- ICDC Leads: Garry Hnatowich & Gursahib Singh

Objectives

As of 2015, 81% of Saskatchewan soil samples had P levels that were below the critical levels and the average pH was 7.4. Higher pH soils, common throughout much of eastern Saskatchewan, also lead to reduced P fertilizer use-efficiency. While Saskatchewan farmers are becoming increasingly aware of the long-term importance of P fertilization and many would like to maintain or build soil residual levels over the long-term, P fertilizer use-efficiency in the year of application is notoriously low (generally below 30%). Consequently, many growers seek to improve this efficiency and see premium formulations (i.e., MES15, Alpine P, and Crystal Green) as possible solutions to this challenge. Due to equipment limitations, only granular P fertilizer products can be included in the proposed demonstration; therefore, the forms are limited to MAP, MES15®, and Crystal Green® (struvite).

Canola is known to be a large user of P and, compared to many crops, responsive to fertilizer applications. Additionally, high rates of seed-placed P fertilizer can reduce seedling survival and establishment in sensitive crops such as canola; however, many prefer to place at least some P in the seed row to ensure it is not limiting early in the season. While P fertilization will typically result in higher canola yields when residual levels of this nutrient are low, the response is sometimes most evident early in the season when more vigorous growth is frequently observed with P fertilization. This is commonly referred to as a 'pop-up' effect and is primarily attributed to seed-placed P fertilizer but can also be observed with side-banded P. The greatest advantages to seed-placed P compared to other placement options are often observed under dry conditions (due to reduced mobility of P in solution) but, unfortunately, this is also when the risk of seedling injury is highest. While side-banding is widely recognized as a viable, safe application method, the majority of P applied during seeding is placed in seed-row (51% by volume compared to 36% for side-banding, Stratus Ag Research 2015).

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Struvite is marketed under the brand name Crystal Green® (5-28-0 plus 10% Mg) and, according to promotional material, boasts superior crop safety with a salt index of 7.7 (compared to 27 for MAP and 21 for MES15) along with improved season long availability relative to more traditional products (crystalgreen.com/nutrient-recovery). While it does not appear in the scientific literature or regional field trials to the same extent as MAP or diammonium phosphate, relevant peer-reviewed research on struvite as a P fertilizer source does exist. Early work at the University of Manitoba found that struvite (whether derived from liquid manure or chemically pure) increased dry matter yields and P recovery over the control but not to the same extent as MAP. The authors suggested that this may have been due to the lower initial solubility of struvite in the high pH Manitoba soils (Ackerman et al. 2013). In later evaluations with wheat and canola, Katanda et al (2016) saw similar early season dry matter yield and uptake efficiency with struvite compared to MAP and, at higher rates, greater biomass yields and P recovery with struvite during the later crop phases. They concluded that struvite could supply sufficient P to sustain yields and achieve overall P use-efficiencies matching or exceeding those for MAP. Citing Ag Quest trials with canola, the company boasts 16% higher plant populations and an 11% yield advantage to struvite compared to 111 kg/ha (total product) of MES15 (crystalgreen.com/agriculture/canola). While there is solid evidence that struvite is effective as a P fertilizer source, independent evaluations under Saskatchewan field conditions will help increase producer awareness and of this product and help them understand if and/or how it may fit in their operations.

Therefore, the objectives are to demonstrate canola response to increasing rates of struvite (i.e. Crystal Green), alone or in a blend, relative to other common phosphorus (P) fertilizer formulations with a focus on stand establishment and seed yield.

Research Plan

The trial was established on ICDC rented land within the South Saskatchewan River Irrigation District (NE17-28-07-W3) on an Elstow loam previously planted to potato. Treatments consisted of a control (no P fertilizer applied), four fertilizer forms applied at three differing rates. The trial was established in a randomized complete block design with four replications. The thirteen treatments are shown in Table 1. All P fertilizer additions were seed-placed at the time of seeding. Nitrogen fertilizer was applied as urea (46-0-0), however, adjustments were made to rates applied to account for the N content in the P fertilizer sources. Therefore, the N fertilizer was balanced across all treatments to apply a total of 100 kg N/ha. Soil available sulphur and potassium were not limiting at this site.

Table 1. Source & Rate of Novel P Fertilizers

Trt #	Fertilizer Form*	P Rate
1	Control	0 kg P_2O_5/ha
2	100% MAP	25 kg P_2O_5/ha
3	100% MES_{15}®	25 kg P_2O_5/ha
4	100% Crystal Green®	25 kg P_2O_5/ha
5	50% MAP + 50% Crystal Green®	25 kg P_2O_5/ha
6	100% MAP	45 kg P_2O_5/ha
7	100% MES_{15}®	45 kg P_2O_5/ha
8	100% Crystal Green®	45 kg P_2O_5/ha
9	50% MAP + 50% Crystal Green®	45 kg P_2O_5/ha
10	100% MAP	65 kg P_2O_5/ha
11	100% MES_{15}®	65 kg P_2O_5/ha
12	100% Crystal Green®	65 kg P_2O_5/ha
13	50% MAP + 50% Crystal Green®	65 kg P_2O_5/ha

*MAP (11-52-0), MES_{15}® (13-33-0-15), Crystal Green® (5-28-0-0-10% Mg)

The trial was seeded with L232P canola on May 6 at a seeding rate of 200 seeds/m^2. Weed control involved a spring pre-seed application of granular incorporated Edge (ethalfluralin) at 6.9 kg/ac, a glyphosate pre-seed burn-off at 1.33 L/ac and in-season tank mix application of Liberty 150 SN (glufosinate; 1.6 L/ac) applied June 17. Control of sclerotinia, black spot and blackleg was with an application of Priaxor (fluxapyroxad + pyraclostrobin; 180 ml/ac) on July 8. Yields were estimated by direct cutting the entire plot with a small plot combine when the plants were dry enough to thresh. Harvest plot size was 8 m x 1.5 m. Plant emergence and final plant density were obtained by counting the number of seedlings in a 1m length of 4 differing rows (2 from the front, 2 from back of individual plots) on June 2 and immediatley after harvest, respectively. The trial was harvested by direct combining on September 8, 2021. Harvested samples were cleaned, and yields were adjusted to a moisture content of 10%.

Soil samples were obtained prior to fertilizer applications and soil nutrient levels determined by Agvise Labs, results are shown in Table 2

Table 2. Soil Test Available Nutrients

Depth (cm)	**pH**	**O.M. (%)**	**C.E.C.**	**NO_3-N (kg N/ha)**	**P (ppm)**	**K (ppm)**	**SO_3-N (kg S/ha)**
0 – 15	7.9	2.7	19.9	33	11	239	128
15 – 30				15			>135
30 - 60				29			

Total in-season rainfall from May through August 17 was 84.1 mm (3.3”). Total in-season irrigation applied was 208.3 mm (8.2”).

Results

Canola seed yield and seed quality characteristics obtained are shown in Table 3. Canola yield was not significantly influenced by P fertilizer additions regardless of form or rate applied. Although the growing season was extremely warm and dry overall yields were surprisingly high. Although canola flowering deration was not recorded it appeared that flowering time was shortened due to temperature and some flower abortion was noticed. However, irrigation was undoubtably extremely beneficial and yields better than expected (though less than often obtained in irrigated research plots). Soil testing procedures indicated the soil contained 11 ppm P_2O_5 (25 kg P_2O_5/ha) and recommended a fertilizer application of 32 kg P_2O_5/ha. The lack of a P fertilizer rate response suggests that plant available P was being released through a dynamic P cycling system enhanced by high temperatures (14 days during July exceeded 30 °C) and intensive irrigation applications. Canola seed oil content, test weight and seed weight were also not influenced by fertilizer applications.

Table 3. Canola Seed Yield & Seed Quality as Affected by P Fertilizer Applications, 2021
Different letters indicate significant differences between treatments (ANOVA, $P \leq 0.05$).

Trt #	Fertilizer Form	P Rate	Yield (kg/ha)	Yield (bu/ac)	Oil %	Test Weight (kg/hl)	TKW (gm/1000)
1	Control	0 kg P_2O_5/ha	4585 a	81.8 a	45.5 a	62.7 a	4.5 a
2	100% MAP	25 kg P_2O_5/ha	4546 a	81.1 a	45.5 a	62.7 a	4.1 a
3	100% MES_{15}®	25 kg P_2O_5/ha	4372 a	78.0 a	44.6 a	63.1 a	4.4 a
4	100% Crystal Green®	25 kg P_2O_5/ha	4664 a	83.2 a	45.6 a	63.1 a	4.2 a
5	50% MAP + 50% Crystal Green®	25 kg P_2O_5/ha	4317 a	77.0 a	45.4 a	63.5 a	4.3 a
6	100% MAP	45 kg P_2O_5/ha	4422 a	78.9 a	45.7 a	63.4 a	4.2 a
7	100% MES_{15}®	45 kg P_2O_5/ha	4959 a	88.5 a	45.4 a	63.2 a	4.2 a
8	100% Crystal Green®	45 kg P_2O_5/ha	4235 a	75.6 a	45.2 a	63.3 a	4.3 a
9	50% MAP + 50% Crystal Green®	45 kg P_2O_5/ha	4545 a	81.1 a	45.5 a	63.0 a	4.2 a
10	100% MAP	65 kg P_2O_5/ha	4536 a	80.9 a	46.1 a	63.0 a	4.3 a
11	100% MES_{15}®	65 kg P_2O_5/ha	4317 a	77.0	45.6 a	63.5 a	4.2 a
12	100% Crystal Green®	65 kg P_2O_5/ha	4602 a	82.1 a	45.7 a	63.2 a	4.2 a
13	50% MAP + 50% Crystal Green®	65 kg P_2O_5/ha	4678 a	83.5 a	45.6 a	63.1 a	4.3 a
		LSD (0.05)	NS	NS	NS	NS	NS
		CV (%)	8.6	8.6	1.4	0.8	3.7

NS = not significant at P<0.05

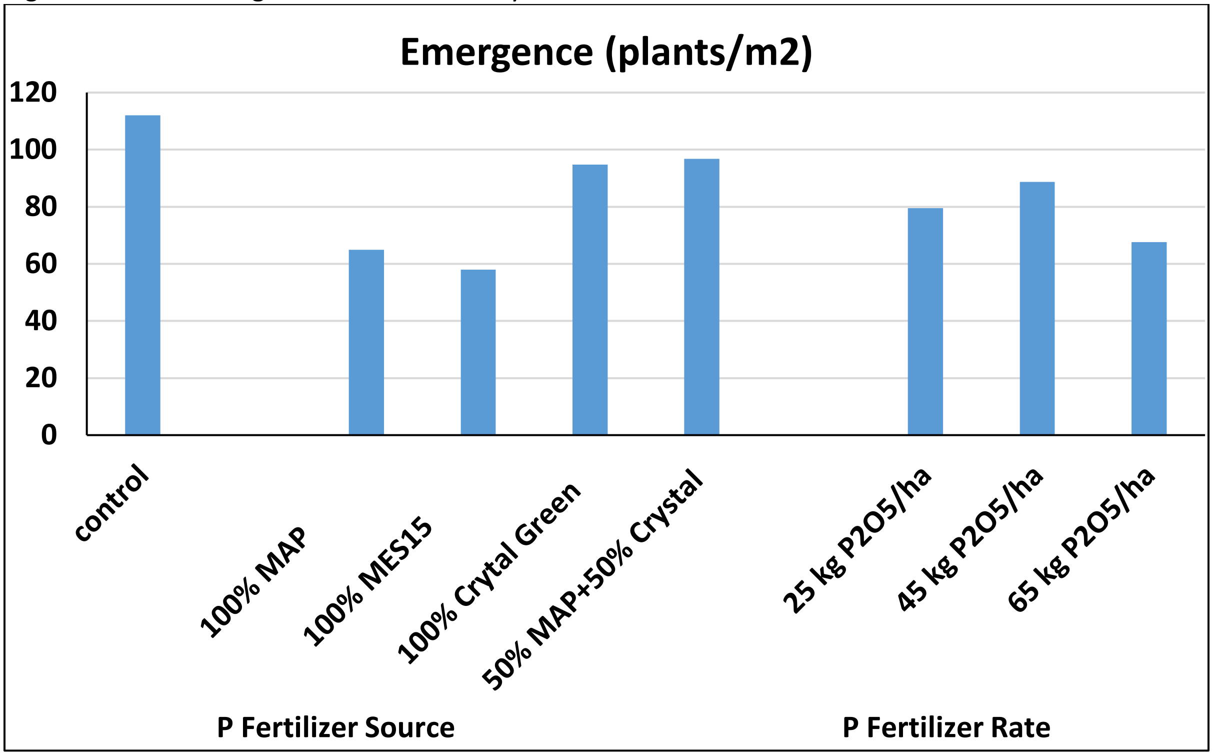
Measured canola plant growth characteristics are provided in Table 4. Canola plant emergence was influenced by both fertilizer P source and by P rate. The overall effect of P source and rate is illustrated in Figure 1 where the results are shown as mean effects of P source and P rate. Results indicate that all P fertilizer sources reduced plant emergence suggesting that seed-placed P was resulting in seed mortality. The struvite, Crystal Green, source of P resulted in significantly less seed mortality compared to either MAP or MES_{15}. Overall, the blend of equal P from MAP and Crystal Green provided similar seed safety as compared to 100% Crystal Green. Results conform to other research which has shown struvite can reduce seed placed P fertilizer damage to germinating/emerging plants. Plant emergence did not significantly decline until the maximum rate of 65 kg P_2O_5/ha was applied (mean effect). The struvite P fertilizer sources demonstrated significant seed safety even at the 65 kg P_2O_5/ha (Table 4). Final plant stand was numerically higher than original plant emergence, this difference is due to inability to distinguish main stem from branch stems and/or further plant emergence after original plant establishment was determined. However, Crystal Green again appeared to have numerically higher values than the other P fertilizer sources. Neither plant height nor plant maturity was affected by fertilizer P applications. Fertilizer applications had no impact on plant lodging, lodging did not occur in the trial (data not shown).

Table 4. Canola Establishment and Agronomics as Affected by P Fertilizer Applications, 2021
Different letters indicate significant differences between treatments (ANOVA, $P \leq 0.05$).

Trt #	Fertilizer Form	P Rate	Emergence (plants/m2)	Final Plant Stand (stocks/m2)	Plant Height (cm)	Days to Maturity
1	Control	0 kg P_2O_5/ha	112 a	104 a	89 a	90 a
2	100% MAP	25 kg P_2O_5/ha	83 bcd	75 bcd	86 a	91 a
3	100% MES_{15}®	25 kg P_2O_5/ha	55 ef	51 d	88 a	92 a
4	100% Crystal Green®	25 kg P_2O_5/ha	95 abc	94 abc	87 a	91 a
5	50% MAP + 50% Crystal Green®	25 kg P_2O_5/ha	85 abcd	63 cd	87 a	91 a
6	100% MAP	45 kg P_2O_5/ha	66 def	55 d	87 a	91 a
7	100% MES_{15}®	45 kg P_2O_5/ha	74 cde	57 d	93 a	90 a
8	100% Crystal Green®	45 kg P_2O_5/ha	107 ab	96 abc	85 a	90 a
9	50% MAP + 50% Crystal Green®	45 kg P_2O_5/ha	109 ab	113 a	88 a	91 a
10	100% MAP	65 kg P_2O_5/ha	46 f	57 d	87 a	91 a
11	100% MES_{15}®	65 kg P_2O_5/ha	46 f	51 d	90 a	92 a
12	100% Crystal Green®	65 kg P_2O_5/ha	82 bcd	74 bcd	89 a	90 a
13	50% MAP + 50% Crystal Green®	65 kg P_2O_5/ha	97 abc	102 ab	89 a	90 a
		LSD (0.05)	27	35	NS	NS
		CV (%)	22.8	32.3	4.7	1.4

NS = not significant at P<0.05

Figure 1. Plant Emergence as Influenced by P Fertilizer Source & P Fertilizer Rate.



Crop Rotation Benefits of Annual Forages Preceding Spring Cereals

Funding

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

Organizations

- Wheatland Conservation Area (WCA), Swift Current
- Irrigation Crop Diversification Corporation (ICDC), Outlook

Project Lead

- WCA Lead: Bryan Nybo
- ICDC Leads: Erin Karppinen & Garry Hnatowich

Objectives

This project is based on ongoing work demonstrated by Dr. Jillian Bainard at AAFC-Swift Current. Most recently, her research has addressed environmental stability by exploring ways to reduce herbicide and fertilizer inputs (Bainard, 2018), improve forage and feed grains by assessing the nutritive value of these mixtures (Bainard et al., 2018), and determining the economic and agronomic impact of incorporating annual forage mixtures into a cropping system (Bainard et al., 2014). Results from past and ongoing projects have found that creating polyculture mixtures (more than one species) with annual crops can result in high quality forage, increased biomass production, enhanced weed suppression, greater microbial activity and diversity, and increased soil nutrients.

Many producers are looking to improve soil rotational health and effects in order to create environmental stability that allows for a reduction in herbicides and fertilizers, higher quality forages, and provides multiple benefits for monoculture in the following year. Benefits to improving soil health includes the integration of larger, and more stable aggregates occurring in soils after annual forage polycultures are grown, indicating increased microbial activity and overall soil quality compared to single seeded monoculture (**Control**), such as barley or oats.

Although mixtures are not likely to maintain fertility over multiple years without additional inputs, legume species (**Nitrogen-Fixing Mix**) may allow for less fertilizer to be applied in both crop years due to the N fixation occurring in the soil.

Weed suppression in a cereal crop after incorporating forages into a rotation is significantly higher. Mixtures with higher amounts of root crops, or brassica species (**Weed Control Mix**) may account for some weed control, with the possibility of reducing herbicide applications in the following cereal year. Care must be taken to create a mix in which the proportion of Brassica species are not too high, as they have shown to contain high amounts of nitrates and sulfate, which is toxic to animals at high levels.

Polyculture mixes are shown to create higher quality forages compared to a single monocrop. It is important to pick mixes with that provide high crude protein and low non-digestible fibre with high digestibility. As many producers are creating their own mix, they may prefer to make something simple, which will still accomplish a range of tasks, therefore includes a balance of legumes, cereals, and brassicas (**Balanced Mix**), or a balanced mix, with more species to increase biomass (**Simple Balanced Mix**). Others may be willing to produce a more complicated polyculture that includes more species. The more species included, the higher the productivity to improving biomass yield and increasing the nutritional value of the forage (**Complex Balanced Mix**).

As for the cereal monoculture in the following year, grain yield increases are shown when forages precede cereal crops in a rotation, especially when mixtures that include N-fixing legumes are included allowing a lower input fertility system. Having a cover crop that can accomplish a range of tasks, including weed control, improved forage nutrition, and nitrogen fixation for the following crop provides a number of benefits to improving overall soil rotational health and effects (**Complex Soil Amendment Mix**).

Research Plan

In year 1 of the trial the treatments identified in Table 1 were established. Forage material harvested indicated that the greatest biomass was obtained with the Complex Balanced Mix, the lowest with the Balanced Mix. Remaining treatments did not result in forage yield differing significantly from the control barley treatment. After forage harvest a post-harvest tank mix application of Roundup® (glyphosate; 2 L/ac) and Heat® (saflufenacil; 2 L/ac) was applied to terminate growth.

Table 1. Detailed treatment list.

Treatment	# of Species	Proportion	Purpose of Treatment	Species
1	Monoculture	1C	Control	C: Advantage Barley
2	3 species	1L:1C:1B	Balanced Mix	L: Persian Clover C: Advantage Barley B: Groundhog Radish
3	3 species	3L	N-Fixing Mix	L: Persian Clover, Forage Pea (Leroy), Hairy Vetch
4	4 species	1L:2C:1B	Simple Balanced Mix	L: Persian Clover C: Advantage Barley, Haymaker Oats B: Groundhog Radish
5	6 species	1L:2C:3B	Weed Control Mix	L: Persian Clover C: Advantage Barley, Haymaker Oats B: Groundhog Radish, Tillage Radish, Winfred Radish
6	6 species	2L:2C:2B	Complex Balanced Mix	L: Persian Clover, Hairy Vetch C: Advantage Barley, Haymaker Oats B: Groundhog Radish, Winfred Radish
7	8 species	2L:4C:2B	Complex Soil Amendment Mix	L: Persian Clover, Hairy Vetch C: Advantage Barley, Haymaker Oats Corn, Millet B: Groundhog Radish, Winfred Radish

L = Legume species; C = Cereal species; B = Brassica species

In year 2, AAC Wheatland VB spring wheat was seeded on top of year 1 plots. Seeding occurred on May 14, 2021 at a seeding rate of 300 seeds/m^2.

On May 14, 2021, spring wheat (AAC Wheatland VB) was seeded directly onto the preceding years annual forage stubble. Therefore, the trial remained as a total of 7 treatments arranged in a four-replicate randomized complete block design trial. At seeding, all plots received 75 kg N/ha as side-banded urea (46-0-0) and 25 kg P_2O_5/ha as side-banded monoammonium phosphate (MAP; 11-52-0). Weed control consisted of a post-emergence tank mix application of Simplicity™ (pyroxsulam; 28 g/ac) and Buctril® M (bromoxynil + MCPA ester; 0.4 L/ac) applied June 8. A foliar fungicide application of Priaxor (fluxapyroxad + pyraclostrobin) occurred on July 8, 2021. 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 August 26. 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 was 106.3 mm (4.2") and total in-season irrigation was 235.0 mm (9.3").

Results

Agronomic information captured for spring wheat reseeded onto annual forage mixture stubble is presented in Table 2. Seed yield of wheat grown on both the N-Fixing and Complex Balanced treatments were statistically higher yielding than the control treatment (barley stubble). In the previous year the N-Fixing forage harvest was not statistically differing from the barley forage control. The yield response of wheat grown on the N-Fixing stubble can be attributed to potential higher levels of organic N being mineralized by legume residue and/or disease suppression offered by legume inclusion compared to a cereal-cereal rotation. As no disease symptoms were observed the yield response was believed due to higher levels of mineralized N to wheat. The Complex Balanced treatment produced the highest forage yields the previous year, again the higher proportion of legumes in this mixture is presumed to have provided the yield response in wheat yield. All mixed forage treatments resulted in numerically higher yields compared to the monoculture treatment.

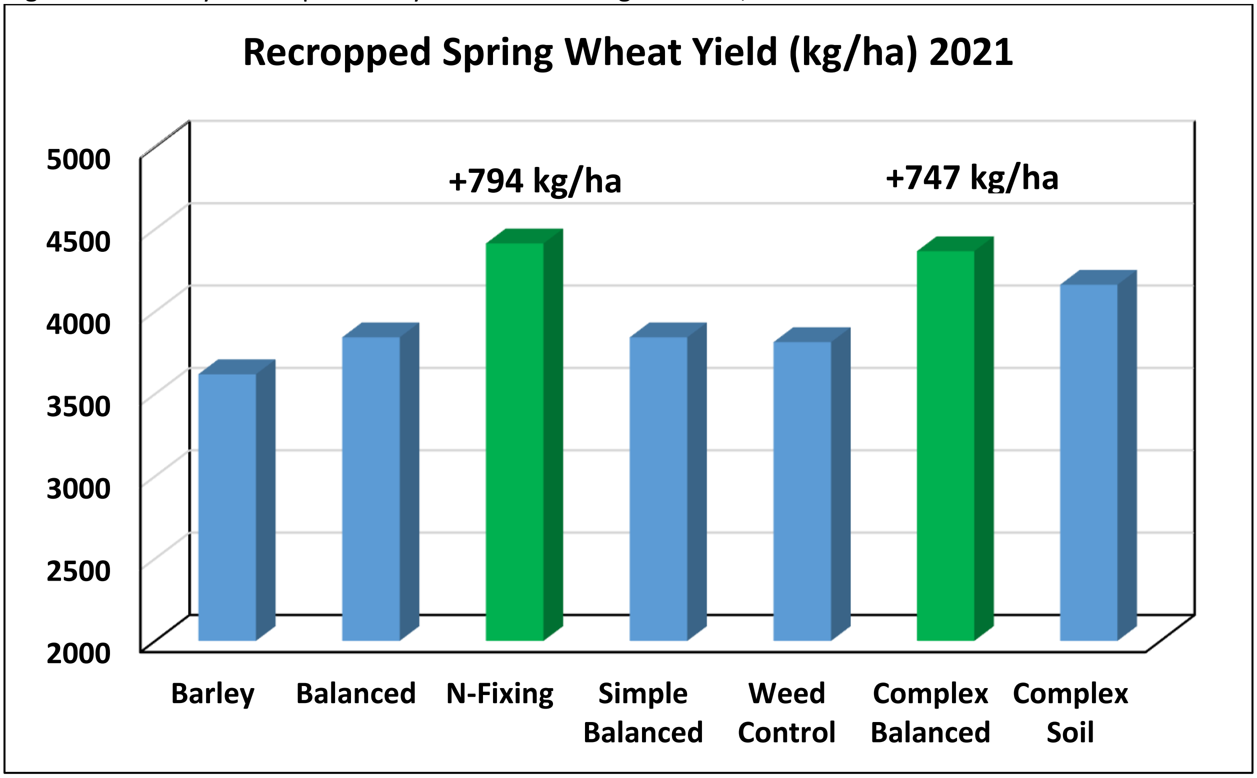
Seed protein content was significantly higher with the N-Fixing treatment, further suggesting available soil N was released by legume residue decomposition. Previous forage treatments had no impact on any other agronomic characteristic.

This is the 2nd and final year of this study. Results generated by ICDC will be provided to the Principal Investigators at the Wheatland Conservation Area at Swift Current for the preparation of a dual site final report

Table 2. Wheat yield, seed quality and agronomics for each forage stubble treatment.
Different letters indicate significant differences between treatments (ANOVA, $P \leq 0.05$).

2021 Forage Mix	**Yield (kg/ha)**	**Protein (%)**	**Test Weight (kg/hl)**	**TKW (gm)**	**Plant Population (plant/m2)**	**Height (cm)**	**Weed Control (1=weedless; 5=weedy)**	
							Pre-emerge	**Post-emerge**
Control	3619 b	12.3 b	75.8 a	33.6 a	237 a	65 a	1.3 a	2.3 a
Balanced	3893 ab	12.2 b	75.9 *a*	33.9 a	259 a	68 a	1.8 a	1.8 a
N-Fixing	4413 a	14.3 a	75.7 *a*	36.4 a	274 a	68 a	1.0 a	2.0 a
Simple Balanced	3843 ab	11.9 b	77.4 a	33.9 a	254 a	68 a	1.3 a	1.8 a
Weed Control	3814 ab	11.8 b	74.8 a	35.1 a	258 a	65 a	1.0 a	2.0 a
Complex Balanced	4366 ab	12.1 b	75.8 a	36.3 a	267 a	68 a	1.5 a	1.5 a
Complex Soil Amendment	4163 ab	12.7 b	76.3 a	35.0 a	277 a	68 a	1.0 a	1.8 a
LSD (0.05)	748	1.2	NS	NS	NS	NS	NS	NS
CV (%)	12.5	6.7	2.1	6.0	14.6	3.9	33.4	36.5

Figure 1. Wheat yield on previous years annual forage stubble, 2021



Conclusions

This study was conducted over two consecutive growing seasons. In the first year 6 annual forage mixtures comprised of 3, 4, 6 or 8 species were compared to forage barley. In year-1 the Complex Balanced Mix (2L:2C:2B) was higher yielding and had higher NDF, compared to barley. And although the N-Fixing Mix was not higher yielding than the control barley in year-1, there were benefits to forage quality (i.e., increased protein and macromineral contents). In year-2 these two forage mixture treatments provided much higher wheat yields compared to the monoculture cereal control. Results would suggest that the year-2 wheat yield response was attributed to the biological N fixation associated with legumes in both forage mixtures. Cattle producers would also have to consider the forage quality of these treatments considering in year-1 energy (TDN) and digestibility (ADF) were higher in the barley forage treatment. However, this study location does demonstrate demonstrates that a legume or balanced polyculture mix, including legumes) has potential to increase biomass yield and forage quality over a monoculture production system.

Acknowledgements

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Demonstrating Effects of Insecticide Application Timing and Seeding Date on Pea Aphid Damage to Lentils and Field Peas

Funding

Funded by the Strategic Field Program (SFP)

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Outlook
- Saskatchewan Ministry of Agriculture (SMOA), Outlook
- Agriculture & Agri-Food Canada (AAFC), Saskatoon
- South East Research Farm (SERF), Redvers
- Wheatland Conservation Area (WCA), Swift Current

Project Lead

- SMOA Lead: James Tansey
- ICDC Leads: Erin Karppinen & Garry Hnatowich
- Tyler Wist, AAFC - Saskatoon

Objectives

The objectives of this study were to:

(1) To demonstrate and compare the effects of applying insecticidal control of pea aphid prior to and after flowering in lentils and field peas; and

(2) To demonstrate the effects of seeding date on the effects of pea aphid damage to lentils and field peas.

Pea aphid pressure on lentils has been high in recent years and was at outbreak densities in 2019. Current recommendations for control of these insects in both peas and lentil are based on thresholds developed for Century peas (an old variety, no longer grown) and work from the US. These thresholds and recommendations for pea aphid control are associated with evaluations of aphid populations at the beginning of flowering. Recent evidence developed by Drs. Tyler Wist (AAFC) and Sean Prager (U of S) indicates that insecticide applications to pulse crops prior to flowering can have dramatic effects on aphid damage. That is, there is recent evidence that the timing of insecticide applications is as important as aphid density (assuming that the insects are at damaging levels). Planting date also has the potential to influence the effects of aphids. Early seeded crops have the potential to develop past the vulnerable flowering stage before aphids reach damaging levels. Validating information collected by AAFC and demonstrating effects in demonstration plots for growers will do much to improve aphid control in lentils and peas and contribute to our understanding of control strategies.

Research Plan

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

A field demonstration with pea and lentil was established in the spring of 2021 at the CSIDC on-station location (Field 8). The trials were established in a split plot design with seeding date as the whole plots and insecticde application as the subplots. Each treatment was replicated 4 times. Seeded plot size was 8 m in length and 1.5 m wide. At seeding, pea and lentil plots received 15 kg P_2O_5/ha as seed placed monoammonium phosphate (11-52-0) and 3.7 kg/ha Nodulator® Duo SCG inoculant.

Seeding, harvest, and chemical application dates are provided in Table 1. Pea and lentil were planted at three seeding dates: i) mid May (early), ii) early June (mid), and iii) mid June (late). Insecticide application ocurred at three timings: i) not applied (control), ii) prior to flowering, and iii) post-flowering. Using sweep nets, aphid densities were evaluated: i) 48 hours prior to insecticide application, ii) 48 hours post insecticide application, and iii) 7 days post insecticde application.

Table 1. Seeding, harvest, and chemical application dates.

Trt	Seeding Date		Insecticide Application		Herbicide Date	Harvest Date
1	Early	May 14/21	control	n/a	Jun 16/21	Sep 3/21 pea Sep 23/21 lentil
2			pre-flower	Jul 2/21		
3			post-flower	Jul 16/21		
4	Mid	May 27/21	control	n/a	Jun 16/21	Sep 3/21 pea Sep 23/21 lentil
5			pre-flower	Jul 8/21		
6			post-flower	Jul 27/21*		
7	Late	Jun 15/21	control	n/a	Jul 7/21	Oct 6/21 pea Sep 23/21 lentil
8			pre-flower	Jul 12/21		
9			post-flower	Aug 11/21		

* applied July 27 to pea, July 30 to lentil

Weed control consisted of post-emergent tank mix applications of Viper® ADV (imazamox + bentazon; 0.4 L/ac) and 28% UAN (urea-ammonium nitrate; 0.8 L/ac) for peas and Odyssey Ultra NXT™ (imazamox + imazapyr; 17.4 g/ac) and Merge® Adjuvant (surfactant blend + solvent; 0.5 L/ac) for lentils. Matador® (lambda-cyhalothrin; 0.032 L/ac) was applied to both peas and lentils in treatments that required an insecticide application (Table 1). A fungicidal application of Priaxor (fluxapyroxad and pyraclostrobin @ 180 ml/ac) was applied July 8. Mid-seeded and late pea and lentil plots were desiccated with Reglone® Ion (diquat, 0.83 L/ac) to assist harvesting.

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. Plot samples were cleaned, and yields were adjusted to 14.5% moisture.

In-season precipitation was 105.5 mm (4.2”) and total in-season irrigation applied was 218.4 mm (8.6”).

Mean monthly temperatures and precipitation amounts are listed in Tables 2 and 3. The 2021 season was warmer than the long-term average with respect to temperature, rainfall was significantly well below average.

Table 2. Mean monthly temperature from May to August 2021 at the ICDC trial location.

Location	**Year**	**May**	**June**	**July**	**August**	**Sept**	**Average**
		------------ *Mean Temperature (°C)* -----------					
Outlook	2021	10.1	18.8	21.6	17.9	14.4	16.6
	Long-term	***11.3***	***16.0***	***18.6***	***17.8***	***12.7***	**15.3**

Table 3. Precipitation amounts vs. long-term (30 year) means for the 2021 growing season.

Location	**Year**	**May**	**June**	**July**	**August**	**Sept**	**Average**
		------------- *Precipitation (mm)* --------------					
Outlook	2020	44.5	10.3	13.8	37.7	0.2	106.5
	Long-term	***43.2***	***69.3***	***57.6***	***44.2***	**32.7**	**247.0**

Results

Maturity was intended to be measured with both crops. However, a great amount of variation occurred with both crops between replications. It is suspected that this variation was caused by potatoes produced on this field four years prior. This residual rotational effect was not anticipated and resulted in plant maturity being delayed on half the reps and resulting maturities unreliable and questionable.

Seeding date was the only factor driving differences in yield in field pea (Table 4). Statistical procedures indicated revealed a high coefficient of variation (CV) for lentil yield (Table 5). This is also attributed to the variability exhibited between replications. No confidence should be allowed lentil seed yield other than it is likely valid that yield dramatically declined with the late seeding date. Seeding date did impact other seed parameters measured in a manner not unexpected. However, insecticide application had no influence on yield or seed quality in either crop. Dr Tyler Wist (AAFC) is conducting the aphid population count for the individual sweep timings conducted through the growing season which is presently on-going. However, ambient aphid populations appeared to be below economic threshold levels and had no major impact on either pea or lentil in 2021.

These results will be combined with other testing locations and a final report prepared.

Table 4. Influence of seeding date and insecticide application on yield and maturity of pea, 2021. Different letters indicate significant differences between seeding dates (ANOVA, *P* ≤ 0.05).

Factor	**Pea**			
	Yield (kg/ha)	**Protein (%)**	**Test Weight (kg/hL)**	**1K Seed Weight (gm)**
Seeding Date				
Early Seeded	6782 a	25.1 a	81.1 b	251 a
Mid Seeded	5279 b	25.5 a	80.6 c	232 b
Late Seeded	1088 c	24.9 a	82.1 a	186 c
LSD (0.05)	458	0.55	0.5	14
CV (%)	12.4	2.6	0.7	7.6
Insecticide Application				
No Application	4429 a	25.1 a	81.5 a	219 a
Pre-Flower	4529 a	25.3 a	81.3 a	225 a
Post-Flower	4191 a	25.1 a	81.0 a	224 a
LSD (0.05)	NS	NS	NS	NS
Seeding Date x Insecticide Application				
LSD (0.05)	NS	NS	NS	NS

NS = not significant

Table 5. Influence of seeding date and insecticide application on yield and maturity of lentil, 2021. Different letters indicate significant differences between seeding dates (ANOVA, *P* ≤ 0.05).

Factor	Lentil			
	Yield (kg/ha)	**Protein (%)**	**Test Weight (kg/hL)**	**1K Seed Weight (gm)**
Seeding Date				
Early Seeded	3361 a	17.4 ab	76.9 a	45.7 a
Mid Seeded	3527 a	17.6 a	76.9 a	45.5 a
Late Seeded	1336 b	17.1 b	77.5 a	45.7 a
LSD (0.05)	555	0.4	NS	NS
CV (%)	24.7	2.8	2.0	4.8
Insecticide Application				
No Application	2444 a	17.5 a	76.8 a	45.9 a
Pre-Flower	2993 a	17.3 a	77.2 a	46.0 a
Post-Flower	2788 a	17.3 a	77.3 a	45.5 a
LSD (0.05)	NS	NS	NS	NS
Seeding Date x Insecticide Application				
LSD (0.05)	NS	NS	NS	NS

NS = not significant

<u>Combined 2020-2021 Results – Yield</u>

Combined two-year summary of pea and lentil yield is shown in Table 6. Not unexpected yields differed between growing seasons and with seeding date. Insecticide application also did not apparently influence yield of either pea or lentil. No seeding date by insecticide application interactions occurred (p-value 0.71 for pea, 0.77 for lentil). However, aphid populations are not included in this report. These will be determined by Tyler Wist (AAFC) and results summarized by James Tansey. This biotic factor will be assessed across trial locations and test years.

Table 6. Influence of seeding date and insecticide application on yield of pea & lentil over two years. Different letters indicate significant differences between seeding dates (ANOVA, $P \leq 0.05$).

Factor	Pea		Lentil	
	Yield (kg/ha)	**Yield (bu/ac)**	**Yield (kg/ha)**	**Yield (lb/ac)**
Year				
2020	1889 b	28.1 b	962 b	858 b
2021	4383 a	65.2 a	2741 a	2445 a
Pr > F (p-value)	0.001	0.001	0.001	0.001
Seeding Date				
Early Seeded	4720 a	70.2 a	2401 a	2142 a
Mid Seeded	3711 b	55.2 b	2266 a	2021 a
Late Seeded	978 c	14.5 c	887 b	792 b
Pr > F (p-value)	0.001	0.001	0.001	0.001
Insecticide Application				
No Application	3181 a	47.3 a	1695 a	1512 a
Pre-Flower	3218 a	47.8 a	1964 a	1752 a
Post-Flower	3009 a	44.7 a	1896 a	1691 a
Pr > F (p-value)	0.41	0.41	0.20	0.20

Acknowledgements

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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: Gursahib Singh, ICDC 2021
- Project P.I: Jessica Enns, WARC 2019

Organizations

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

Objectives

Aphanomyces euteiches is an important disease of field peas that is caused by a complex of root pathogens. Cultural and chemical controls are available to reduce the adverse impact of this disease on root development, growth and yield. Still, when used individually, none of these practices are highly effective. Utilizing multiple control strategies, including herbicides, seed treatment, fertilizer rates and foliar nutrient applications to limit the effects of aphanomyces may prove the most effective to improve pea root health. This demonstration will help producers identify which management strategies will result in the greatest increase in plant health and consequentially crop yield. The economics of each strategy will be analyzed to aid producers in determining which practice is most productive and cost-effective.

The objective of the study is 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

This trial was initiated in the spring of 2019 and 2021 at four facilities in Saskatchewan- WARC (Scott), ICDC (Outlook), NARF (Melfort) and WCA (Swift Current). Each year, the trials were established in a factorial RCBD design with double wide plots and four replications. The factors evaluated were fertility, herbicide, seed treatment, and foliar nutrients for a total of ten treatments (Table 1). At all locations, each year before seeding, the soil was tested for the presence of *Aphanomyces*. The land tested positive for *Aphanomyces* in the spring via soil sample results from Discovery Seed Labs and Agvise for all the sites. Field peas were directly seeded into the previous cereal stubble at all locations. Seeding difficulties occurred due to the compacted soil conditions at Melfort in 2019. Different yellow pea varieties were grown as per the availability but with a seeding rate of 85 seeds/m^2 and target depths of approximately 2- 2.5 inches depending on equipment and spring soil moisture. Times of the various field operations and crop assist products used at each location are shown in Table A1 and Table A2.

Treatment List:

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

TRT	Pre-Seed Herbicide	Fertilizer (lb/ac)	Seed Treatment	Foliar Nutrient
1	Glyphosate	20 P only MAP[1] "Low"	No ST	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 (Fn)
6	Glyphosate	50 P, 20 K, 10 S[2] "High"	No ST	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

Gly= Glyphosate, Tri= Trifluralin, Fertilizer "Low"; "High", ST= Seed Treatment, VM= Vibrance Maxx, I= Intego, Fn= Foliar Nutrient

[1] Low (20P) – application of 20 lb/ac of actual phosphorus (total of 4 lb/ac of nitrogen)

[2] High (50P, 20K, 10S)- application of 50 lb/ac of actual phosphorus, 20 lb/ac of actual potassium, 10 lb/ac of actual sulphur (total of 20lb/ac of nitrogen)

Data Collection:

Plant densities were determined by counting the numbers of emerged plants on 2 x 1meter row lengths per plot approximately four weeks after crop emergence. Disease root rating assessments were assessed twice between three to five weeks after planting (WAP) and at seven to eight WAP on five plants per plot. The timing of ratings depended on soil moisture levels and crop growth stage at each location. At seven weeks after seeding, the crop stage of the peas was early to 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, and 5= root rot spread to the whole root. Yields were determined from cleaned harvested grain samples and corrected to the required moisture content (16% moisture). An economic analysis was conducted to determine which treatment was most economically efficient. Weather data was collected from Environment Canada.

Growing Conditions:

Mean monthly temperatures and precipitation amounts for all locations are listed in Tables 2 and 3. The 2019 season was cooler than the long-term average at all sites, whereas 2021 temperatures were above the long-term average. Rainfall was below average for all sites in both growing seasons except Scott and Swift Current (Table 3). Research plots at Outlook were irrigated throughout the growing season to keep up with the crop demand (128.5 mm in 2019 and 213 mm in 2021).

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)					
	2019	9.9	16.0	18.0	16.2	NA	15.0
Outlook	2021	10.2	18.6	21.6	17.9	NA	17.1
	Long-term	***11.5***	***16.1***	***18.9***	***18***	**NA**	**16.1**
	2019	*9.1*	*14.9*	*16.1*	*14.4*	11.3	11.7
Scott	2021	8.9	17.3	19.6	17.2	NA	13.3
	Long-term	***10.8***	***14.8***	***17.3***	***16.3***	**11.2**	**14.1**
	2019	*9.5*	*15.8*	*17.7*	*16.8*	NA	14.9
Swift Current	2021	9.5	18.4	21.7	18	NA	16.9
	Long-term	***11***	***15.7***	***18.4***	***17.9***	**NA**	**15.8**
	2019	8.8	15.3	16.9	14.9	11.2	13.4
Melfort	2021	9.6	18.2	20.1	16.9	14	15.8
	Long-term	**10.7**	**15.9**	**17.5**	**16.8**	**10.8**	**14.3**

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

Location	Year	May	June	July	August	September	Total
		Precipitation (mm)					
Outlook	2019	13.2	90.2	43.8	39.6	NA	186.6
	2021	44.5	10.3	13.8	37.7	0.2	106.5
	Long-term	***43.2***	***69.3***	***57.6***	***44.2***	**32.7**	**247.0**
Scott	2019	12.7	97.7	107.8	18	41.8	278
	2021	43.9	43.8	10.4	51.3	NA	150.1
	Long-term	***38.9***	***69.7***	***69.4***	***48.7***	**26.5**	**253.2**
Swift Current	2019	13.3	156	11.1	42.6	NA	223
	2021	35	29.6	38.9	55.8	NA	159.3
	Long-term	***42.1***	***66.1***	***44***	***35.4***	**NA**	***187.6***
Melfort	2019	18.8	87.4	72.7	30.7	43.0	252.6
	2021	31.4	37.6	0.2	69.3	7.5	146
	Long-term	**42.9**	**54.3**	**76.7**	**52.4**	**38.7**	**265.0**

Results

Plant Densities

Crop emergence slightly varied among locations with Melfort < Swift Current < Scott < Outlook increasing in average plant densities. In general, all sites had an acceptable level of establishment (Table 4). In 2019, Melfort had stand establishment issues due to soil compaction variability within the study. This resulted in varied emergence throughout the early spring. However, the plants recovered, and maturity between plots was similar, indicating a minimal difference in emergence timing. The crop stand in the second year (2021) was better at all sites, with Melfort < Swift Current < Scott < Outlook increasing in average plant densities (Table 4.).

Disease Root Ratings

The disease pressure at the first (3 to 5 WAP) and second (7 or 8 WAP) disease ratings varied among years (2019 vs 2021) and between the four locations (Scott vs. Outlook vs. Melfort vs. Swift current). Treatment combinations did not affect disease suppression at any of the sites except Melfort at 3 WAP in 2019 (Table 5). Disease pressure at the first disease rating was similar in both growing seasons (2019 and 2021) as the spring environmental conditions were similar in both years (Table 5). However, due to less precipitation in 2021 as compared to2019, the disease pressure in 2019 was higher than in 2021 at the second disease rating. Disease ratings were higher at Scott and Outlook in both years as compared to Melfort and Swift Current.

2019

Disease ratings at 3 WAP were relatively low across all sites, with disease levels averaging at less than half the roots infected (< 2 out of 5). Disease ratings were the highest at Scott 3 WAP with disease pressure greatest with Gly + 20 P. Less than a 25% difference was observed from the most infected to the least infected diseased roots. Root disease symptoms did not occur at Outlook, whereas at Swift Current and Melfort the disease was rated as < 2 (disease present on less than half to a quarter of the root) at 3 WAP (Table 5). Disease pressure was limited at 3 WAP mainly due to the dry conditions that persisted at all the sites early in the growing season (Table 3).

Above normal precipitation at Scott (Table 3) contributed to high disease pressure compared to the other three sites. The disease pressure at 8 WAP was 63% more than at 3 WAP. The most diseased plants occurred when low fertilizer (20 P) + Gly was used compared to the higher fertilizer applications (50 P, 20 K, 10 S). The least diseased roots were reported with the combination of Gly + 50 P, 20 K, 10 S + VM + I and Tri+ 50 P, 20 K, 10 S + VM + I + FN.

Disease ratings at Outlook were slightly lower as compared to Scott and did not exhibit the same trend noted above. The combination of Tri+ 50 P, 20 K, 10 S + VM + I had slightly more disease than the other combinations, and the disease pressure was lowest for the low fertility (20 P) treatments (Table 5). Disease pressure among all treatments was relatively low, with less than 8% difference between the most infected and least infected roots. Disease ratings at Swift Current were slightly lower than Outlook, and all treatments had very similar root disease ratings that equaled 2.7 to 3.5 (root disease was marginally less than half to slightly greater than half of the root). As ratings were so similar between treatments, no trend was detected. Disease ratings at Melfort were the lowest regardless of the heavy rainfall that occurred in June (33 mm above the long-term average) and on average precipitation in July (Table 3). The disease ratings fluctuated between 0 and 1 (no symptoms to some apparent symptoms observed). As symptoms were minor, it wasn't easy to detect any trends.

2021

Due to the relatively cool spring, crop development was delayed, and the first disease ratings were done at 5 WAP when the crop was at the six nodes stage. Treatments (Table 1) did not affect disease levels at all sites. Overall disease pressure at 5 WAP was low and varied among all four sites. Outlook being the irrigated site, had readily available soil moisture, which favoured disease and had the highest disease pressure (mean disease rating - 0.7; Figure 1), followed by Scott (mean disease rating - 0.2) and Melfort (mean disease rating - 0.1) (Table 5). At Swift Current no damage roots were noticed at 5 WAP due to the dry conditions, and plots were rated as zero for disease incidence and severity. At Outlook treatment- Gly + 20 P +VM +I had the highest disease pressure (disease rating – 1.4) at 5 WAP. At Scott and Melfort, treatment- Gly + 20 P and treatment- Tri + 20P + VM + I + FN respectively resulted in the highest disease ratings (disease rating – 0.4 and 0.4; Table 5).

The second disease rating was done at 8 WAP across all sites, and treatments again had no significant effect on disease suppression at all locations. Across four locations, disease pressure was highest at Outlook (mean disease rating – 3.8), followed by Scott (mean disease rating – 2.1) and Melfort (mean disease rating – 0.5) at 8 WAP. Dry conditions persisted throughout the growing season at Swift Current leading to low disease levels. The trend of disease suppression by treatments was different at all sites. At Outlook, treatment- Gly + 20 P +VM +I resulted in the highest disease ratings, whereas the lowest disease was recorded in treatment- Gly + 50 P, 20K, 10S +VM +I (Table 5). The highest disease was recorded for treatment- Gly + 20 P at Scott, whereas at Melfort treatment- Gly + 50P 20K, 10S demonstrated the highest disease ratings (Table 5).

Yield

Yield differed among all sites in both growing seasons and was not significantly influenced by any of the inputs applied, except Scott in 2019 (P =0.0132). Each location demonstrated a slightly different yield response to the input combinations. Overall yields were impacted by both disease pressure and drought conditions; combined yields of 2019 were higher than 2021 (Table 6). Each location demonstrated a slightly different yield response to the input combinations. In 2019, all five treatment combinations with high fertility had higher yields than low fertility treatments. In contrast, the fertility effect on yield was less apparent in 2021. The use of seed treatment and foliar nutrients were quite variable and did not appear to have a consistent effect on yield, particularly when averaged across all sites.

2019

Yields at Scott were the lowest compared to all four sites. The meagre yields were likely attributed to the intense root disease pressure recorded (Table 5). The highest yields were achieved by adding higher rates of fertilizer (50 P, 20 K, 10 S) to result in a 9 bu/ac yield gain compared to when low fertilizer (20 P) was applied (Table 6). At Outlook, the disease levels were slightly lower than at Scott, however, Outlook had much higher yields (on average 44 bu/ac higher). This could indicate that the disease pressure had less of an influence on overall yields at Outlook than at Scott, and therefore the effects of the inputs were less evident at Outlook. The three highest yielding treatments differed by herbicides applied (Glyphosate vs. trifluralin), fertility (high vs. low), seed treatment used (Untreated vs Vibrance Maxx vs. Vibrance Maxx and Intego) and the absence and presence of a foliar nutrient applied (Table 6). A yield benefit of 6 bu/ ac was achieved when two or more inputs (Gly + high fertility, Tri + low fertility and Tri + high fertility) were used in combination over the lowest yielding treatment (Gly + 20 P). The three highest yielding input combinations reported at Outlook were two of the lowest yielding at Swift Current. The combination of Tri + low fertility + VM and Gly + high fertility had the lowest yields, while the combination of Tri + high fertility + VM, Gly + low fertility + VM + I and Tri + low fertility +VM +I + Fn had the highest yields (Table 6). The common input between the three highest yielding treatments was applying a seed treatment of Vibrance Maxx (VM) with and without Intego (I). The yield trends at Melfort once again varied from the three previous sites in which the three highest yielding treatments were (1) Gly + high fertility, (2) Gly + low fertility+ VM + I, and (3) Tri+ high fertility + VM. The common factor between the three high-yielding treatments was when glyphosate was combined with high fertility or seed treatment (VM + I). The lowest yielding treatments were when glyphosate was used with a low fertility (Table 6).

2021

At all locations, the yield was not significantly influenced by any of the inputs applied. At Scott, the highest and lowest yielding treatments differed by herbicide application (trifluralin vs. glyphosate), fertility [high (50 P, 20 K, 10 S) vs low (20 P)] and seed treatment (Untreated vs. Vibrance Maxx and Intego) and resulted in a 5.2 bu/ac yield gain (Table 6). At Outlook, yields were higher than Scott, even with higher disease pressure. This could indicate that readily available soil moisture through irrigation overall helped the damaged roots to meet the plants water demand. The highest yielding treatment had a yield advantage of 15.5 bu/ac as compared to the low yielding treatment. Like the 2019 growing season, the highest yields were achieved when high fertility was used compared to low fertility in the lowest yielding treatment. The yield at Melfort was highest among all four sites, with an average of 53 bu/ac, but the trends once again varied from the other three sites. The common factor between the two high yielding treatments was seed treatment (VM or VM + I), whereas the common factor in the two lowest yielding treatments was low fertility (20 P; Table 6). Yields at Swift Current were the lowest compared to all four sites. The very low yields were likely attributed to moisture stress and dry conditions, which prevailed in the 2021 growing season (Table 2). The lowest yielding input combinations reported at Outlook were the highest yielding at Swift Current. The combined analysis of all sites showed that high fertility treatments had slightly higher yields than low fertility treatments.

Out of the four inputs (fertility, herbicide, seed treatment and foliar nutrients) used in the current study, the most common factor that influenced disease severity and field pea yields were the fertilizer rates (20 P vs. 50 P, 20 K, 10S). The effect of foliar nutrients, seed treatment, and herbicide is less clear, and so is the interaction between these inputs and fertility. Higher fertilizer rates (P) resulted in higher yields and marginally reduced disease pressure at Scott in 2019. Although the fertilizer rates effect of yield and disease was not significant at the remaining seven site years, there was a trend of increased yield with high fertility treatments (Table 6.). The current study results correspond with earlier studies focused on the effects of inorganic phosphate fertilizer and arbuscular mycorrhizal fungi (AMF) on *Aphanomyces* in pea roots (Dehne 1982; Linderman 1994; Bodker et al. 1998; Thygesen et al. 2004). These studies reported that AMFs enhance plant phosphate uptake, improve overall plant vigour, and increase field pea roots' tolerance capacity. Moreover, this enhanced plant development may increase phosphorus concentration in the plant, which eventually reduces disease development in peas (Bodker et al. 1998).

The effect of herbicide application (trifluralin vs glyphosate) on yield and disease suppression was less apparent than fertilizer response. Previous studies on chemical management strategy found that application of dinitroaniline herbicide such as trifluralin improved pea yield in *Aphanomyces* contaminated soils (Katan and Eshel 1973; Grau and Reiling 1976; Teasdale et al. 1997; Harvey et al. 1975). Harvey et al. (1975) reported higher yields when peas were grown in *Aphanomyces* infected soils treated with trifluralin. Similarly, Teasdale et al. (1997) stated that applying a dinitroaniline herbicide would inhibit the production of motile zoospores (the infecting propagule of the pathogen), which delayed the root infection by 2- weeks. This delay resulted in additional plant growth that allowed the peas to withstand the effects of subsequent disease development better. The results from this study didn't provide any concrete evidence of delayed infection as stated by previous studies, but overall, trends indicate that infection may have been slightly delayed. The inconsistency in results and efficacy of trifluralin among sites could be attributed to various factors like the application to incorporation timing and environmental and soil conditions. Generally, trifluralin must be applied and incorporated within 24 hours after application due to it's high sensitivity to volatilization. The depth of incorporation, soil temperature and soil moisture may all influence the rate of degradation and efficacy of trifluralin.

Additionally, the seeding depth and amount of surface plant residue may play a role in its efficacy. In this study, trifluralin application did not affect disease levels, and yield and response varied among all sites. Although, combining high fertilizer with trifluralin resulted in the two highest yields at Scott, the highest at Swift Current and the third and fourth highest yields at Outlook in 2019, the combined effect was less evident in 2021. The possible reason for variable response between growing seasons could be due to drought conditions in 2021 which reduced the efficacy of both fertilizer and herbicide.

Like herbicide application, the effects of seed treatments were quite variable. The efficacy of the seed treatment may have been influenced by the environmental conditions as the spring was quite dry at all locations. Seed treatments are best utilized under wet, moist conditions conducive for disease development within the first few weeks of application. As moisture stressed conditions in 2019 and 2021 likely reduced the efficacy of seed treatments and therefore had a negligible effect on the degree of *Aphanomyces* infection on peas.

The least effective method to managing *Aphanomyces* on field peas was the application of a foliar nutrient. There is little research to support the effects of a foliar nutrient, and this study has provided little evidence of its intended benefits. The application of foliar nutrients may help improve late-season vigour but overall, its effect was minimal and variable amongst all locations.

Economic Analysis:

Similar to yield trends which were different for all sites in both years, the most profitable treatment combination differed among locations (Table 7). When combining the yield from all sites, the most profitable combination was the application of Gly + high fertility (50 P, 20 K, 10 S). However, this combination holds less promise to improve field pea tolerance to *Aphanomyces*. The only site where the treatment effect significantly increased yield was Scott in 2019, trifluralin + high fertility (50 P, 20 K, 10 S) + Vibrance Maxx was the most profitable combination, and this combination was equally profitable as the Gly + high fertility (50 P, 20 K, 10 S).

Table 4. Observed field pea plant densities (plants/m^2) influenced by herbicide, fertilizer, and seed treatment in *Aphanomyces* infected soils at Scott, Outlook, Swift Current, and Melfort SK, 2019 and 2021.

Treatments	2019				2021				Combined 2019	Combined 2021	Combined 2019+2021
	Scott	*Outlook*	*Swift Current*	*Melfort*	*Scott*	*Outlook*	*Swift Current*	*Melfort*			
Gly + 20 P	70	88	64	63	90	112	82	76	74	90	81
Gly + 20 P+ VM + I	63	81	69	64	83	126	72	79	74	90	80
Tri + 20P + VM	74	80	75	67	79	90	61	69	72	87	74
Tri + 20P + VM + I	74	90	70	55	84	113	64	76	72	85	78
Tri + 20P + VM + I + FN	69	80	68	62	80	113	63	76	71	84	77
Gly + 50 P, 20 K, 10 S	66	96	55	58	84	96	69	66	70	83	74
Gly + 50 P, 20 K, 10 S + VM + I	70	82	66	55	90	117	73	68	70	83	78
Tri+ 50 P, 20 K, 10 S + VM	70	76	78	58	84	94	77	76	69	82	77
Tri+ 50 P, 20 K, 10 S + VM + I	67	71	73	61	88	103	77	71	68	79	76
Tri+ 50 P, 20 K, 10 S + VM + I + FN	75	86	74	60	85	102	68	74	68	75	78
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Gly= Glyphosate, Tri= Trifluralin, Fertilizer "Low"; "High", ST= Seed Treatment, VM= Vibrance Maxx, I= Intego, Fn= Foliar Nutrient, NS = not significant

Table 5. Observed root rot disease ratings at 3 to 5 and 7 to 8 weeks after planting (WAP) influenced by herbicide, fertilizer, seed treatment and foliar nutrients applied on field peas seeded in *Aphanomyces* infected soils at Scott, Outlook, Swift Current, and Melfort SK, 2019.

Treatments	2019								2021								Combined 2019		Combined 2021		Combined 2019+2021	
	Scott		*Outlook*		*Swift Current*		*Melfort*		*Scott*		*Outlook*		*Swift Current*		*Melfort*							
	Disease ratings I (week 3 to 5) and II (week 7 or 8)																					
	I	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*	*I*	*II*
Gly + 20 P	2.0	4.8	0	4.3	1.8	3.0	1.0	0.3	0.4	2.6	1.0	3.8	0	0	0.2	0.6	0.4	3.3	0.5	2.3	0.4	2.4
Gly + 20 P+ VM + I	1.6	5.0	0	4.1	1.5	3.1	1.0	0.3	0.1	2.1	1.4	4.1	0	0	0.0	0.4	0.4	3.3	0.5	2.2	0.3	2.4
Tri + 20P + VM	1.6	4.5	0	4.2	1.7	3.1	1.2	0.4	0.1	2.3	0.4	3.6	0	0	0.1	1.1	0.4	3.2	0.2	2.3	0.2	2.4
Tri + 20P + VM + I	1.9	4.8	0	4.1	1.4	2.7	1.1	0.1	0.2	1.7	1.2	3.6	0	0	0.1	0.4	0.4	3.1	0.5	1.9	0.3	2.2
Tri + 20P + VM + I + FN	1.6	5.0	0	4.4	1.5	3.5	1.0	0.1	0.2	2.1	0.6	4.0	0	0	0.4	0.4	0.4	3.1	0.4	2.2	0.3	2.4
Gly + 50 P, 20 K, 10 S	1.6	4.5	0	4.2	1.8	3.0	1.1	0.8	0.2	2.4	0.7	3.9	0	0	0.2	0.8	0.3	3.1	0.4	2.3	0.3	2.5
Gly + 50 P, 20 K, 10 S + VM + I	1.5	3.8	0	4.4	1.6	2.9	1.2	0.9	0.4	2.3	0.5	3.3	0	0	0.1	0.4	0.3	3.0	0.3	2.0	0.3	2.2
Tri+ 50 P, 20 K, 10 S + VM	1.8	4.5	0	4.4	1.6	3.1	1.2	0.3	0.2	1.6	0.4	3.7	0	0	0.0	0.5	0.3	3.0	0.2	1.9	0.3	2.3
Tri+ 50 P, 20 K, 10 S + VM + I	1.8	4.5	0	4.5	1.7	3.1	1.1	1.2	0.2	1.6	0.7	3.9	0	0	0.0	0.1	0.3	3.0	0.3	1.8	0.3	2.3
Tri+ 50 P, 20 K, 10 S + VM + I + FN	1.6	3.8	0	4.3	1.6	3.3	1.2	0.7	0.1	1.4	0.6	3.8	0	0	0.1	0.4	0.3	2.9	0.3	1.8	0.3	2.2
LSD (0.05)	NS	NS	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-	NS	NS	NS	NS	NS	NS	NS	NS

Gly= Glyphosate, Tri= Trifluralin, Fertilizer "Low"; "High", ST= Seed Treatment, VM= Vibrance Maxx, I= Intego, Fn= Foliar Nutrient, NS = not significant

Table 6. Field pea yield (bu/ac) grown under different management strategies including pre-seed herbicide, fertilizer, seed treatment and foliar nutrients in *Aphanomyces* infected soils at Scott, Outlook, Swift Current, and Melfort SK, 2019.

	2019				2021				Combined 2019	Combined 2021	Combined 2019+2021
	Scott	Outlook	Swift Current	Melfort	Scott	Outlook	Swift Current	Melfort			
Gly + 20 P	17.0	64.0	34.0	40.0	32.7	33.1	30.6	53.5	40.2	36.1	38.1
Gly + 20 P+ VM + I	7.0	64.0	38.0	53.0	34.6	33.8	28.4	53.0	42.6	37.4	40.0
Tri + 20P + VM	19.0	69.0	34.0	47.0	35.9	42.3	27.5	54.5	42.2	39.8	41.0
Tri + 20P + VM + I	17.0	65.0	36.0	45.0	33.9	42.1	27.0	51.7	40.8	38.7	39.8
Tri + 20P + VM + I + FN	20.0	67.0	38.0	48.0	34.4	35.2	26.7	51.5	43.3	36.4	39.8
Gly + 50 P, 20 K, 10 S	27.0	71.0	33.0	55.0	36.6	48.9	26.4	53.2	46.7	40.9	43.8
Gly + 50 P, 20 K, 10 S + VM + I	26.0	66.0	36.0	47.0	33.8	43.8	25.9	54.5	44.2	39.9	42.0
Tri+ 50 P, 20 K, 10 S + VM	30.0	65.0	38.0	49.0	33.7	42.0	25.2	53.7	45.7	39.0	42.3
Tri+ 50 P, 20 K, 10 S + VM + I	25.0	67.0	35.0	47.0	37.9	42.2	24.7	52.3	43.9	40.7	42.3
Tri+ 50 P, 20 K, 10 S + VM + I + FN	27.0	68.0	37.0	49.0	36.2	38.1	24.5	53.0	45.3	38.3	41.8
LSD (0.05)	S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Gly= Glyphosate, Tri= Trifluralin, Fertilizer "Low"; "High", ST= Seed Treatment, VM= Vibrance Maxx, I= Intego, Fn= Foliar Nutrient, NS = not significant

Table 7. Economic analysis (net profit) of field pea yield grown under different management strategies including pre-seed herbicide, fertilizer, seed treatment and foliar nutrients in *Aphanomyces* infected soils at Scott, Outlook, Swift Current, and Melfort SK.

	Scott	Outlook	wift curren	Melfort	Scott	Outlook	wift curren	Melfort	
	2019				*2021*				All sites combined
Treatments	**Net Profit ($/ ac)**								
Gly + 20 P	178.24	742.24	382.24	454.24	366.64	371.44	341.44	616.24	431.44
Gly + 20 P+ VM + I	144.24	708.24	396.24	576.24	355.44	345.84	281.04	576.24	420.24
Tri + 20P + VM	175.17	775.17	355.17	511.17	377.97	454.77	277.17	601.17	439.17
Tri + 20P + VM + I	135.17	711.17	363.17	471.17	337.97	436.37	255.17	551.57	408.77
Tri + 20P + VM + I + FN	155.52	719.52	371.52	491.52	328.32	337.92	235.92	533.52	393.12
Gly + 50 P, 20 K, 10 S	273.34	801.34	345.34	609.34	388.54	536.14	266.14	587.74	474.94
Gly + 50 P, 20 K, 10 S + VM + I	227.34	707.34	347.34	479.34	320.94	440.94	226.14	569.34	419.34
Tri+ 50 P, 20 K, 10 S + VM	282.27	702.27	378.27	510.27	326.67	426.27	224.67	566.67	429.87
Tri+ 50 P, 20 K, 10 S + VM + I	206.27	710.27	326.27	470.27	361.07	412.67	202.67	533.87	413.87
Tri+ 50 P, 20 K, 10 S + VM + I + FN	214.62	706.62	334.62	478.62	325.02	347.82	184.62	526.62	392.22

Gly= Glyphosate, Tri= Trifluralin, Fertilizer "Low"; "High", ST= Seed Treatment, VM= Vibrance Maxx, I= Intego, Fn= Foliar Nutrient

Conclusions and Recommendations:

In general, plant densities were acceptable at all locations and were higher in 2021 than in 2019. Disease pressure was limited at 3 WAP primarily due to cool and dry spring conditions that persisted at all the sites. Disease ratings were relatively low across all sites in both years, with disease levels less than half of the roots infected, whereas no root disease symptoms were detected at the time of first disease rating at Outlook in 2019 and Swift current in 2021. Disease pressure at Scott in 2019 at 3 WAP was the highest among all sites, and the greatest disease symptoms were observed with Glyphosate + 20 P. Similarly, at 8 WAP, disease ratings were highest at Scott and increased by 63% compared to 3 WAP. Disease ratings at the three remaining sites ranged from very low (0-1) to moderate (2-4), with Outlook exhibiting the second highest disease ratings.

On the other hand, Outlook had the highest disease pressure at 5 WAP in 2021, with the highest disease ratings for glyphosate + 20 P+ VM + I treatment. Disease ratings at 8 WAP were also highest for Outlook and increased by 81% compared to 5 WAP. In both years the most diseased plants occurred when low fertilizer (20 P) + Gly was used compared to the higher fertilizer applications (50 P, 20 K, 10 S). The trends observed in both years at all locations varied, and it is difficult to confirm a treatment effect based on the disease ratings alone.

The yield was not significantly influenced by any of the inputs applied in both years, except at Scott (P =0.0132). The highest yields at Scott were achieved by adding higher rates of fertilizer (50 P, 20 K, 10 S) to result in a 9 bu/ac yield gain compared to when low fertilizer (20 P) was applied. The trend of yield gain varied among all sites in both years except Outlook, where the combination of Gly+ 50 P, 20 K, 10 S increased yield by 7 bu/ac and 15.5 bu/ac in 2019 and 2021, respectively, compared to the lowest yielding treatment (Gly + 20P) in both years. Usually, the higher fertility treatments provided the greatest yield at all sites irrespective of herbicide, seed, or foliar nutrient application. In contrast, the use of seed treatment and foliar nutrients were quite variable and did not appear to have a consistent effect on yield, especially when averaged across all eight sites. The yield response of all sites was combined to determine the most profitable combination: Gly+ high fertility (50 P, 20 K, 10 S) followed by trifluralin + high fertility (50 P, 20 K, 10 S) + Vibrance Maxx or Intego. With the variable response of yield to the combination of fertilizer and herbicide at all sites, it's hard to make assumptions about the effect of foliar nutrients and seed treatment.

When looking at disease management options in terms of effectiveness and profitability, the three most essential strategies should include (1) proper fertilization (higher than the current standard of 20 lb/ac of P_2O_5), (2) applications of herbicide (glyphosate or trifluralin) to reduce weed pressure and (3) the application of seed treatments in a wet, cold spring. Both years when this study was undertaken were typically drier and the effects of a seed treatment may not have been reported to their fullest potential. Of all the treatment combinations, fertility had the highest impact on yield and disease ratings, whereas other treatment combinations provided less disease tolerance/ suppression evidence. At this point, it's hard to justify that either of the other treatments had any role in delaying infection and improving disease tolerance. Additional research is required to confirm the most effective and profitable combination of field peas grown under *Aphanomyces* infected soils.

Figure 1. Arial view of Outlook research site, the dark brown area showing hot spots of *Aphanomyces* in the research plots. *Aphanomyces* symptoms were detected at 5 WAP and 8 WAP in Outlook 2021.

Supporting Information:

Acknowledgements

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Appendices

Appendix A

Table A1. Times of operations and crop input products utilized by all locations in 2019.

Activity	Location			
	Scott	**Outlook**	**Swift Current**	**Melfort**
Stubble Selection	Canola	Wheat	Durum	Wheat
Pre-seed Herbicide Application	May 24 (Glyphosate 540 @ 1L/ac + Trifuralin 480 EC @ 0.65 L/ac)	May 6 (Glyphosate 540 @ 1L/ac + Trifuralin 480 EC @ 0.65 L/ac)	May 16 (Trifluralin 480 EC @ 690 ml/ac)	May 23 (Trifuralin 480 EC @ 930 ml/ac) + May 30 (Glyphosate 540 1 L/ac)
Seed Treatment	May 28 (Vibrance Maxx @ 325ml/100kg & Vibrance Maxx + Intego @ 325ml/100kg	May 9 (Vibrance Maxx RFC @100 ml/100 kg + INTEGO Solo @ 19.6 ml/100 kg	May 17 (Vibrance Maxx @ 325ml/100kg & Vibrance Maxx + Intego @ 325ml/100kg	May 27 (Vibrance Maxx @ 325ml/100kg & Vibrance Maxx + Intego @ 325ml/100kg
Variety	Arbarth	CDC Inca	CDC Inca	AC Carver
Seeding date	May 28	May 9	May 17	May 27
In-crop Herbicide Application	June 27 (Viper ADV @ 400 ml/ac + UAN @ 0.81 L/ac)	Viper ADV @ 400 ml/ac + UAN @ 0.81 L/ac	June 12 (Viper ADV @ 400 ml/ac + UAN @ 0.81 L/ac)	June 27 (Viper ADV @ 400 ml/ac) + July 5 (Assure II 300 ml/ac)
In-crop Fungicide Application	N/A	Priaxor @ 180 ml/ac	N/A	July 12 (Acapella @ 325 ml/ac)
Desiccation	Aug 20 (Roundup 540 @ 1 L/ac + Aug 28 Reglone Ion @ 0.83 L/ac)	Aug 15 (Reglone Ion @ 0.83 L/ac @ 20gpa	N/C	Sept 16 (Glyphosate 540 @ 0.67 L/ac + Heat LQ @ 59 ml/ac)
Harvest	Sept 5	Aug 21	Aug 20	Sept 23

NA = Not applied
NC = Observation not captured

Table A2. Times of operations and crop input products utilized by all locations in 2021.

Activity	Location			
	Scott	**Outlook**	**Swift Current**	**Melfort**
Stubble Selection	Canola	Wheat	Durum	Wheat
Pre-seed Herbicide Application	May 11 (Glyphosate 540 @ 1L/ac + Trifuralin 480 EC @ 0.65 L/ac)	May 10 (Glyphosate 540 @ 1L/ac + Trifuralin 480 EC @ 0.65 L/ac)	May 17 (Glyphosate 540 @ 670ml/ac + Trifluralin 480 EC @ 690 ml/ac)	May 14 (Trifuralin 480 EC @ 930 ml/ac) + May 30 (Glyphosate 540 1 L/ac)
Seed Treatment	April 30 (Vibrance Maxx @ 325ml/100kg & Vibrance Maxx + Intego @ 325ml/100kg	May 7 (Vibrance Maxx RFC @100 ml/100 kg + INTEGO Solo @ 19.6 ml/100 kg	May 14 (Vibrance Maxx @ 325ml/100kg & Vibrance Maxx + Intego @ 325ml/100kg	May 10 (Vibrance Maxx @ 325ml/100kg & Vibrance Maxx + Intego @ 325ml/100kg
Variety	Arbarth	CDC Inca	CDC Inca	CDC Spectrum
Seeding date	May 12	May 18	May 17	May 27
In-crop Herbicide Application	June 12 (Viper ADV @ 400 ml/ac + UAN @ 0.81 L/ac)	June 09 (Viper ADV @ 400 ml/ac + UAN @ 0.81 L/ac)	June 08 (Viper ADV @ 400 ml/ac + UAN @ 0.81 L/ac)	June 8 (Viper ADV @ 400 ml/ac) + July 5 (Assure II 300 ml/ac)
In-crop Fungicide Application	Dyax @ 160 mL/ac	N/A	N/A	July 09 (Priaxor @180ml/ac)
Desiccation	July 30 (Reglone Ion @ 0.83 L/ac)	Aug 6 (Reglone Ion @ 0.83 L/ac @ 20gpa	Aug 12 (Reglone Ion @ 0.83 L/ac @ 20gpa	Aug 05 (Glyphosate 540 @ 0.67 L/ac)
Harvest	Aug 5	Aug 13	Aug 20	Aug 17

NA = Not applied

Abstract:

A study was initiated in Saskatchewan, Canada, to demonstrate multiple management strategies to reduce the effect of *Aphanomyces* on field pea root health through root health assessments and overall yield production. The demonstration was arranged as a randomized complete block design, doubled wide, with four replicates at Scott, Outlook, Swift Current and Melfort in 2019 and 2021. The factors evaluated were herbicide (Glyphosate vs. trifluralin), seed treatment (none vs. Vibrance Maxx vs. Vibrance Maxx + Intego), fertility (20 P_2O5 vs. 50 P_2O5, 20 K, 10S) and foliar nutrient application for a total of 10 treatments. Disease ratings 3 to 5 WAP were relatively low across all sites. Disease ratings were higher at Scott and Outlook in both years than Melfort and Swift Current. At all sites, disease pressure was higher at the second disease rating (7 WAP or 8 WAP) than the first disease rating (3 to 5 WAP). The disease suppression trends with respect to applied inputs varied amongst all locations. The most diseased plants occurred when low fertilizer (20 P) + Gly was used compared to the higher fertilizer

applications (50 P, 20 K, 10 S). In general, it is difficult to confirm a treatment effect based on the disease ratings alone. The applied inputs did not influence the yield at any site, except Scott in 2019 (P =0.0132). The highest yields at Scott were achieved by adding higher fertilizer rates (50 P, 20 K, 10 S) than when low fertilizer (20 P) was applied. Similar to the disease suppression response, the average yield of the remaining seven sites increased when high fertilizer rates were used as compared to low. When averaged across all sites, the two most profitable combinations were Gly+ high fertility (50 P, 20 K, 10 S) and Tri + high fertility (50 P, 20 K, 10 S) + Vibrance Maxx or Intego. The most profitable input to utilize was high fertilizer rates, whereas herbicide application, seed treatments, and foliar nutrient response were less promising in the current study. Additional research is required to confirm the most effective and profitable combination of field peas grown under *Aphanomyces* infected soils.

Extension Activities:

The preliminary results of this study were presented at the Australian Seminar in Horsham, October 2019 with approximately 50 people in attendance by Jessica Enns. The results were also shared by Sherrilyn Phelps, Saskatchewan Pulse Growers at various grower extension events (+200 to date) as well as at the Agronomy Research Update 2019 (250 attendees), and at CropSphere (150 attendees) in collaboration with Jessica Enns. A fact sheet will also be generated and distributed on the WARC website as well as all Agri-ARM and WARC events to ensure the information will be transferred to producers.The trial at Swift current was promoted on a CKSW radio program called "Walk the Plots" that was broadcasted on a weekly basis throughout the summer and may also be highlighted by Bryan Nybo, Wheatland Conservation Area at the Swift Current Winter Pulse Meetings on February 27, 2020. Results of the trial have been included in the 2019 & 2021 ICDC Annual Research and Demonstration Report. Dr. Singh presented the 2021 ICDC results of the trial at the Annual SIPA/ICDC AGM held at the Dakota Dunes casino Dec. 7 & 8 with 130 registered in-person and 29 on-line participants. Further in 2021 ICDC produced a video of the project which can be viewed on the ICDC Irrigation Saskatchewan YouTube site at https://www.youtube.com/watch?v=zVXm6D5nPoE .

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Nitrogen Fertilization of Irrigated Wide-Row Dry Bean

Funding

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Project Lead

- Project P.I: Garry Hnatowich & Gursahib Singh

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 2021 three individual research trials were established within the South Saskatchewan River Irrigation District (SSRID). CDC WM-3 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 2021. 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. All three trial locations were seeded on May 27, 2021. Weed control involved a spring pre-seed application of granular incorporated Edge (ethalfluralin) at 6.9 kg/ac, a glyphosate pre-seed burn-off at 1.33 L/ac and in-season tank mix application of Viper ADV (imazamox & bentazon) at 400 ml/ac plus Basagran Forte (bentaon) at 135 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 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 rows of each plot were undercut with a small plot research undercutter (2 rows mechanically undercut, the 3rd row hand pulled) and the plants windrowed and allowed to dry prior to combining. Prior to undercutting all plots were assessed for *sclerotinia* (white mold) disease incidence. All trials were undercut on August 18, 2021. Combining was conducted with a Wintersteiger small plot combine equipped with a dry bean pick-up reel. Seed was cleaned and yields adjusted to 16% moisture.

All trials were harvested on August 30, 2021. Due to sandblasting due to high winds only three reps were harvested at both Knapik and Pederson locations.

Environmental conditions occurring through the growing season (September included) are provided in Tables 2 & 3. The 2021 growing season within the SSRID region was very dry and very hot. Temperatures exceeded 30 °C on 7 days in June, 14 days in July and 6 days in August. Although dry bean is a warm temperature crop, and although all trials were irrigated, visible leaf drop and curling occurred on many of these days of excessive temperatures.

In-season irrigations amounts applied were 218 mm (8.6") at CSIDC, 208 mm (8.2") at Knapik, and 208 mm (8.2") at Pederson locations.

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	43	123	May 27	August 18	August 30
Knapik	13	20	May 27	August 18	August 30
Pederson	47	76	May 27	August 18	August 30

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

	Year		
Month	**2021 mm (inches)**	**30 Year Average mm (inches)**	**% of Long-Term**
May	44.5 (1.8)	43.2 (1.7)	103
June	10.3 (0.4)	69.3 (2.7)	15
July	13.8 (0.5)	57.6 (2.3)	24
August	37.7 (1.5)	44.2 (1.7)	85
September	0.2 (-)	32.7 (1.3)	1
Total	106.5 (4.2)	247.0 (9.7)	**43**

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

	Year		
Month	**2021**	**30 Year Average**	**% of Long-Term**
May	55	61	90
June	317	242	131
July	677	509	133
August	922	752	123
September	993	818	121

Results

Agronomic data or observations collected are shown in Tables 4 through 9 for the CSIDC, Knapik and Pederson 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.

Two agronomic parameters intended to be recorded were not captured. Days to maturity could not accurately be measured as the crop was undercut, however, no apparent differences in plant maturation were observed for any treatment, at any location. Pod clearance determination was conducted at the time of undercutting. However, it became apparent at all locations that the variation within each treatment was very high, and the resulting information would provide little insight to treatment effects. Suffice to say that overall N fertilizer applications did not seem to influence pod height in 2021.

Dry bean yield obtained at all locations were acceptable with the Pederson location exceeding 4000 kg/ha on average. Tables 4 – 9 readily identify that N fertilizer treatment effects were virtually non-existent in 2021. Yields, both seed and biomass, were not affected by N fertilizer applications. Likewise, tissue N values and total N uptake were not affected by treatments. This lack of response would indicate that individual dry bean plants were obtaining adequate N through either biological N fixation and/or through residual soil N.

Although not a part of the study the lack of visual N fertilizer response throughout the growing season required investigation. It should be noted that a proven *rhizobium* inoculant for dry bean was not commercially available in 2021 so the beans in this trial were uninoculated. The lack of fertilizer response might be due to differing and/or compounding factors at each trial location.

Plant root excavations at CSIDC indicated all plants, regardless of N fertilizer, were well nodulated and apparently actively fixing N as indicated by their dark red coloration. Typical root nodulation from this site is shown in Pictures 1 & 2. Indigenous *rhizobium leguminosarum bv. Phaseoli*, possibly added by prior inoculated dry bean production, may have minimized N fertilizer response at this location. In one of the P.I.'s (Garry Hnatowich) 40+ year research experience, he has never witnessed this degree of nodulation occurring in Saskatchewan, despite being the scientist on record for three dry bean inoculant formulation registrations! A further confusing factor is that this plot of land at CSIDC has not had dry bean grown on it within the last decade. Indigenous rhizobia might be native and not been introduced through inoculation. Alternatively, if their presence was introduced, it demonstrates the persistent nature and survivability of *rhizobium leguminosarum bv. Phaseoli*. An additional curiosity is the apparent lack of nodulation reduction with added N fertilizer which might typically be expected. We cannot explain with certainty these observations. In general, across numerous nitrogen fertilizer trials conducted on various crop species in 2021 the fertilizer response was less than anticipated. A possible explanation was that due to above normal temperatures, and with intensive irrigation, a large amount of organic N was mineralized and utilized by plants, which likely occurred at all three test locations. Knapik – this site did have the presence of nodules on plant roots but in far fewer numbers.

Treatment influence on dry bean growth and development is shown in a factorial manner for combined site analysis in Tables 10. Data is assessed using factorial analysis (common control treatment used for each N source). Combined site analyses also demonstrated a lack of response to nitrogen fertilizer rates and nitrogen fertilizer source. Combined N fertilizer rate effect on seed yield is illustrated in Figure 1, the effect of N fertilizer source in Figure 2.

This is the second year of an intended three-year study; it will be repeated in 2022.

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Financial support was provided by the Agricultural Development Fund (ADF) initiative under the Canada-Saskatchewan Canadian Agricultural Partnership (CAP) bi-lateral agreement. Funding is gratefully acknowledged.

Table 4. CSIDC Trial (1) – Dry Bean Agronomic Observations 2021.
Different letters indicated significant differences between treatments (ANOVA, *P* ≤ 0.05).

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	3278	2923	22.7 bcd	79.4	318	1363	231	2.7	63.3
30 kg N Urea	3225	2876	23.0 abc	78.6	314	1317	223	2.6	57.8
60 kg N Urea	3231	2881	22.4 cd	79.3	315	1724	281	2.7	75.1
90 kg N Urea	3157	2816	22.2 d	78.6	315	1556	264	2.6	67.9
120 kg N Urea	2885	2574	22.7 bcd	78.1	315	1525	257	2.6	66.4
150 kg N Urea	3108	2772	23.4 ab	78.2	322	1887	311	2.5	76.8
30 kg N ESN	3152	2811	22.7 bcd	78.8	321	1519	261	2.5	65.6
60 kg N ESN	3302	2945	23.4 ab	78.5	325	1693	277	2.7	74.0
90 kg N ESN	3161	2820	22.7 bcd	78.6	311	1456	243	2.5	59.3
120 kg N ESN	3091	2757	23.7 a	78.6	317	1603	262	2.5	65.9
150 kg N ESN	3748	3343	23.5 a	78.8	329	1918	302	2.6	79.0
LSD (0.05)	NS	NS	0.7	NS	NS	NS	NS	NS	NS
CV (%)	11.2	11.2	2.3	0.9	4.9	22.3	19.9	6.7	19.4

Table 5. CSIDC Trial (2) – Dry Bean Agronomic Observations 2021.

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	NC	1	NC	0	40	23
30 kg N Urea	NC	1	NC	0	39	23
60 kg N Urea	NC	1	NC	0	41	25
90 kg N Urea	NC	1	NC	0	40	25
120 kg N Urea	NC	1	NC	0	41	23
150 kg N Urea	NC	1	NC	0	41	24
30 kg N ESN	NC	1	NC	0	38	24
60 kg N ESN	NC	1	NC	0	41	22
90 kg N ESN	NC	1	NC	0	40	22
120 kg N ESN	NC	1	NC	0	40	25
150 kg N ESN	NC	1	NC	0	44	22
LSD (0.05)		-		-	NS	NS
CV (%)		-		-	8.1	17.0

NC = not captured, no differences observed between treatments

Table 6. Knapik Trial (1) – Dry Bean Agronomic Observations 2021.

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	3034	2706	22.1	80.6	335	1480	138	3.2	43.6
30 kg N Urea	3219	2872	22.4	80.5	326	1525	140	3.2	45.6
60 kg N Urea	3535	3153	22.6	80.6	328	1468	131	3.2	43.3
90 kg N Urea	3208	2861	22.7	80.3	320	1535	152	3.1	47.9
120 kg N Urea	3439	3067	22.9	81.0	319	1551	127	3.0	38.9
150 kg N Urea	3660	3265	22.7	80.4	320	1912	162	3.0	51.6
30 kg N ESN	3373	3008	21.5	80.8	315	1735	157	2.9	45.6
60 kg N ESN	3611	3221	22.7	80.5	316	1759	157	3.0	47.3
90 kg N ESN	3690	3291	22.1	81.3	327	1822	149	3.0	44.5
120 kg N ESN	3552	3168	23.1	80.1	312	1930	178	3.0	54.0
150 kg N ESN	3539	3156	22.8	81.0	298	1853	144	2.9	43.6
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	12.3	12.3	3.6	0.6	6.0	16.5	27.2	4.8	27.8

Table 7. Knapik Trial (2) – Dry Bean Agronomic Observations 2021.

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	NC	1	NC	0	37	24
30 kg N Urea	NC	1	NC	0	36	21
60 kg N Urea	NC	1	NC	0	38	22
90 kg N Urea	NC	1	NC	0	37	22
120 kg N Urea	NC	1	NC	0	41	24
150 kg N Urea	NC	1	NC	0	39	22
30 kg N ESN	NC	1	NC	0	37	24
60 kg N ESN	NC	1	NC	0	41	22
90 kg N ESN	NC	1	NC	0	38	19
120 kg N ESN	NC	1	NC	0	38	23
150 kg N ESN	NC	1	NC	0	41	24
LSD (0.05)		-		-	NS	NS
CV (%)		-		-	6.2	20.7

NC = not captured, no differences observed between treatments

Table 8. Pederson Trial (1) – Dry Bean Agronomic Observations 2021.

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	3956	3529	21.7	78.4	290	4147	782	2.5	197
30 kg N Urea	3865	3448	22.0	78.3	292	3257	625	2.4	152
60 kg N Urea	4136	3689	22.1	78.0	307	3623	709	2.8	206
90 kg N Urea	3958	3530	22.1	78.5	305	3203	605	2.3	140
120 kg N Urea	3955	3527	22.5	78.2	309	3481	669	2.6	200
150 kg N Urea	3970	3541	22.7	77.9	296	3383	644	2.6	183
30 kg N ESN	4039	3603	22.8	78.6	312	3699	715	2.5	189
60 kg N ESN	4075	3634	21.7	78.3	306	3494	654	2.6	178
90 kg N ESN	3722	3320	22.4	78.7	327	3335	621	2.4	171
120 kg N ESN	3736	3332	22.8	78.1	302	3260	667	2.9	219
150 kg N ESN	4237	3779	22.6	77.9	305	3576	668	2.3	161
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	9.6	9.6	4.6	0.5	6.9	20.2	18.5	11.2	18.7

Table 9. Pederson Trial (2) – Dry Bean Agronomic Observations 2021.

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	NC	1	NC	0	47	27
30 kg N Urea	NC	1	NC	0	46	27
60 kg N Urea	NC	1	NC	0	47	24
90 kg N Urea	NC	1	NC	0	43	24
120 kg N Urea	NC	1	NC	0	46	26
150 kg N Urea	NC	1	NC	0	46	34
30 kg N ESN	NC	1	NC	0	49	23
60 kg N ESN	NC	1	NC	0	46	23
90 kg N ESN	NC	1	NC	0	44	21
120 kg N ESN	NC	1	NC	0	46	25
150 kg N ESN	NC	1	NC	0	49	24
LSD (0.05)		-		-	NS	NS
CV (%)		-		-	8.8	20.0

NC = not captured, no differences observed between treatments

Table 10. Combined Site Analyses – Factorial for Trial Location, N Fertilizer Rate and N Fertilizer Source, 2021. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

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	3229 b	2880 b	22.9 a	78.8 b	317 a	1575 b	261 b	2.6 b	67.7 b
Knapik	3408 b	3040 b	22.5 b	80.6 a	321 a	1671 b	148 c	3.1 a	45.8 c
Pederson	4075 a	3635 a	22.3 b	78.2 c	300 b	3795 a	720 a	2.5 b	182.7 a
LSD (0.05)	222	198	0.4	0.3	9	250	36	0.12	10.5
CV (%)	13.7	13.7	3.9	0.8	6.6	23.4	21.4	9.4	23.0
N Rate									
Control	3448	3075	22.2 c	79.4	311	2331	384	2.8	101.4
30 kg N	3476	3100	22.4 bc	79.2	314	2251	365	2.7	92.6
60 kg N	3640	3247	22.5 ab	79.2	314	2386	383	2.8	103.9
90 kg N	3564	3179	22.3 c	79.3	316	2241	352	2.6	88.4
120 kg N	3535	3153	23.0 a	79.0	312	2385	391	2.8	107.2
150 kg N	3760	3354	22.9 ab	79.0	310	2486	384	2.7	98.9
LSD (0.05)	NS	NS	0.56	NS	NS	NS	NS	NS	NS
N Source									
Urea	3531	3150	22.5	79.2	313	2298	371	2.8	97.7
ESN	3610	3220	22.6	79.2	313	2396	382	2.7	99.8
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Location x N Rate Interaction									
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Location x N Source Interaction									
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
N Rate x N Source Interaction									
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Location x N Rate x N Source Interaction									
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figure 1. Mean Influence of N Fertilizer on Combined Site Dry Bean Yield, 2021

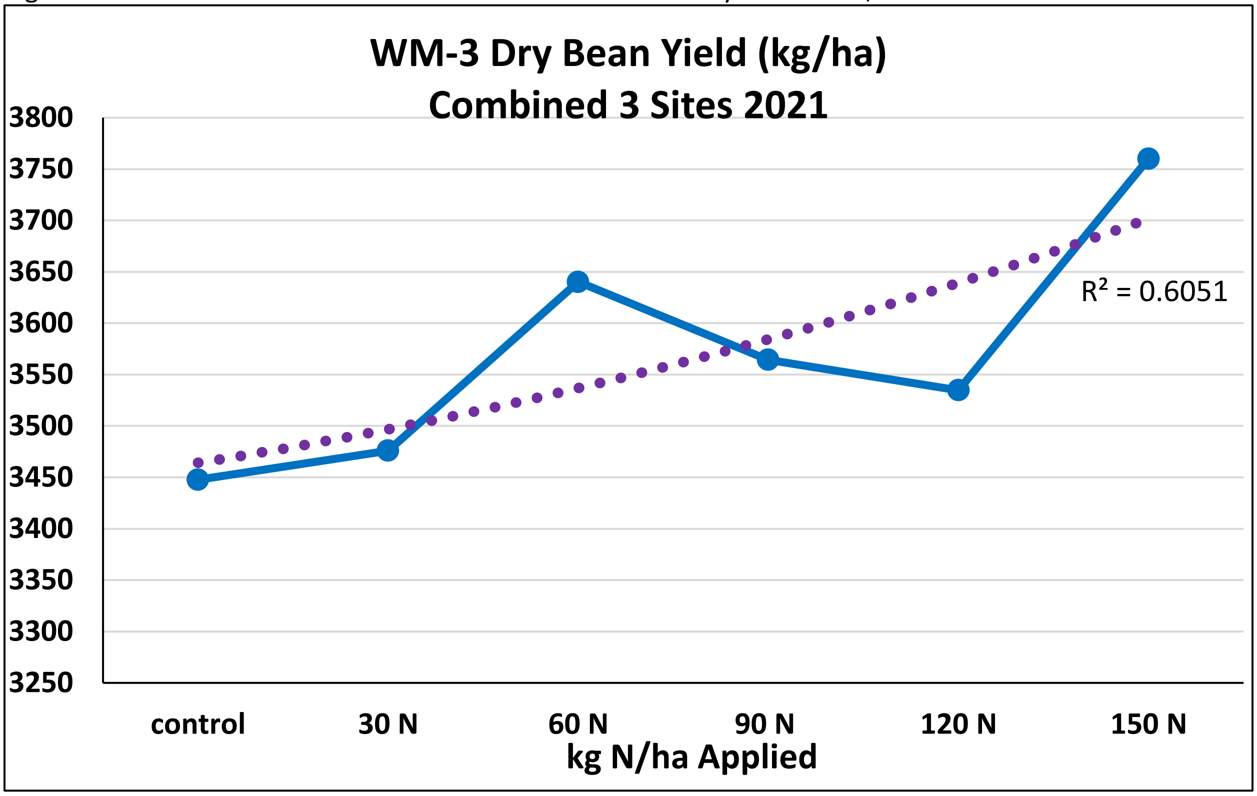
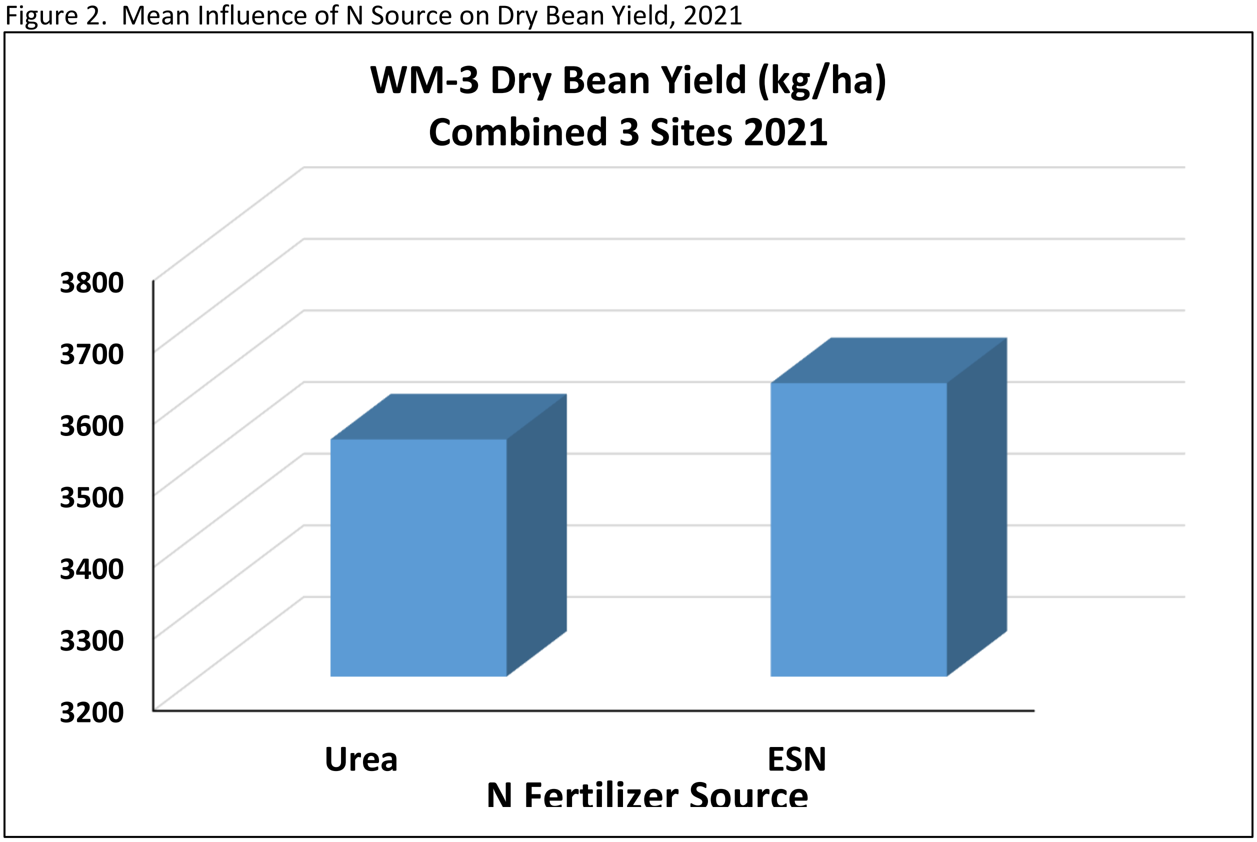


Figure 2. Mean Influence of N Source on Dry Bean Yield, 2021



Picture 1. Plant root nodulation of uninoculated dry bean at CSIDC, 2021.

Picture 2. Dry bean nodule at CSIDC, 2021

Effect of Tillage Management and Seeding Date on Dry Bean Establishment and Yield

Funding

Funded by the Strategic Field Program (SFP)

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Outlook

Project Lead

- SMOA Lead: Mark O'Connor
- ICDC Lead: Gursahib Singh & Garry Hnatowich

Objectives

Dry bean is a warm season crop with an epigeal emergence which is favored by warm soil conditions. Germination and emergence is enhanced when soil temperatures are 15-16°C. At this temperature emergence is generally 7 days. At temperatures below 12°C the time to emergence is extended and plants are less vigorous (Alberta Pulse Growers). Previous work with soybean, also an epigeal germination crop, indicated plant stand reductions when seed was planted into cool soil temperatures (G. Hnatowich & D. Lee, 2018). The dilemma with dry bean seeding date also involves its susceptibility and sensitivity to spring and/or fall frost if seeding is delayed too far. Soils warm quicker with tillage, however, this disregards best management practices (BMP's) in some situations and adds additional expense. Under irrigation, tillage is often employed particularly for traditional row crop dry bean production. With additional irrigable acres in the foreseeable future and an interest in dry bean production in suitable dryland regions of Saskatchewan there is need to evaluate solid seeded systems, particularly, where direct seeding is a standard practice. Soils in direct seeding systems are slower to warm and therefore might benefit from some light tillage to facilitate dry bean production. Alternately, seeding date can be delayed until soils are appropriately warm without endangering maturity and harvest. Black and Navy market dry bean lend themselves to the potential of solid seeded production and eliminate the expense of added on-farm row crop equipment.

The objective of the study is to evaluate the relationship between stubble management and consequently, soil warming, and seeding date on emergence and plant stand of dry bean and its subsequent seed yield.

Research Plan

The trial was established on-station at CSIDC (Field 8 west) on a field previously planted to spring wheat. The trial was established in a 3 x 3 level factorial in a randomized complete block design with 4 replicates. The first factor will contrast tillage treatments. The three tillage treatments were:

1. Heavy Tillage – plots were tilled with a tractor attached rototiller until soil was blackened and then harrow packed.
2. Mid Tillage – plots were tilled with a cultivator and harrow packed.
3. No Tillage – plots were undisturbed, and beans planted into standing stubble.

The second factor was seeding dates. CDC Blackstrap, a Black market class dry bean was solid-seeded on all plots on 25 cm (10") row spacings. Plots were seeded on,

1. May 10
2. May 19 (target date intended was May 21 but seeded earlier due to expected inclement weather)
3. June 1

Seeded plot size was 1.5 m wide (6 dry bean rows) and 10 m in length, plots were later trimmed to 1.5 m x 8.0 m harvest dimensions. Dry bean *rhizobia* inoculant was commercially unavailable, so all plots received a side band application of 135 kg N/ha as urea at seeding, along with 15 kg P_2O_5/ha seed-placed monoammonium phosphate.

Weed control involved a spring pre-seed application of granular incorporated Edge (ethalfluralin) at 6.9 kg/ac, a glyphosate pre-seed burn-off at 1.33 L/ac and in-season tank mix application of Viper ADV (imazamox & bentazon) at 400 ml/ac plus Basagran Forte (bentaon) at 135 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.

Pod height was determined just prior to harvest by collecting 5 random plants per plot and counting the number of pods with < 5.0 cm of distance from the soil surface to the pod. This is deemed the minimum distance required for the combine cutter bar to cut below the pod and minimize harvest loss. Therefore, a lower value is desirable.

Prior to harvest all plots were assessed for *sclerotinia* (white mold) disease incidence. The trial was harvested in a straight cut operation with a Wintersteiger small plot combine on September 3. Seed was cleaned and yields adjusted to 16% moisture.

In-season precipitation was 106.5 mm (4.2") and total in-season irrigation applied was 218.4 mm (8.6").

Results

Mean monthly temperatures and precipitation amounts are listed in Tables 1 and 2. The 2021 season was warmer than the long-term average with respect to temperature, rainfall was significantly well below historic averages.

At each seeding date soil temperatures, at intended seeding depth, soil temperatures were recorded. Results are shown in Table 3. Tillage in 2021 did not influence soil temperature. Soil temperatures from May 1 to May 10 were higher than normal which is reflected in the soil temperatures recorded on May 10. By May 19 soil temperatures declined, also reflecting environmental conditions where daytime maximum and minimum temperatures averaged 7.9 °C and -0.8°C, respectively at, or about, seeding.

Table 1. Mean monthly temperature from May to August 2021 at the ICDC trial location.

Location	**Year**	**May**	**June**	**July**	**August**	**Sept**	**Average**
		------------ *Mean Temperature (°C)* -----------					
Outlook	2021	10.1	18.8	21.6	17.9	14.4	16.6
	Long-term	***11.3***	***16.0***	***18.6***	***17.8***	***12.7***	**15.3**

Table 2. Precipitation amounts vs. long-term (30 year) means for the 2021 growing season.

Location	**Year**	**May**	**June**	**July**	**August**	**Sept**	**Average**
		-------------- *Precipitation (mm)* --------------					
Outlook	2020	44.5	10.3	13.8	37.7	0.2	106.5
	Long-term	***43.2***	***69.3***	***57.6***	***44.2***	**32.7**	**247.0**

Table 3. Soil Temperatures at Seeding.

Treatment	Soil Temperature at 5 cm		
	May 10	May 19	June 1
Heavy Till	15.5	10.3	30
Mid Till	15.5	10.2	32
No Till	15.5	10.1	33

At no time were soil temperatures, at seeding depth, influenced by tillage treatments.

Agronomic data collected is shown in Tables 4 and 5. Seed yield and was not influenced by tillage. As soil temperatures were not affected by tillage it is reasonable that seed yield was not influenced by this factor. With respect to seeding date, yields increased as date of seeding was delayed. This again, was not unexpected and mimics results found with warm season legumes in Saskatchewan. Statistical analyses did however reveal a significant tillage x seeding date interaction. This response is illustrated in Figure 1. The main interactions occur between tillage and seeding date with respect to the May 10 and May 19 operations. On May 10 it is possible that the soils did warm quicker in the days from planting to seedling emergence where heavy tillage was utilized, resulting in a higher yield. Conversely, when environmental temperatures declined at, and following, planting on May 19, the undisturbed treatment may have been buffered from soil temperature change by the protective undisturbed stubble and thatch debris. This may have attributed to a yield response.

Protein content of seed was not influenced by treatments. Test weight was highest with the no till treatment, the difference however was agronomically and economically insignificant. Test weight was not influenced by seeding date. Seed weight was significantly higher under a no till regime than when tillage was utilized. Seed weight also declined with each delay in planting date. No hypothesis will be made regarding treatment effects on test weight and seed weight until additional years of data are available.

Table 4. Influence of Treatments on Dry Bean Yield and Seed Characteristics. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

Treatment	**Yield (kg/ha)**	**Yield (lb/ac)**	**% Protein**	**Test weight (kg/hl)**	**Seed weight (g/1000)**
Tillage					
Heavy Till	3778 a	3353 a	32.7 a	77.2 ab	173 b
Mid Till	3382 a	3016 a	32.3 a	77.1 b	170 b
No Till	3759 a	3353 a	31.9 a	77.6 a	182 a
LSD (0.05)	NS	NS	NS	0.4	6.1
CV (%)	13.0	13.0	6.9	0.6	4.1
Seeding Date					
May 10	3284 b	2929 b	31.7 a	77.4 a	180 a
May 19	3647 ab	3253 ab	32.2 a	77.3 a	173 b
June 1	3988 a	3557 a	32.9 a	77.3 a	172 b
LSD (0.05)	397	354	NS	NS	6.1
Tillage x Seeding Date Interaction					
	S	S	NS	S	NS

S = significant at P<0.05   NS = not significant at P<0.05

The influence of treatments on some plant characteristics are provided in Table 5. Days for plant emergence and plant maturity were not influenced by the tillage regime. Plant emergence and maturity was accelerated with each delay in seeding. Pod clearance was not influenced by tillage operations but was affected by seeding date. A greater number of pods were positioned lower on the plant, and would be subject to direct combine losses, with the earliest seeding date. As seeding date was delayed the pods were formed higher on the plant. Likewise, plant height increased with each delay in seeding date but was not affected by tillage. Plant populations were not affected by tillage treatments, but plant establishment improved with each delay in seeding date. Sclerotinia disease pressure was absent in 2021.

Table 5. Influence of Treatments on Dry Bean Yield Agronomics. Different letters indicated significant differences between treatments (ANOVA, $P \leq 0.05$).

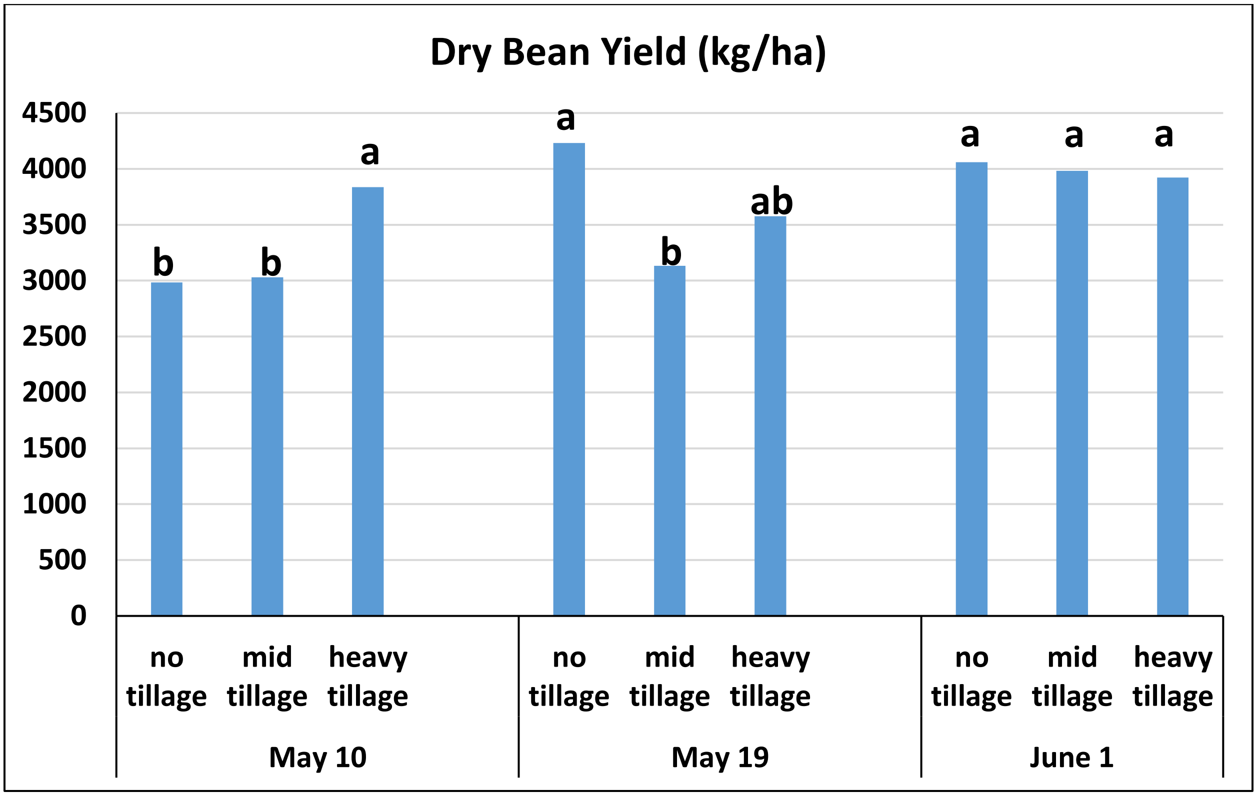
Treatment	**Days to Emerge**	**Days to Mature**	**Pod Clearance**	**Height (cm)**	**Plant Population (plants/m2)**
Tillage					
Heavy Till	8 a	87 a	1.7 a	40 a	34 a
Mid Till	9 a	87 a	1.8 a	42 a	32 a
No Till	9 a	89 a	1.9 a	42 a	34 a
LSD (0.05)	NS	NS	NS	NS	NS
CV (%)	8.2	2.7	62.0	11.5	13.8
Seeding Date					
May 10	12 a	97 a	2.5 a	38 b	30 c
May 19	9 b	89 b	1.8 ab	41 ab	33 b
June 1	6 c	77 c	1.1 b	45 a	40 a
LSD (0.05)	0.6	2.0	0.9	4.0	3
Tillage x Seeding Date Interaction					
	S	NS	NS	NS	NS

S = significant at P<0.05

NS = not significant at P<0.05

This is the 1st year of a three-year study and will be repeated in 2022 & 2023.

Figure 1. Dry Bean Seed Yield as Influenced by Tillage Operation and Seed Date.



Agronomic and Breeding Approaches to Improve the Harvestability of Dry Bean

Funding

Funded by the Agricultural Development Fund

Organizations

- University of Saskatchewan
- Irrigation Crop Diversification Corporation (ICDC), Outlook

Project Lead

- U of S Lead: Dr. Kirstin Bett
- ICDC Leads: Gursahib Singh & Garry Hnatowich

Objectives

Harvestability related harvest loss in dry bean production is one of the most important contributing factors to yield loss, and low pod height at harvest is one of the primary factors to this loss. Harvest loss could be even more severe in narrow-row/solid-seeded dry bean production system when direct combined. Seed loss was significantly greater (23.2%) under direct harvest due to the pod height related harvest efficiency (Eckert, et al., 2011). Most available dry bean varieties have only 70-85% of pods above the critical height, with some of them as low as 65% (www.saskpulse.com). This would potentially mean a 15–35% pod loss during the harvest.

Plant density has been shown to affect pod height, with higher density leading to increased height of the pods in some pulse crops like chickpea (Gan et al., 2002), pea (Yucel, 2013; Stepanovic et al., 2017) and soybean (Mehmet, 2008; Kang et al., 2017), but information on dry bean lacks. Meanwhile, plant density that is too high often may reduce the yield potential in dry bean production (Shirtliffe and Johnston, 2002; Pfiffner et al., 2014). Optimal plant population density is an important factor to improve the pod height/harvestability as well as to obtain the potential yields of the varieties. Hence, in this project, we will fill the information gap by investigating the effects of seeding rates on the pod height and therefore harvestability under narrow-row condition to maximize yield potential of current dry bean varieties.

Research Plan

The trial was established on-station at CSIDC (Field 8 west) on a field previously planted to spring wheat. The trial was established in a factorial randomized complete block design with 4 replicates. Two varieties from with three differing dry bean market classes were seeded at rates to achieve four differing target plant populations as outlined in Table 1.

Table 1. Dry Bean Treatments, 2021.

Variety	Market Class	Target Plant Population
Envoy	Navy	30, 35, 40 and 45 plants/m^2
Portage	Navy	30, 35, 40 and 45 plants/m^2
CDC Blackstrap	Black	30, 35, 40 and 45 plants/m^2
AAC BlackDiamond	Black	30, 35, 40 and 45 plants/m^2
CDC WM-3	Pinto	25, 30, 35, and 40 plants/m^2
Island	Pinto	25, 30, 35, and 40 plants/m^2

Dry bean varieties were sourced and packaged to obtain the desired target plant population at the University of Saskatchewan. Number of seeds planted was adjusted for each plant population and adjusted for seed size and % germination. All varieties were seeded on May 19. Seeded plot size was 1.5 m wide (6 dry bean rows) and 8 m in length, plots were later trimmed to 1.5 m x 6.0 m harvest dimensions. Dry bean *rhizobia* inoculant was commercially unavailable, so all plots received a side band application of 25 kg N/ha as urea at seeding, along with 20 kg P_2O_5/ha seed-placed monoammonium phosphate. An additional 80 kg N/ha was top dressed prior to seeding.

Weed control involved a spring pre-seed application of granular incorporated Edge (ethalfluralin) at 6.9 kg/ac, a glyphosate pre-seed burn-off at 1.33 L/ac and in-season tank mix application of Viper ADV (imazamox & bentazon) at 400 ml/ac plus Basagran Forte (bentaon) at 135 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.

The trial was harvested in a straight cut operation with a Wintersteiger small plot combine on September 21. Seed was cleaned and yields adjusted to 16% moisture.

In-season precipitation was 106.5 mm (4.2") and total in-season irrigation applied was 218.4 mm (8.6").

Results

No results will be presented at this time. Data analysis is continuing and under review. However, achieved plant populations did not approach the intended target plant populations. It is uncertain as to the cause of this, it might be biotic or abiotic in nature. However, seed yields obtained exhibited higher than reliable variation. This project is on-going and under review with the University of Saskatchewan.

Faba bean agronomy to enhance yield, hasten maturity and reduce disease

Funding

Funded by the Saskatchewan Pulse Growers (SPG)

Project Lead

- Project P.I: Chris Holzapfel, IHARF
- ICDC Lead: Garry Hnatowich/Gursahib Singh

Organizations

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

Objectives

Although peer-reviewed research and agronomic information in general for faba beans in western Canada is limited, all the concepts we propose to demonstrate have been previously investigated; albeit, not necessarily within any given individual project.

Seeding dates have been evaluated on numerous occasions and generally show that faba beans should be seeded as early as possible to maximize yields and increase the likelihood that the crop will reach maturity in a timely manner. In a four-year study focussed on soybean adaptation relative to other pulses, faba beans seeded in early- to mid-May consistently yielded higher and matured earlier than later seeding dates and yield losses could be severe when seeding was delayed until late-May or early-June (Holzapfel and Nybo, 2018). Early work in central Alberta evaluated seeding dates ranging from May 2 to June 11 and even minor delays from May 2 to May 15 resulted in a 43-47% yield loss. Delaying seeding to June 11 led to 83-85% yield losses (Kondra 1975). Over a two-year period in Winnipeg, delaying seeding from April 25 to May 23 led to yield reductions of 28-36% while May 9 seeding resulted in a significant yield loss relative to the earliest date in 1 of 2 years (McVetty et al. 1986).

Focussing on seeding rates, Shirtliffe et al. (2019) recently found that relatively low populations of 20-30 plants/m2 were required for maximum yield; however, these somewhat marginal populations could occasionally delay maturity and lead to challenges with weed competition. Kondra (1975) tested seeding rates of 100, 150, and 200 kg/ha and only reduced yields at the lowest rate; however, information on actual plant populations or seed size were not provided. McVetty, et al. (1986) looked at seeding rates of 23, 35, 46, and 58 plants/m2 and, consistent over the two-year period and with Shirtliffe et al. (2019), only reported a yield reduction at the lowest rate. In combination with varying row spacing levels, Holzapfel (2018) demonstrated seeding rates of 25, 45, and 65 seeds/m2 under dry conditions and saw a slight linear yield increase with increasing seed rate; however, the effect was small with only 139 kg/ha (≈2 bu/ac) observed between the highest and lowest rates. Increasing seeding rate accelerated maturity by 3 days when averaged across row spacing levels.

Faba bean response to fungicide is less well understood; however, several diseases can affect and have been observed in faba bean in western Canada. Chocolate spot has traditionally been thought to be the most important of these; however, over the last two-years of monitoring and surveying there has also been Stemphylium blight and Alternaria present as presented during the Western Forum of Pest Management meetings (2019 and 2020). Ascochyta blight, powdery mildew, rust and white mould can also occur but have had limited prevalence in Saskatchewan to date. Yield increases with fungicide applications have been elusive in research to date; however, anecdotally, growers and agronomists have seen yield increases on occasion. There is also uncertainty surrounding the optimal timings of application and effects on maturity. Shirtliffe et al. (2019) frequently reduced disease severity with fungicide applications but the most effective products only resulted in a 10% yield increase in 10% of the site-years. Under slightly drier than normal conditions at Indian Head (2015), dual fungicide applications (Headline followed by Priaxor 10 days later) did not significantly impact yield relative to the control but increased seed size from 398 g/1000 seeds to 416 g 1000/seeds (Holzapfel 2016). This increase and visual differences in late-season disease levels and maturity suggest that the potential for yield increases existed; however, the magnitude of the increase in seed size was less than 5%.

The objectives of the proposed project are to demonstrate:

- The ability of early seeding to optimize yield and allow for earlier faba bean harvest
- The effects of higher seeding rates on disease development, maturity, and yield.
- The capacity for foliar fungicide applications to reduce disease, enhance yield, and potentially delay maturity

Research Plan

A field demonstration with faba beans was established in the spring of 2021 on the federal CSIDC Research Station (field 8). The trial was established in a factorial randomized complete block design, each treatment was replicated 4 times. The proposed treatments were factorial combination of two seeding dates (early versus delayed), two fungicide treatments (untreated versus foliar fungicide applied), and two seeding rates (45 seeds/m2 and 65 seeds/m2) (Table 1). The first seeding date treatment was seeded on April 30 (as early as possible under local conditions); whereas the second seeding date treatment was seeded on May 15 (with a minimum of 14 days between dates). Prior to seeding the entire plot area received 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) to control weeds. Individual seeded plot size was 10 m in length and 1.5 m wide. All plots received 25 kg P2O5/ha as 12-51-0 as a sideband application during the seeding operation. Granular inoculant (TagTeam Faba) was seed placed during the seeding operation at a rate of 4 kg/ha. Both seeding dates received one fungicidal application of Priaxor (fluxapyroxad & pyraclostrobin) fungicide on July 5 and July 16 respectively. Plant density was determined by counting all plants in four 1.0 m lengths of row from each treatment plot (front and back). Plots were harvested September 23, plot harvest area was 8 m in length by 1.5 m wide. All plots were rated for chocolate spot before fungicide application, and samples of plants were sent to the Crop Protection Lab (Ministry of Agriculture- Regina) for disease identification.

Results

The mean treatment effect on yield, seed quality and agronomic traits are tabulated in Table 2.
This project was a demonstration to address the two major (disease and maturity) challenges in producing faba beans. Seeding date, fungicide application and seeding rate all had a significant effect on plant stand. Plant populations were higher in early seeded, higher seeding rate and non-fungicide applied plots than late seeded, low seeding rate, and fungicide applied plots. Due to dry conditions, the

disease pressure in both early vs late and high seeding rate vs low seeding rate plot was negligible, so it was hard to see the effect of fungicide application in the absence of disease.
The yield was not affected by any treatment, and the average yield was 50 bu/ac. Faba bean seed quality parameters were not generally influenced by seeding date, fungicide application and seeding rate. Crop maturity was variable between plots, but neither treatment had any significant effect.

Results from this ICDC trial will be combined with those of other participating sites for an interim report of results for 2021.

Acknowledgements
The Saskatchewan Pulse Growers provided financial support. All funding is gratefully acknowledged.

Table 1. Proposed faba bean agronomy treatments for enhanced maturity and disease management

#	Seeding Date	Fungicide [X]	Seeding Rate
1	Early [Z]	None	45 viable seeds/m^2
2	Early	None	65 viable seeds/m^2
3	Early	180 ml Priaxor/ha	45 viable seeds/m^2
4	Early	180 ml Priaxor/ha	65 viable seeds/m^2
5	Delayed [Y]	None	45 viable seeds/m^2
6	Delayed	None	65 viable seeds/m^2
7	Delayed	180 ml Priaxor/ha	45 viable seeds/m^2
8	Delayed	180 ml Priaxor/ha	65 viable seeds/m^2

[Z] Seeded as early as possible under local conditions (target between Apr-25 and May-7)
[Y] Seeded between May-20 and May-30 (minimum of 14 days after 1st date)
[X] Tailored for individual seeding dates; target ≈7-10 days after first flowers are observed (earlier may be warranted if disease pressure is high and symptoms are already present

Table 2. Impact of Treatments on plant densities, yield, protein, test weight and maturity

Group	Treatments	Plant density (per m^2)	Yield (bu/ac)	Protein (%)	Test weight (kg/hl)	Maturity (days)
Seeding date	Early	52.6	55.7	25.6	74.85	102
	Delayed	47.9	49.8	25.1	73.619	96
	LSD (0.05)	0.0162	NS	<0.001	NS	NS
	CV	3.7	4.3	0.2	2.4	
Fungicide	None	53.2	56.7	25.5	75.413	99
	Priaxor	47.3	48.8	25.3	73.056	99
	LSD (0.05)	0.0033	NS	NS	NS	NS
	CV	3.7	4.3	0.2	2.4	
Seeding rate	45 seeds/m2	41.2	53.9	25.5	75.256	99
	65 seeds/m2	59.3	51.6	25.3	73.213	98
	LSD (0.05)	<0.0001	NS	NS	NS	NS
	CV	3.7	4.3	0.2	2.4	

Hemp Seeding Date Demonstration for Grain Production

Funding

Funded by the Strategic Field Program (SFP)

Project Lead

- Project P.I: MOA required to appoint
- ICDC Lead: Gursahib Singh/Garry Hnatowich

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Gursahib Singh & Garry Hnatowich
- Indian Head Research Foundation (IHARF), Chris Holzapfel
- Northern Applied Research Foundation (NARF), Brianne McInnes
- Western Applied Research Corporation (WARC), Kayla Slind

Objectives

The project demonstrates different seeding dates of 3 varieties of conventional hemp to show producers the ideal time for seeding in various Saskatchewan locations.
This demonstration will provide producers with data for different hemp varieties in a wide range of seeding dates in Saskatchewan. Hemp is a newer crop in Saskatchewan and is a high value crop (worth around $0.75-$0.90/lb) and has good potential yields in Saskatchewan (average 660-1070 lbs/acre). Discovering optimum seeding dates for this higher value crop will encourage local growth in the conventional hemp industry and help ensure new growers access information that will contribute to their success. Having regional seeding date and variety recommendations would increase acres of this crop in Saskatchewan would provide value added opportunities and a higher gross return per acre. Having different crops in your rotation is important for managing disease and pest problems and provides economic benefits to producers. With increased pathogens associated with major crops currently grown (fusarium in wheat and clubroot in canola), increasing economic crops in rotations are becoming more important. Demonstrating the high potential return of this crop and how the currently registered varieties perform will help producers decide if they want to include this crop into their rotation. Demonstrating the wide effective seeding date window of this crop will also show producers how growing hemp can help with time management in spring.

Research Plan

The project was seeded in a randomized complete block design with fours replications including three hemp varieties. Outlook was the only irrigated sites; whereas Melfort, Scott and Indian Head were non-irrigated. The three seeding dates were end of May, middle of June and beginning of July. The three varieties (Finola, Picolo and X59) selected were high yielding, dwarfs and suitable for Saskatchewan conditions . Plot dimensions were 1.5 m by 8.0 m with recommended row spacing and target population of 100 – 125 plants/m2. Fertilizer was applied in a sideband to reduce the risk of seed injury, and rates were dependent on soil test results. Plant vigour was visually assessed for each treatment 2-3 weeks after planting. Plant heights was measured prior to harvest and days to maturity was assessed for each variety and seeding date. Plots were direct combined depending upon the maturity of each variety and seeding dates. Yields were determined from cleaned harvested grain samples and corrected to the required moisture content.

Results

The growing conditions of 2022 were extremely hot and dry which ultimately effect the plant height, vigor and establishment at all sites.. In particular, the early July seeding date plots did not establish at one site due too little to no rain in June or July. At Outlook, even with season long irrigation, height varied with plots due to the extreme heat.

Data Collected for year-one of the program consists of yield, height and maturity (Tables 1-4). Seeding dates had a significant effect yield at all sites with mid June being the one with the highest yield (Table 1 and Table 2). Outlook had the highest yield among the four sites, followed by Indian head. Due to poor growing conditions and lack of moisture, the lowest yields were recorded at Melfort.

Varieties had a significant effect on yield at Melfort, Indian Head and Scott. Yield slightly varied among varieties, with Picola < Katani < X59 increasing in yield. The interaction between different seeding dates and varieties was only significant at Scott and Indian Head with all the three varieties yielding better under mid-June seeding date (Table 2).

Table 1: Analysis of variance (P-values) for seeding dates and varieties effect on yield at four sites in Saskatchewan in 2021,

	Melfort	***Outlook***	***Scott***	***Indian Head***
Date	0.0378	NS	0.0025	0.0001
Variety	<0.0001	NS	0.0001	0.0003
*Date*Variety*	NS	NS	0.0028	0.0001
Grand Mean	221.66	1234.9	582.11	1084.4
CV	18.94	22.3	7.6	5.19

NS = Not Significant

Table 2: Seeding dates effect on mean yield measured at four sites

Seeding dates				
	Melfort	***Outlook***	***Scott***	***Indian Head***
Late (early-July)	242.15	1111.1	525.4	1113.7
Mid (Mid-June)	201.17	1446.2	731	1221.4
Early (Late-May)	-	1147.4	489.9	918
Varieties				
Katani	163.22	1178.6	554.8	1046.6
Picola	160.01	1139.1	541.4	1053.7
X59	341.74	1387	650.1	1152.8
Seeding dates* Varieties				
Mid*X59	-	-	851.2	1302.3
Mid*Picolo	-	-	674.7	1194
Mid*Katani	-	-	667	1168
Late*Picolo	-	-	574	1153.8
Late*Katani	-	-	534.7	1151.3
Early*X59	-	-	525	1120.3
Late*X59	-	-	516.5	1036

Early*Katani	-	-	462.7	820.5
Early*Picolo	-	-	433	813.2

Table 3 Varieties effect on mean yield measured at four sites

Variety	*Melfort*	*Outlook*	*Scott*	*Indian Head*
Katani	163.22	1051.3	494.75	933.5
Picola	160.01	1016	482.83	939.9
X59	341.74	1237.1	579.83	1028.2

Height was not recorded at Outlook due to large variation within plots but was measured at the other three locations (Table 3). Seeding date affected height at two of the three sites, whereas varieties across all sites had no effect on height except at Scott. The possible explanation for the height difference may be due to the extended growing season for the early seeding dates [higher days to maturity (DTM)], allowing more time for vegetative growth.

The measuring of DTM turned out to be more difficult than expected. The research available stated to use the tailgate test, where one gets a plant and smacks it on a truck tailgate and counts the number of seeds that fall out; the other method is to check the lower 2/3's of the plant for seed ripening. These methods were not consistent so in the next year of this project, we plan to gather more information, and develop a consistent method with the assistance of Blue Sky Hemp Ventures, a hemp processing company based in Rosetown and Saskatoon. With the data we did collect both seeding dates and varieties were the most significant cause for variance in maturity (Table 4).

Table 3: Analysis of variance (P-values) for seeding dates and varieties effect on plant height at four sites in Saskatchewan in 2021

	Melfort	*Outlook*	*Scott*	*Indian Head*
Date	0.0005	NC	NS	0.0116
Variety	NS	NC	0.0112	NS
*Date*Variety*	NS	NC	NS	NS
Grand Mean	80.347	NC	65.678	106.42
CV	16.58		8.79	4.93

NS = Not Significant
NC = Observation Not Captured

Table 4: Analysis of variance (P-values) for seeding dates and varieties effect on days to maturity (DAT) at four sites in Saskatchewan in 2021

	Melfort	*Outlook*	*Scott*	*Indian Head*
Date	<0.0001	NS	<0.0001	NC
Variety	<0.0001	NS	<0.0001	NC
*Date*Variety*	<0.0001	NS	<0.0001	NC
Grand Mean	112.8	105	96.7	NC
CV	13.8	27.03	7.33	

NS = Not Significant
NC = Observation Not Captured

Interim conclusion

In year-one, we have found that the seeding date significantly affects yield and height. The maturity was more affected by varieties. With the extreme heat and lack of moisture in 2021 growing season these values may not represent the actual characteristics of hemp and the effect of seeding dates, so, weather permitting, years two and three will help focus on the values.

Technology Transfer activities

In 2021 a video was created to generate awareness of the project which can be viewed on the ICDC Irrigation Saskatchewan YouTube site at https://www.youtube.com/watch?v=Z4g5g1jvkH4.The plots were shown and the project was discussed by Chris Holzapfel during the Indian Head Crop Management Field Day, hosted on July 20 and attended by approximately 75, excluding staff and directors.

Varietal Assessment of Forage Seed Production

Funding

Funded by the Strategic Field Program (SFP)

Project Lead

- SMOA Lead: Terry Kowalchuk
- U of S Lead: Dr. Bill Biligetu
- SFSDC Lead: JoAnne Relf-Eckstein
- ICDC Leads: Erin Karppinen & Garry Hnatowich

Organizations

- Irrigation Crop Diversification Corporation (ICDC), Outlook
- Saskatchewan Ministry of Agriculture (SMOA), Outlook
- University of Saskatchewan (U of S), Saskatoon
- Livestock and Forage Centre of Excellence (LFCE), Saskatoon
- Saskatchewan Forage Seed Development Commission (SFSDC), Saskatoon

Objectives

The objectives of this project were:

(1) To assess seed yield for the forage seed crops commonly grown in Saskatchewan;
(2) To evaluate forage seed as a possible irrigated cash crop as a means of expanding the sector;
(3) To explore potential turf grass varieties as a possible diversification opportunity for the forage seed sector; and
(4) To enable the SRP chair for forage breeding to evaluate seed production of new lines and compare to current commercial varieties.

At one time Saskatchewan was the second largest producer of forage seed in Canada. Over the past decade overall forage seed production has declined. As a result, the Saskatchewan Forage Seed Development Commission is interested in exploring opportunities for growing their sector. This project seeks to provide seed yield data for current forage seed species and turf varieties within the South Saskatchewan Irrigation Development Areas and the University of Saskatchewan. Evaluating seed production trials on irrigated land may provide growers with a new cash crop that would fit well into current horticultural and small grain rotations. An irrigated site at Outlook would provide additional seed yield data as part of this assessment. Information from both trials will be used to help promote the forage seed sector and encourage new growers to enter the market in both traditional and non-traditional seeding areas. There is a lack of data about seed yield for specific forage varieties. This project will help producers make more informed decisions by providing information for estimating net returns. These estimates will also help new or potential growers assess opportunities for growing various forage seed crops under irrigation. Existing growers will be able to use the information as a benchmark for yield comparisons to their own operations. If they have not tried growing a particular species or variety, it will also give them an idea of the average yield potential.

Research Plan

Note that this trial was also established under dryland conditions at the Livestock and Forage Centre of Excellence near Clavet, SK.

Forage plots were established on May 29, 2020 at the ICDC Knapik off-station location. A total of 28 treatments were arranged in a three-replicate split plot design, with species as the whole plots and variety as the subplot (Table 1). A composite soil sample was collected prior to seeding and fertilizer applications were based off soil nutrient determinations (Table A2). At seeding, each plot received 35 kg P_2O_5/ha as mid row-banded monoammonium phosphate (MAP; 11-52-0). On October 9, 2020 100 kg N/ha of urea was broadcast across the entire trial. Weed control was not required during the growing season. In-season precipitation was 144.0 mm (5.7") and total in-season irrigation applied was 213.4 mm (8.4").

Table 1. Treatment list and seed information.

Entry	Species	Variety	Seeding Rate (plants/m^2)	Germination (%)	Seed Weight (g/100)
1	Hybrid Bromegrass	AC Knowles (check)	300	82	0.40
2	Hybrid Bromegrass	AC Success (check)	300	84	0.45
3	Hybrid Bromegrass	S9073Q	300	92	0.40
4	Hybrid Bromegrass	S9570	300	82	0.44
5	Hybrid Bromegrass	S9593	300	94	0.41
6	Meadow Bromegrass	Fleet (check)	300	90	0.49
7	Meadow Bromegrass	S9549	300	96	0.53
8	Smooth Bromegrass	Carleton (check)	300	32	0.32
9	Crested wheatgrass	Kirk (check)	300	74	0.32
10	Crested wheatgrass	S9598	300	80	0.29
11	Hybrid wheatgrass	AC Saltlander (Check)	300	82	0.43
12	Hybrid wheatgrass	S9615	300	86	0.38
13	Hybrid wheatgrass	S9600	300	72	0.36
14	Western wheatgrass	Walsh (check)	300	60	0.52
15	Northern wheatgrass	Elbee (check)	300	78	0.26
16	Intermediate wheatgrass	Chief (check)	300	82	0.70
17	Intermediate wheatgrass	S9578	300	90	0.62
18	Tall Fescue	Courtenay (check)	300	86	0.23
19	Tall fescue	S9582	300	98	0.23
20	Timothy	Climax (check)	460	96	0.07
21	Timothy	ST1	460	96	0.06
22	Creeping red fescue	Boreal	300	90	0.14
23	Perennial ryegrass	Replicator	300	92	0.27
24	Festolulium	Lofa	300	88	0.37
25	Galega	Common	400	78	0.59
26	Cicer milkvetch	Oxley II (check)	400	62	0.37
27	Sainfoin	Common	200	88	1.91
28	Sainfoin	SF900	200	90	1.93

Mean monthly temperatures and precipitation amounts are listed in Tables 2 and 3. The 2020 season was comparable to the long-term average with respect to temperature, but rainfall was below average.

Location	Year	May	June	July	August	Average
		----------- *Mean Temperature (°C)* -----------				
Outlook	2020	11.3	15.9	19.1	18.8	16.3
	Long-term	***11.5***	***16.1***	***18.9***	***18.0***	**16.1**

Table 3. Precipitation amounts vs. long-term (30 year) means for the 2020 growing season.

Location	Year	May	June	July	August	Average
		------------- *Precipitation (mm)* -------------				
Outlook	2020	27.8	79.2	29.6	19.0	155.6
	Long-term	***42.6***	***63.9***	***56.1***	***42.8***	**205.4**

Results

This trial was in its second year of establishment. The trial was compromised by a seeder distributor blockage at seeding such that most plots were seeded to 4 rows rather than 6. Winter kill eliminated the forage legumes. Seed yield was very low with forage grasses. Therefore, no data will be presented for the past year. This trial is being reconsidered and may be re-seeded in 2022.

Acknowledgements

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

Demonstration of Irrigation Scheduling Using Remote Sensor Technology

Funding

This project was funded by the Ag Demonstration of Practices and Technology (ADOPT) program, through the Canadian Agricultural Partnership (CAP).

Principal Investigator

- Jay Bauer M.Sc. AAg; Irrigation Soils Agrologist

Organizations

- Canadian Herb, Specialty Agriculture and Natural Health Products Canada
- Saskatchewan Ministry of Agriculture
- Irrigation Crop Diversification Corporation (ICDC)
- Canada- Saskatchewan Irrigation Diversification Centre (CSIDC)

Objectives

The objective of this demonstration is to show how soil moisture sensor technology can provide useful information to assist with irrigation scheduling decision making. This project will investigate a soil moisture sensor and data processing software produced by the company CropX. The soil moisture sensor data is integrated into an online and mobile platform that forecasts soil moisture and provides irrigation recommendations.

Project Rationale

The adoption of soil moisture sensors for irrigation scheduling can provide valuable information that can reduce the chance of over and under irrigating. Keeping soil moisture in the optimal range for crop growth can maximize crop yield and quality, increase water use efficiency, and reduce pumping costs. Adoption of irrigation scheduling technology has had a slow uptake with irrigators in Saskatchewan due to a variety of factors including a steep learning curve of scheduling systems and software, high water tolerance of commonly grown low-value crops and producer scepticism on return on investment. With more user-friendly soil moisture sensor platforms on the market and the expansion of high-value crops being grown under irrigation, there is a great potential for sensor-based irrigation scheduling to improve the profitability and efficiency of irrigation in Saskatchewan.

Methodology

The initial intent of this project was to provide the producer with an irrigation scheduling recommendation based on information from the CropX soil sensor system in one field then have the producer irrigate a different field based on their traditional irrigation scheduling technique. We would then compare soil moisture and yield data from the fields to help determine how much value the producer gained from using the CropX sensors. However, due to the exceptionally hot growing season, the producer was not comfortable drying down the field to the refill point due to sandy sections in the field that are susceptible to drought stress in hot conditions. The producer irrigated both fields on the same irrigation schedule with input from our interpretation of the CropX soil moisture data. Due to this divergence from the experiment design, this report presents the accuracy of the CropX soil moisture sensors and software, and how this data can be used in irrigation scheduling.
The field site of this project is located on two adjacent center pivot irrigated quarter sections north of

Outlook, SK. Both fields consist of a Brown Chernozemic soil formed in dominantly very fine sandy loam lacustrine materials, belonging to the Bradwell Association. There is minimal topographic variation and coarse textured sandy soils in small patches. Both fields were seeded to durum wheat on May 21, 2021 and harvested on September 11, 2021. Both fields were fertilized with Amidas Urea 40-0-0-6 at a rate of 213 lbs/acre (float) and a mixture of 58% Phosphate Mono-Ammonium 11-52-0-0 and 42% Potash 0-0-60-0 at a rate of 121 lbs/acre (sideband).

Three CropX soil moisture sensors were installed in each field in locations determined to have minor differences in growth patterns based on satellite-derived NDVI data, suspected to be caused by soil texture variability. The sensors were then launched into the CropX online software platform along with the optional soil, crop, and irrigation system information. The CropX sensors measured percent volumetric water content (%VWC), Electrical Conductivity and Temperature at 20 cm and 45 cm depths from June 6, 2021 to August 31, 2021. The proprietary CropX software automatically calculates the soils field capacity, refill point and wilting point. These values are automatically adjusted during the growing season as the software learn from the data, but the user has the option to manually set these parameters in a static position. The software also calculates a profile sum graph, which is a measure of the total available water in the soil profile. A 5-day soil moisture forecast is calculated on the profile sum graph. The sensors have a Wholesale price of $699 and a data subscription annual fee of $275 per sensor. There is not a Canadian distributor currently, but they are looking for one.

Figure 1 illustrates the 20 cm CropX soil moisture data and auto calibrated field capacity and 50% refill point collected at three locations in each quarter section. This data shows variability in soil moisture trends related to soil texture and landscape variability among the sensor locations. The soil water status of both fields was maintained between field capacity and the 50% refill point by applying daily 8 mm irrigation applications for most the growing season. Both fields produced a yield of 80 bu/ac with a total of 32 mm of irrigation water applied.

Site F1-A, F1-C and F2-A show a similar moisture trend of VWC being maintained between field capacity and the refill point for the irrigation season (Figure 1). The location of these sensors has a very fine sandy loam soil and produced healthy crop growth. The sensor at location F1-A produced a lower VWC than the data from locations F1-C and F2-A, even though the gravimetric soil data from these locations was found to be comparable (Table 1). Inconsistencies in the soil moisture sensor data typically require user interpretation; however, the CropX software accounted for this difference by setting a lower field capacity and refill point at this location.

Location F1-B and F2-C have a more finely textured soil relative to the dominant soil texture in the quarters. The soil moisture status from these locations was high and had several dates where the moisture level saturated above field capacity. The high moisture levels at these locations may have been caused by the irrigation applications exceeding crop demand. These more finely textured soils are slow to drain making them more suspectable to saturation under high moisture conditions, whereas locations with more coarsely textured soils like those found at location F1-A, F1-C and F2-A could freely drain any excess applied water.

At location F1-B, the CropX software continued to raise the field capacity value as irrigation applications caused the soil to become saturated (Figure 2). These high moisture readings that decrease quickly is an indication that surface and/or sub-surface runoff is occurring from adjacent land and that this excess moisture is then decreasing from both crop use and deep percolation through the fine textured soil layer below. It is probable that the FC value determined by the CropX software at this location is artificially high, which could cause a producer to under irrigation their crop if they were solely relying on this sensor for scheduling decision making.

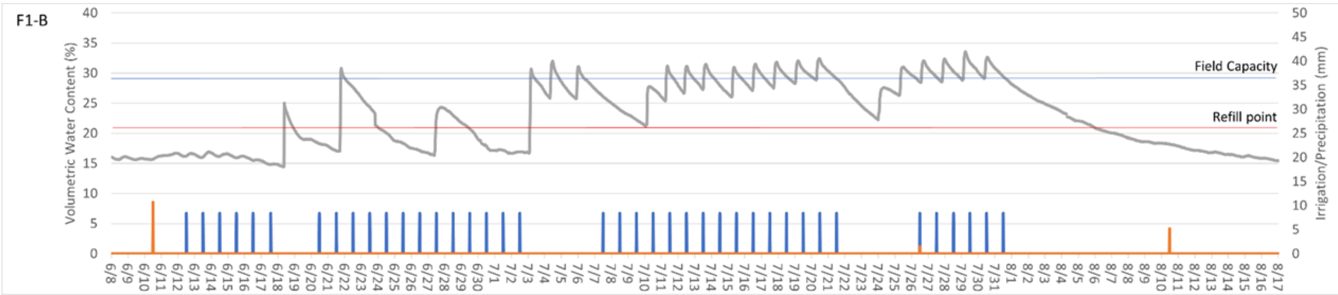
The sensor at location F2-B was not able to consistently register the moisture from irrigation applications. This sensor was not installed to the recommended depth because it was binding in the coarse sand at this location. This may have caused the data inconsistency, or it may have been caused by a poor sensor contact to the coarse sand. This is something to look out for in very coarse textured soil but should not be a common issue because this soil type is not recommended for irrigation production due to poor growth caused by poor fertility and low water holding capacity in this soil type.

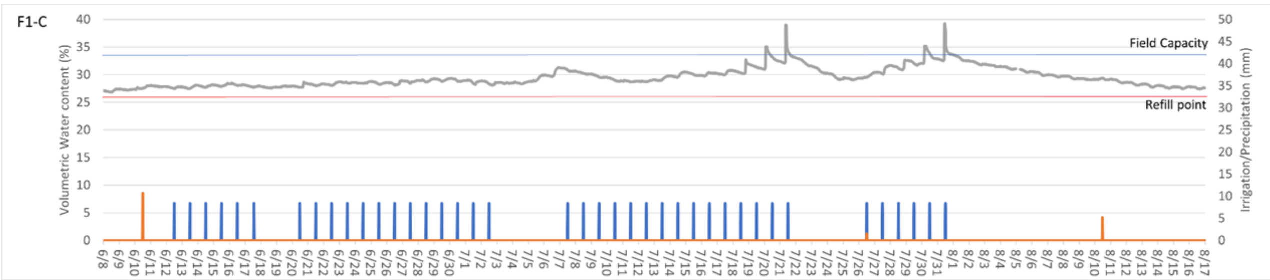
The following scenarios highlight how the CropX soil moisture data provided useful information for decision making in this unusual growing season where the pivot was rarely turned off to keep up with high evaporation demand. In June, the producer needed to dry out the crop canopy to apply a fungicide application. There was a break in the hot weather on July 7 and the soil sensors were registering near field capacity and the soil moisture forecast showed that there was several days before the crop would reach the refill point. With this information, the producer was confident that they had several days to dry the field out and apply the fungicide without causing drought stress. The data was also useful for determining when to turn the pivots off when the soil exceeded field capacity as the irrigation systems had caught up with the high crop water use in July. Near the end of July, the irrigation systems were applying the daily 8 mm of water and the crop was starting to lodge in small patches and begin to mature. The producer knew they needed to turn off the irrigation pivots for the season soon to reduce the lodging risk, so they utilized the sensor data to time the end of the irrigation season once the sensors had indicated that the soil had reached field capacity.

Extension activities that highlighted this project include:

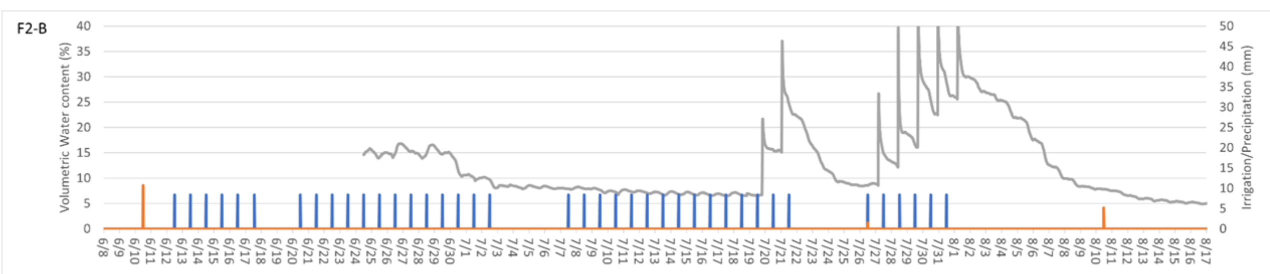
- Video Presentation for the CSIDC Virtual Field Day November 2, 2021
- Approximately 170 people registered for the event.
- Video posted on the Irrigation Saskatchewan ICDC (Youtube page and has 50 views)
- https://www.youtube.com/watch?v=15FuqZnjLng
- ICDC Program Report 2021

Figure 1: Time Series volumetric water content (right axis) and irrigation/precipitation data (left axis) for the 2021 growing season. Field capacity and refill point lines are based on CropX auto calibration software. The refill point was set to 50% of available water.


F1-B
Volumetric Water Content (%)
Irrigation/Precipitation (mm)
Field Capacity
Refill point


F1-C
Volumetric Water content (%)
Irrigation/Precipitation (mm)
Field Capacity
Refill point


F2-A
Volumetric Water content (%)
Irrigation/Precipitation (mm)
Field Capacity
Refill point


F2-B
Volumetric Water content (%)
Irrigation/Precipitation (mm)

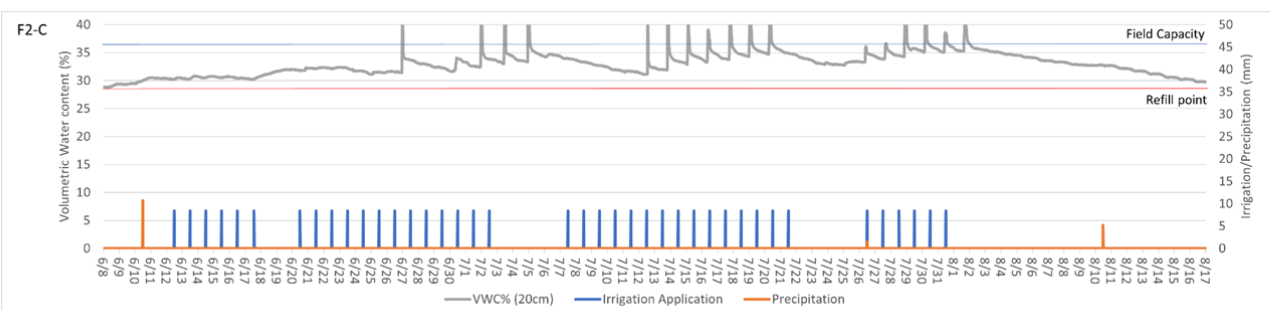

F2-C
Volumetric Water content (%)
Irrigation/Precipitation (mm)
Field Capacity
Refill point
VWC% (20cm)
Irrigation Application
Precipitation

Figure 2: Soil Profile Sum extracted from the CropX data report for sensor location F1-B.

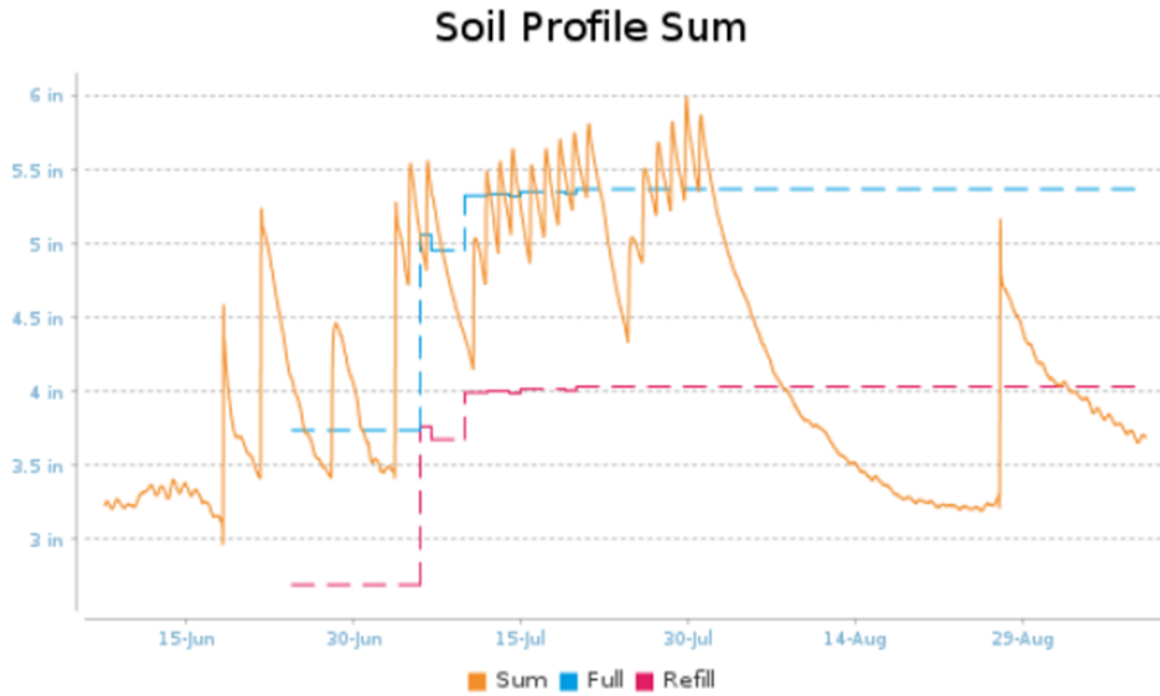


Table 1: Gravimetric Water content (GWC) and Volumetric Water Content (VWC) from the Field 1 CropX soil sensors locations.

CropX Sensor Location	Date/Time	GWC 10-30 cm (g/g)	CropX Sensor 20 cm VWC (%)
F1-A	5-Jul-21 16:30	19.1	22.9
F1-B	5-Jul-21 16:30	19.6	28.5
F1-C	5-Jul-21 16:30	20.6	29.5
F1-A	28-Jul-21 9:30	19.9	21.2
F1-B	28-Jul-21 9:30	19.3	28.8
F1-C	28-Jul-21 9:30	21.6	31.4

Table 2: Soil textures at the CropX sensor locations.

Sensor Location	Soil Texture 0-30 cm	Soil Texture 30-60 cm
F1-A	VFSL	VFSL
F1-B	VFSL	SiL
F1-C	VFSL	VFSL
F2-A	VFSL	VFSL
F2-B	LS	S
F2-C	SCL	SiCL

Conclusions and Recommendations

The CropX data platform was found to be able to provide accurate soil information and could correct for some inconsistencies in sensor data. However, the software did have some issues interpreting data from the sensors located in areas that experienced soil saturation issues. This inconsistent data at some of the sampling locations highlights the importance of placing sensors in areas of the field with different soil moisture tendencies and having some knowledge of how to interpret the data.

It is typically recommended to utilize soil sensors data to allow a field to draw down moisture until a refill point of 50% of available moisture, then to fill the moisture back up to field capacity at a rate that matches the soil infiltration capacity. This best management practice maximizes crop yield and water use efficiency by maintaining adequate moisture for crop growth, reducing evaporation loss and disease pressure in moist crop canopies caused by small frequent irrigation applications, and preventing waterlogging in low areas and deep percolation of water caused by irrigating above field capacity. Due to the exceptionally hot and dry growing season and low moisture holding capacity of coarse textured soils, the producer was required to irrigate at the maximum system output (8 mm/day) all but 10 days from June 12 to August 1. By irrigating so aggressively the producer was able to maintain adequate soil moisture to achieve a high yield while sacrificing some water to deep percolation and increasing disease pressure by keeping the crop canopy moist. During a milder growing season, the producer would have had more flexibility to utilize the soil moisture data by allowing the soil to slowly draw down moisture to the refill point then quickly filling it back up to field capacity. Even though it was not an ideal growing season to capture the full value of the soil moisture sensors, there were several scenarios where the data helped make critical decisions. The sensors help to plan when to dry out the crop canopy for a fungicide treatment, prevented over irrigating under an aggressive irrigation schedule, and time when to stop irrigating to ensure there was enough moisture for the crop to achieve its yield potential while balancing the risk of lodging.

Soil moisture sensor technology has become more user-friendly and affordable and has proven to be a valuable tool of irrigators in many jurisdictions. To further the progress of helping irrigations in Saskatchewan to adopt this valuable technology, there needs to be more projects that get producers using this and similar technologies so they can learn how to interpret the data, realize what benefits it can bring to their irrigation operations, and then share what they learn with their peers.

Acknowledgements

- Sarah Sommerfeld and Ryan Grunerud, collaborating producers, for letting us experiment on their land and participating in this project.
- Cara Drury, MOA Irrigation Agrologist, for project organization and implementation.
- Sarah Peterson, MOA Agrology Summer Student, for project implementation.
- Neha Kaushik, MOA Irrigation Technician, for project implementation.

Abstract/Summary

The goal of this project is to demonstrate how the CropX soil moisture sensors and web/mobile data interpretation platform can help with irrigation scheduling decision making. The CropX sensors and software were found to provide accurate data on current soil moisture status to help the collaborating producers make informed irrigation scheduling decisions. The CropX software integrates soil moisture sensor data into a user-friendly platform, but it still requires some relatively straightforward training on how and where to install the sensors and how to interpret the data. The value of these sensors was somewhat limited in this hot drought year because the sandy loam wheat field that they were installed in required nearly as much water as the irrigation system could apply. However, the sensors helped with

irrigation timing around fungicide spraying, when to stop irrigation to avoid wasteful and harmful over irrigation and ending the irrigation season with enough moisture in the field for the crop to finish growing while balancing lodging risk. It is anticipated that the data from these sensors could be more valuable in a milder growing season with a less extreme evaporative demand. There is a great opportunity in Saskatchewan for the CropX soil moisture sensor system to improve crop yield and quality and make the most out of our shared water resources.

This project was highlighted at the 2021 CSIDC Virtual Field Day and will be published in the ICDC Program Report 2021. The field day had approximately 170 registered attendees.

FRUIT AND VEGETABLE CROPS

Specialty Agriculture Demonstration

Funding

This project was funded by the Ag Demonstration of Practices and Technology (ADOPT) program, through the Canadian Agricultural Partnership (CAP).

Principal Investigator

- Cara Drury, PAg, Irrigation Agrologist, Ministry of Agriculture

Organizations

- Canadian Herb, Specialty Agriculture and Natural Health Products Canada
- Saskatchewan Ministry of Agriculture
- Irrigation Crop Diversification Corporation (ICDC)
- Canada- Saskatchewan Irrigation Diversification Centre (CSIDC)

Objectives

The objective of this trial is to provide an opportunity for new growers and buyers to see these specialty crops produced in Saskatchewan's growing conditions. The specialty crops include:

(1) Monkshood, *Aconitum carmichaelli*
(2) Foxglove, *Digitalis sp.*
(3) Valerian, *Valeriana officinalis*
(4) Chicory*, Cicoria siciliana*
(5) Oregano, *Origanum vulgare*
(6) Caraway, *Carum carvi*
(7) Borage, *Borago officinalis*
(8) Coriander, *Coriandrum sativum*
(9) Hops, *Humulus lupulus*
(10)Hemp (for CBD oil), *Cannabis sp.*

Project Rationale

- Specialty crops are potentially high value markets that are available to Saskatchewan producers, as well as a way for producers to diversify their cropping mix.
- The field crop varieties are a good rotation crop to reduce disease incidents such as club root.
- Currently there are new buyers looking for growers to produce these specialty crops, but due to the low acres of production, the potential new growers are not familiar with these crops. A demonstration of how these crops respond to Saskatchewan's growing conditions will help bridge this gap.

- This project will provide information that will allow growth and market opportunities for the specialty crops in Saskatchewan.

Research Plan

Significant delays in accessing facilities and land at CSIDC occurred in the spring due to Covid-19. It was originally planned to start plants in CSIDC's greenhouse, then transplanting to the herb garden. It was not possible to start seeds in the greenhouse; therefore, many plants were direct seeded and slow to develop.

The borage, hemp, coriander, caraway and chicory seed were planted on May 27. An EarthWay planter, was used to seed at ¼" depth and seeding disks appropriate to each seed size. The oregano, valerian and hops were mailed out from Richters' on May 25, due to shipping delays from Covid-19 they did not arrive in Outlook until June 3 (oregano) and 4 (valerian and hops). All plants were alive when they arrived, but not in the best condition. Transplanting took place on June 4 and 5. Due to delays and access restrictions from Covid-19 restrictions, this project has been extended for an extra year.

Results

Monkshood, Aconitum carmichaelli was planted from root stock into pots on April 23, 2020 and kept indoors under grow lights. Once outdoor temperatures improved and there was no longer a risk of frost, the plants were transplanted to the herb garden plots at CSIDC, May 27, 2020. In the first year of growth the plants established well and grew vigorously but did not produce blooms.

No special treatment was taken to over winter the plants and survival was assessed in the spring of 2021. As of June 2021, all established transplants survived the winter. The 2021 growing season was exceptionally hot and dry in Outlook, SK, with the month of July receiving a total of 1.5 mm precipitation. Despite the hot and dry growing conditions, the monkshood plants have grown vigorously, as of September 15, 2021, the flowers have started to bloom.

On August 20, 2021, three monkshood plants were dug up and had fresh weights of the roots recorded. The tuber weights were 418.1 g, 398.3 g and 317.8 g.

Figure 1. Monkshood Root Stock

Figure 2. Monkshood Roots Fall 2021

Foxglove, Digitalis sp. was started from seed on April 23 ,2020 and grown in greenhouse until transplanted to the herb garden plots at CSIDC, May 27, 2020. Thirty plants were planted and 24 established in 2020 but flowering never did take place.

No special treatment was taken to over winter the plants and survival was assessed in the spring of 2021. As of June 2021, five plants survived the winter. At that point this was considered a crop failure and no further measurements or notes were recorded.

Valerian, Valeriana officinalis was purchased from Richter's as 12 seedling plugs. Due to shipment delays (Covid-19 related) the plugs arrived in poor condition and only 11 survived. The seedlings established well, but never reached maturity or flowered. A single plant was dug up in the fall of 2020 to have the root examined. The roots were found to be quite small, so the remaining plants were left for harvest in the fall of 2021.

No special treatment was taken to over winter the plants and survival was assessed in the spring of 2021. As of June 2021, all established transplants survived the winter. The 2021 growing season was exceptionally hot and dry in Outlook, SK. Despite the hot and dry growing conditions, the valerian plants have grown vigorously and formed full blooms.

On August 20, 2021, three valerian plants were dug up and had fresh weights of the roots and shoots recorded.

Table 1. Valerian harvest weights

Valerian	Roots (g)	Shoots (g)
Plant 1	241	412
Plant 2	61	108
Plant 3	319	459

Chicory, Cicoria siciliana was direct seeded on May 27, 2020, using an EarthWay planter. Seed was planted at ¼" depth and watered by hand until germinated. The chicory did not produce well compared to previous years that it has been grown at CSIDC. Establishment was patchy and growth slow, this is attributed to some of the seedlings possibly being damaged or removed with early weed control and poor soil nutrition. There were 65 plants harvested, with a total fresh root weight of 499 g.

Figure 3. Harvested Chicory 2020

Figure 4. Harvested Chicory Root 2020

Oregano, Origanum vulgare was purchased from Richter's as a 90-count plug tray. Due to shipment delays (Covid-19 related) the plugs arrived in poor condition and only 67 survived. The plugs were planted on June 4, 2020. The plants grew vigorously and competed well with weeds. In the fall of 2020, ten plants were harvested, and fresh weights were recorded. The average fresh weight of an individual plant was 198 g.

No special treatment was taken to over winter the plants and survival was assessed in the spring of 2021. As of June 2021, all established transplants survived the winter. The 2021 growing season was exceptionally hot and dry in Outlook, SK. Despite the hot and dry growing conditions, the oregano plants have continued to grow vigorously.
Caraway, Carum carvi was direct seeded on May 27, 2020, using an EarthWay planter. Seed was planted at ¼" depth and watered by hand until germinated. The plot did not fare well. The first round of seeding failed to establish, and the second round of seeding was too late in the season to achieve any marketable growth. The poor establishment and growth are attributed to the age of the provided seed (estimated at 5-7 years) and poor soil nutrition. The plants that did establish were left to overwinter and grow for another season.

No special treatment was taken to over winter the plants and survival was assessed in the spring of 2021. As of June 2021, more plants germinated in the spring of 2021 than the spring of 2020. The 2021 growing season was exceptionally hot and dry in Outlook, SK. The plants had good vegetative growth but did not flower or set seed.

Borage, Borago officinalis was direct seeded on May 27, 2020, using an EarthWay planter. Seed was planted at ¼" depth and watered by hand until germinated. The borage established well and flowered but did not achieve the full growth potential of the plants. No seed weights were recorded.

Coriander, Coriandrum sativum was direct seeded on May 27, 2020, using an EarthWay planter. Seed was planted at ¼" depth and watered by hand until germinated. The coriander plots had poor establishment in the spring and were over-seeded to increase stand productivity. The result was coriander minor producing 400 g of seed, (roughly 19 bu/ac) and coriander major producing 220 g (roughly 9 bu/ac). Both varieties produced below the provincial average of roughly 34 bu/ac. This reduced productivity is attributed to some of the seedling possibly being damaged or removed with early weed control and poor soil nutrition.

Hops, Humulus lupulus was purchased from Richter's as 6 seedling plugs. Due to shipment delays (Covid-19 related) the plugs arrived in poor condition, but all did survive. There were six hops plants in total, three Sterling and three Glacier. The seedlings established well, but never reached maturity or flowered. The hops plants were trained on a climbing trellis. The total length that the plants achieved in the first growing season ranged from 5'2" to 13'8". Hops do not produce much for cones in their first year of growth: therefore, no harvest was recorded in 2020.

No special treatment was taken to over winter the plants and survival was assessed in the spring of 2021. As of June 2021, all six hops plants survived. The hot dry growing season of 2021 may have set these plants back a bit, but their overall growth was vigorous. The three Sterling plants grew to a height averaging 13' 9" and the three Glacier plants grew to a height averaging 13' 3". As of August 20, 2021, one of the Glacier plants produced cones. The cones were harvested and had a fresh weight of 125 g.

The remaining plants did not form cones, likely due to heat and water stress.

Hemp (for CBD oil), Cannabis sp. was direct seeded on May 27, 2020, using an EarthWay planter. Seed was planted at ¼" depth and watered by hand until germinated. Two of the three hemp varieties produced well, Piccolo and CFX-2 produced tall stands with good seed production. Katani did not achieve the same plant height or level of seed production. Seed yields from 2020 were CFX-2 37.6 bu/ac, Piccolo 17.6 bu/ac and Katani 1.5 bu/ac. This reduced productivity is attributed to the Katani plot being in a shadier location with less background soil nutrients available. These three varieties were planted again in the spring of 2021, but due to the hot, dry conditions establishment was poor, the plants that did grow produced poorly and no seed weights were recorded for 2021.

Conclusions and Recommendations

Specialty crops are potential diversification options for growers in Saskatchewan. The growth of specialty crops requires attention and maintenance. Not all crops grown in this trial produced to their fullest potential. Poor crop performance is likely due to weather conditions, site limitations (shade and soil nutrition), broken irrigation lines and unforeseeable complications due to the COVID-19 pandemic.

Despite these limitations, some crops did stick out for their production. Monkshood proved to be a crop that establishes and over winters very well. The plants produced large healthy tubers with the potential to divide tubes and multiply production. Oregano also established and over wintered very well. This crop also competed very well with weeds due to it's closed canopy.

All these crops show potential for small acre production in Saskatchewan, if due attention is paid to site selection, plant nutrition and plot maintenance. It is also worth noting that it is highly recommended to know each crop's individual market well before starting production of specialty crops.

Extension

The information from this trial was extended through:

- The interim report (2020) being shared on the Canadian Herb Specialty Agriculture and Natural Health Products Coalition's Facebook page
- A virtual tour of the project was shared on the Canadian Herb Specialty Agriculture and Natural Health Products Coalition's Facebook page
- The virtual tour video

Abstract/Summary

Specialty crops are small acre, high value crops that fill niche markets. Some specialty crops offer a high value option for crop rotations, while others provide options to growers with a small land base.

Due to the current low acreage and niche markets of these crops in Saskatchewan, new growers and purchasers are often unfamiliar with them. This trial offered an opportunity for potential growers and purchasers to view ten different specialty crops, grown in Saskatchewan's environmental conditions. The ten specialty crops were: monkshood (*Aconitum carmichaelli*), foxglove (*Digitalis sp*.), valerian (*Valeriana officinalis*), chicory (*Cicoria siciliana*), oregano (*Origanum vulgare*), caraway (*Carum carvi*), Borage (*Borago officinalis*), coriander (*Coriandrum sativum*), hops (*Humulus lupulus*), hemp (*Cannabis sp*.).

Not all crops grown in this trial produced to their fullest potential. Poor crop performance is likely due to weather conditions, site limitations (shade and soil nutrition), broken irrigation lines and unforeseeable complications due to the COVID-19 pandemic. Despite these limitations, two crops did stick out for their production. Monkshood and oregano established, over wintered, and produced very well. All demonstrated crops do show potential for small acre production in Saskatchewan, if due attention is paid to site selection, plant nutrition, plot maintenance and markets.

Determining Size Profiles of Saskatchewan Grown Cantaloupe for a Retail Market

Funding

This project was funded by the Ag Demonstration of Practices and Technology (ADOPT) program, through the Canadian Agricultural Partnership (CAP).

Principal Investigator

- Cara Drury, PAg, Irrigation Agrologist, Ministry of Agriculture

Organizations

- Saskatchewan Vegetable Growers' Association
- Saskatchewan Ministry of Agriculture
- Irrigation Crop Diversification Corporation (ICDC)

Objectives

(1) The objective of this project is to demonstrate:
(2) Potential of growing cantaloupe for Saskatchewan's fresh retail market.
(3) Creating a size profile for Saskatchewan retailers to categorize locally grown cantaloupe.
(4) Determining self-life of vine ripened cantaloupe.

Project Rationale

The market for Saskatchewan grown cantaloupe is growing. Federated Co-operative Limited (FCL) has expressed interest in finding local suppliers of Saskatchewan grown cantaloupe, but currently do not have a size profile available to categorize the crop. Understanding the size distribution of the crop will give Coop time prior to the next production season to establish their marketing program based on what will be produced in SK. It will also give the producers time prior to the 2022 growing season to order the correct packaging and labels so that the entry into retail with this product is seamless. The information gathered from this trial will be used to help develop a standard size profile that describes and categorizes Saskatchewan grown cantaloupe for the retail market. This demonstration will also provide growers with examples of ten different varieties of cantaloupe, showing their agronomic needs, productivity potential, growth habit and shelf life.

Research Plan

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 planting. The site was fertilized to provide 57 lb N/ac, 120 lb P/ac and 135 lb K/ac (a total of applied plus residual).

The cantaloupe seed was started in greenhouse and kept until the three true leave stage. Transplanting into the field took place on June 1, 2021. The demonstration had eight varieties of cantaloupe grown in six-meter rows, ten plants per row. The cantaloupe was grown under black plastic mulch, with trickle irrigation, using standard growing practices.

Harvest took place at “full slip,” when cantaloupe is vine ripe. Plants were checked for ripe fruit twice a week, starting on August 4. Once fruit was harvested it was counted, measured around circumference, and weighed.

Sugar content of the fruit were periodically measured using a Brix Meter. The dates that the sugars were measured are August 12, August 27 and September 2.

The data recorded on storage and shelf-life was found to be incomplete and therefore was not used.

Results

Fruit yield per variety, average fruit weight and average fruit circumference are recorded in Figure 1. Figure 2 displays the range of fruit circumference, giving a better indication of which varieties have a consistently sized fruit.

Sugar content, measured by Brix meter was found to very slightly per fruit. An average of sugar content is displayed in Table 1. As a scale to compare values the company Brix provides expected values for common fruits and vegetables. Cantaloup is listed as:

8 Poor

12 Average

14 Good

16 Excellent.

Not as an official part of the trial a cantaloupe was purchased from a local grocery store and included on a taste test. Despite having a similar Brix value, it was still found to be less flavourful than the locally grown fruit. Therefore, Brix values should only be considered as one part of the fruits flavour profile.

The harvest dates and relative harvest volumes are displayed in Table 2. In this table, the darker the colored bar indicates a larger volume of fruit harvested; a white bar indicates that no fruit of that variety was harvested on that date.

Figure 1. Cantaloupe Size Profile, 2021. Comparing variety yields, average weight and average fruit circumference.

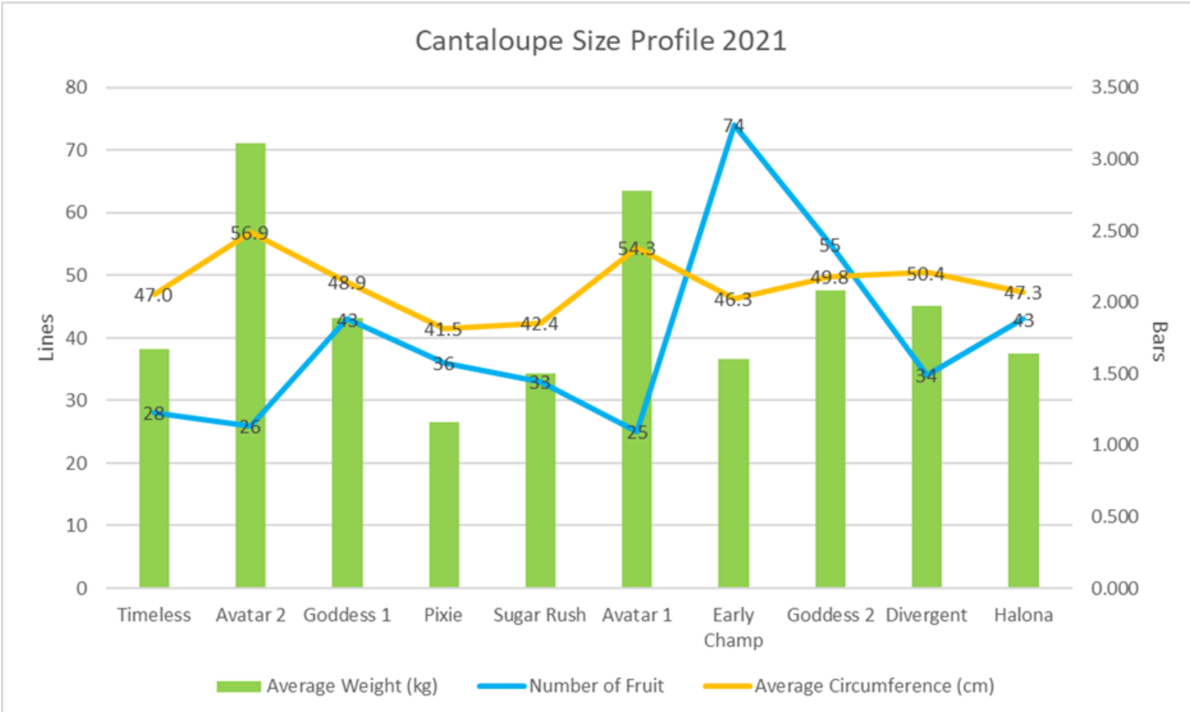


Figure 2. Cantaloupe Circumference Range, 2021. Comparing variety's ability to produce consistently sized fruit.

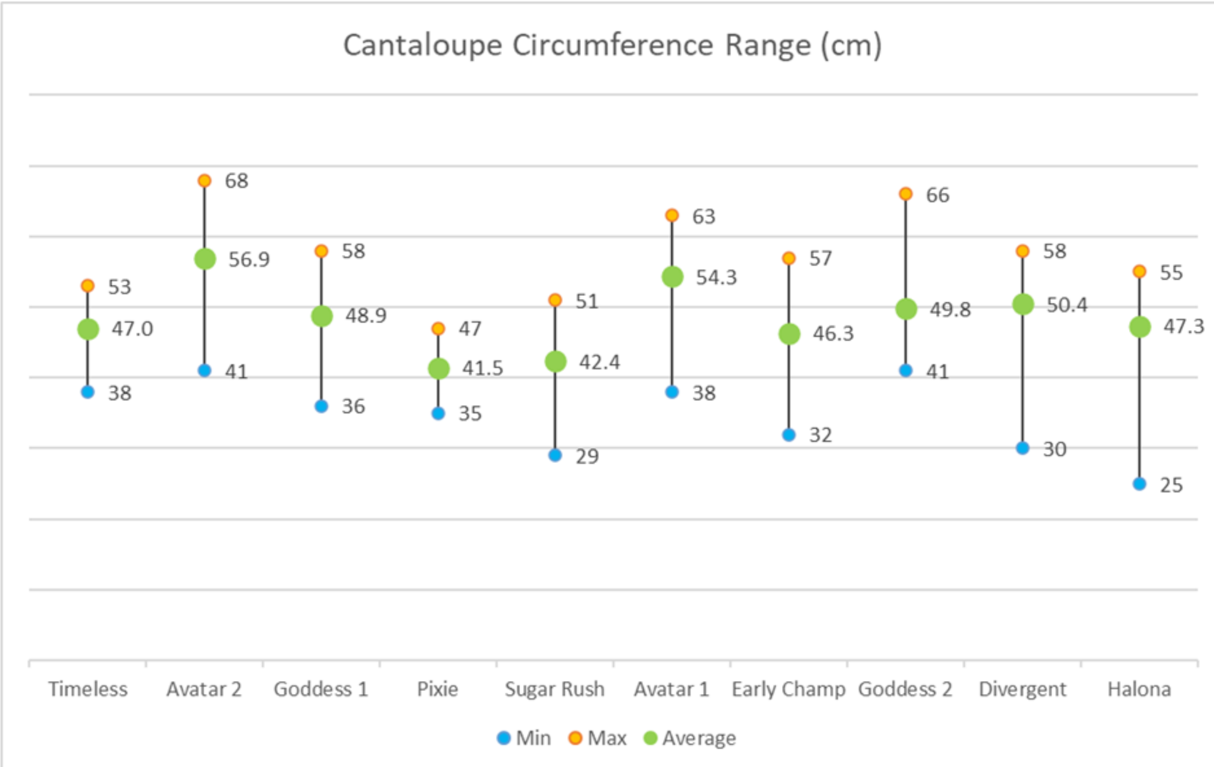


Table 1. Average Sugar Content Per Cantaloupe Variety, Measured by Brix Meter.

Variety	Average Sugar Content %
Timeless	14.4
Avatar	11.8
Goddess	10.3
Pixie	16.0
Sugar Rush	13.3
Early Champ	10.8
Divergent	11.25
Halona	11.3

Table 2. Harvest Volumes and Dates of 2021 Cantaloupe Trial.

Variety	Aug. 4	Aug. 6	Aug. 9	Aug.12	Aug. 16	Aug. 19	Aug. 23	Aug. 26	Aug. 30	Sept. 2	Sept. 7
Timeless											
Goddess											
Pixie											
Sugar Rush											
Avatar											
Early Champ											
Halona											
Divergent											

Conclusions and Recommendations

The 2021 growing season was an exceptional year for growing irrigated vine crops. The hot dry conditions produced large fruit and very little to no evidence of foliar disease. The results from this trial were somewhat unexpected, in that the fruit produced were larger than what is typical for Saskatchewan growing conditions.

Based on the results found Avatar produced fruit that is larger than what the retailer is interested in; as well as having a short fruiting window (Aug. 23-Sept. 7, Table 2.). Early Champ was found to produce the largest number of fruits, with a long fruiting window (Aug. 4 - Sept. 7). Goddess was found to be an unofficial taste test favourite, that produced the earliest fruit, with long a fruiting window (Aug. 4 – Sept. 7). Pixie and Sugar Rush were of note for their high sugar content (16% and 13.3%, Table 1.) and small size. Unfortunately, both Pixie and Sugar Rush were found to not produce a full and consistent netting (outward appearance) which makes them less visually appealing and difficult to determine when they are ripe. Divergent and Timeless were found to fruit late in the season, which poses as a risk in years with cool summers and or early falls. Halona had a long fruiting window, with good production and netting; but was found to have an undesirable texture in the unofficial taste tests.

The USDA Grading Manual for Cantaloupe has no size requirements for the commercial sale of fresh cantaloupe. It does, on the other hand put an importance on the uniformity of the size of cantaloupe in a crate.
"There are no size requirements; however, uniformity of size is an important factor affecting the appearance and marketing of cantaloups. Any excessive irregularity within containers shall be described and irregularly sized melons shall be scored as a defect against the grade. The placement of somewhat smaller melons in the corners and ends of the containers is customary and should not be scored as irregular if not excessive. The numerical count, when considered in connection with the size of the container, indicates the size.

The following terms shall be used to describe the uniformity of size of the cantaloupes in the container:
Uniform when there is no readily apparent variation of the size of the cantaloups in the container.
Fairly uniform permits packing cantaloups one size above or one size below the
size of most of the cantaloups in the container."
https://www.ams.usda.gov/sites/default/files/media/Cantaloup_Inspection_Instructions%5B1%5D.pdf
With consideration given to the uniformity of size, a preference for the varieties displaying smaller error bars in Figure 2. Pixie, Timeless and Goddess were found to produce the most consistently sized fruit.

Despite there being no size requirement in the current grading standards used to sell cantaloupe commercially, the Saskatchewan retailer is interested in developing one. The retailer would like to develop a grade standard that takes into account the expected size of cantaloupe grown in Saskatchewan and be able to market this fruit differently than the internationally purchased cantaloupe.

Due to the unusual growing conditions experienced in Saskatchewan for the growing season of 2021, it is recommended that this trial be repeated in 2022. It is recommended to remove the varieties Divergent, Timeless and Halona due to their poor performance and add in the variety Athena. Athena is recommended by current growers in Saskatchewan and was planned for use in this trial, but seed was not available at the time of seed sourcing.

Abstract/Summary

The market for Saskatchewan grown cantaloupe is growing. Local retailers have expressed interest in finding local suppliers of Saskatchewan grown cantaloupe, but currently do not have a size profile available to categorize the crop. The objective of this project is to demonstrate the potential of growing cantaloupe for Saskatchewan's fresh retail market, creating a size profile for Saskatchewan retailers to categorize locally grown cantaloupe and determining self-life of vine ripened cantaloupe. Eight varieties of cantaloupe were grown at the CSIDC orchard (Outlook, SK), on black plastic mulch, with trickle irrigation and standard growing practices. The fruit were picked at full slip, over a five week period, as they became ripe. Fruit weight, circumference, yield per variety and harvest dates were recorded. The 2021 growing season was an exceptional year for growing irrigated vine crops. The hot dry conditions produced large fruit and very little to no evidence of foliar disease. The results from this trial were somewhat unexpected, in that the fruit produced were larger than what is typical for Saskatchewan growing conditions. Due to the unusual growing conditions experienced in Saskatchewan for the growing season of 2021, it is recommended that this trial be repeated in 2022. It is recommended to remove the varieties Divergent, Timeless and Halona due to their poor performance and add in the variety Athena.

This project was presented at:

CSIDC Virtual Field Day video available on ICDC's YouTube Channel

https://www.youtube.com/watch?v=VX5Mp9Ere7U

Saskatchewan Irrigation Projects Association (SIPA) AGM and Conference

Demonstration of Short Season Varieties of Sweet Potato

Funding

This project was funded by the Ag Demonstration of Practices and Technology (ADOPT) program, through the Canadian Agricultural Partnership (CAP).

Principal Investigator

- Cara Drury, PAg, Irrigation Agrologist, Ministry of Agriculture

Organizations

- Saskatchewan Vegetable Growers' Association
- Saskatchewan Ministry of Agriculture
- Irrigation Crop Diversification Corporation (ICDC)

Objectives

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 and investigating processing opportunities: nutraceuticals, ethanol, canned and frozen products. As they investigate these opportunities, questions often arise regarding other potential markets. The producers do not have enough information on these crops to make informed decisions. Often, they do 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 three short season sweet potato varieties, allowing them to assess growth habit, hardiness in high tunnels, low tunnels and field conditions, and some basic idea on potential yields in Saskatchewan. With the information gathered, they will be able to determine if this crop is worthwhile pursuing further.

Therefore, this project will demonstrate the potential to produce short season varieties of sweet potato in Saskatchewan. This project will also compare growing these varieties in high tunnels, low tunnels and field conditions.

Research Plan

This project was originally applied for in 2019, planned to run in the 2020 growing year. Due to the COVID-19 pandemic and the subsequent restrictions at the federal research stations, a one-year extension was requested and granted. Therefore, this project was grown in the 2021 growing season.

In the 2021 growing season there was a large number of horticulture research trials planned to take place at CSIDC. This resulted in a shortage of available land and high tunnel space. To maximize space and make the best use of resources, this trial partnered with a larger, federally funded sweet potato research trial. The federal trial project lead is Dr. Jazeem Wahab.

The planned ADOPT trail was to have three varieties of early season sweet potatoes: Radiance, L105 and B456. These varieties would be grown in three plots, eight plants/plot, replicated three times: field, high tunnel and low tunnel. Water was to be supplied by trickle irrigation. Due to the larger size of the federal trial, and the two trials similarities, it was decided to not plant a separate trial and collect data from the federal project. The treatments that planned to use low tunnels were substituted for treatments using crop cover.

The planned federal project was comprised of three studies.

Study 1 - Three varieties: Radiance, Orleans, L105

- Two irrigation treatments: 100% ET, 50% ET
- Two in row spacings: 60 cm, 30 cm
- Two rover cover treatments: open, row cover
- All treatments grown on black plastic mulch.
- Plot plan can be seen in Figure 1.

Figure 1. Sweet Potato Study 1 plot plan

Sweet potato: Cultivar x Spacing x Irrigation

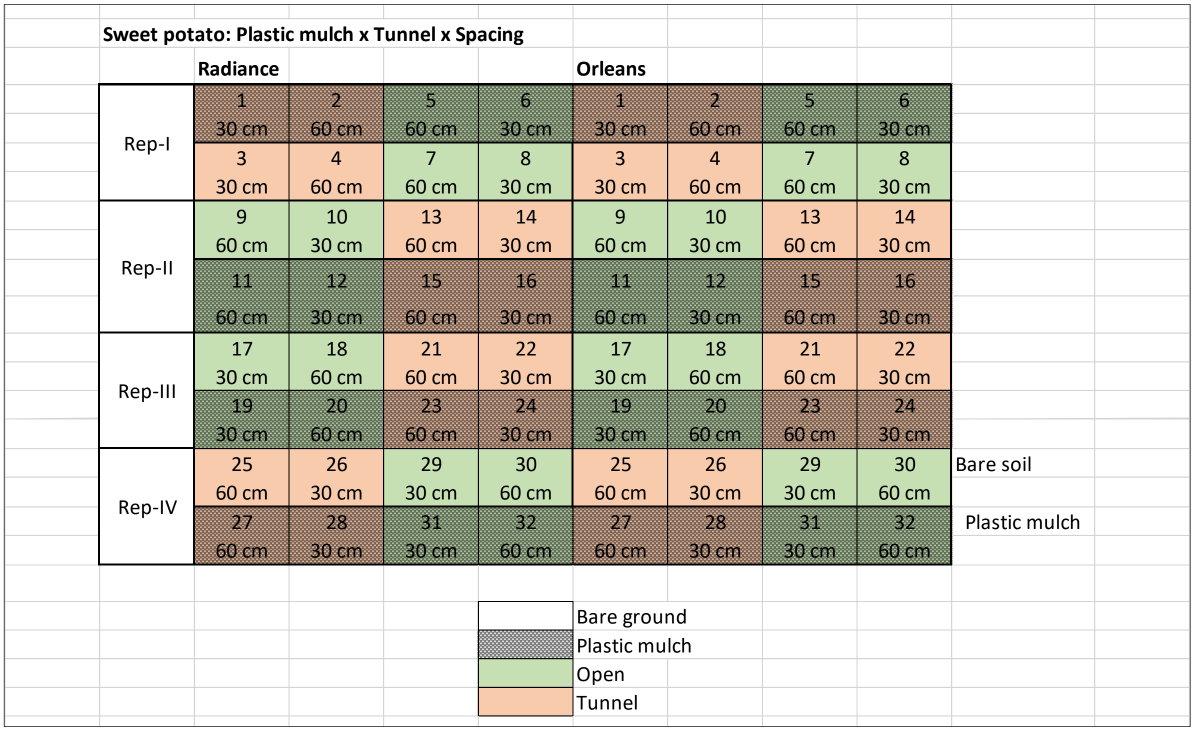
	Radiance					**Orleans**					**L105**		
	1	2	3	4		1	2	3	4		1	2	
Rep-I	5	6	7	8		5	6	7	8		3	4	Rep-I
	9	10	11	12		9	10	11	12		5	6	
Rep-II	13	14	15	16		13	14	15	16		7	8	Rep-II
	17	18	19	20		17	18	19	20		9	10	
Rep-III	21	22	23	24		21	22	23	24		11	12	Rep-III
	25	26	27	28		25	26	27	28		13	14	
Rep-IV	29	30	31	32		29	30	31	32		15	16	Rep-IV

Open
Tunnel
100% ET
50% ET

Study 2 - Two varieties: Radiance, Orleans

- Two mulch treatments: black plastic mulch, bare ground
- Two row cover treatments: open, row cover
- Two in row spacings: 60 cm, 30 cm
- Plot plan can be seen in Figure 2.

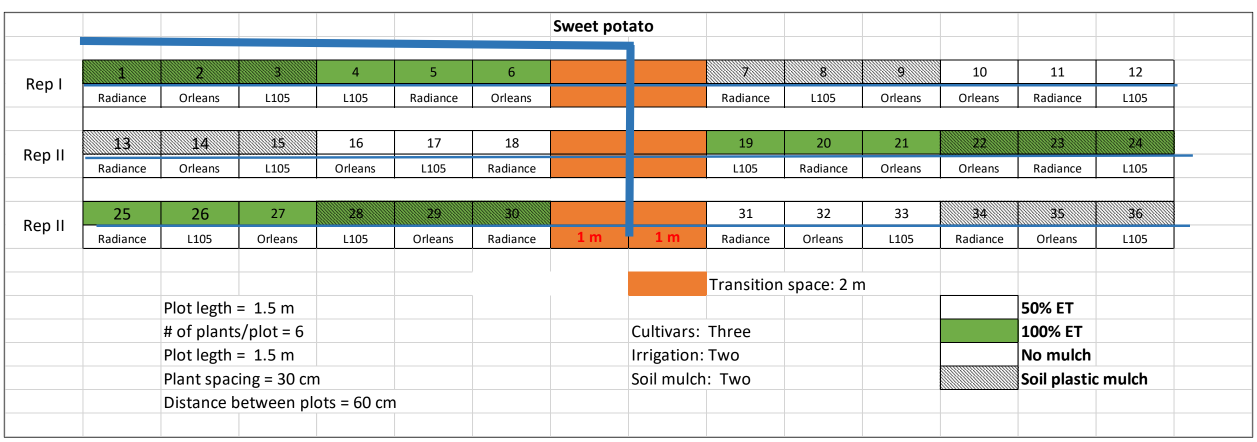
Figure 2. Sweet Potato Study 2 plot plan



Study 3 - Grown in a high tunnel

- Three varieties: Radiance, Orleans, L105
- Two irrigation treatments: 100% ET, 50% ET
- Two mulch treatments: black plastic mulch, bare ground
- Two in row spacings: 60 cm, 30 cm
- Plot plan can be seen in Figure 3.

Figure 3. Sweet Potato Study 2, High Tunnel plot plan.



Planting material for this project was sourced from Vineland Research and Innovation Centre, Lincoln, ON. Unfortunately, only two of the three sweet potato varieties could be provided (Radiance and L105). It is also worth noting that the planting material arrived extremely late, which resulted in a June 24-25 planting date. The ideal planting date would be four to six weeks earlier, in mid-May.

Field preparation of the plots included fertilizer incorporated by rotovator, bed shaping and mulch laying on required treatments. Slips were then hand planted into the various treatments.

Figure 4 shows the equipment used to lay the black plastic mulch and Figure 5 shows the transplanted slips four days after planting. The slips looked quite poor at this time, but most did bounce back and survive.

Data recorded from the federal studies for this ADOPT project include plant counts, tuber yield by count and weight and tuber size distribution.

Results

Study 1 consisted of 32 plots of Radiance slips and 16 plots of L105 slips. These plants were grown in field and had a better survival rate than expected. Overall yield for these plants is low, but this is likely influenced by the late seeding dates. The data recorded from this study is seen in Table 1 and 2.

Study 2 consisted of 32 plots of Radiance slips. These plants were grown in field and had a lower survival rate than Study 1, reasons for this are unclear. Overall yield for these plants is low, but this is likely influenced by the late seeding dates. The data recorded from this study is seen in Table 3.

Study 3 consisted of 12 plots of Radiance slips and 12 plots of L105 slips. These plants were grown in a high tunnel and had a lower survival rate than the plants grown in field. The data recorded from this study is seen in Table 4.

Harvest of Study 1 and 2 were conducted mechanically, with a single row potato digger (Figure 9), the harvest inside the high tunnel was completed by hand (Figure 10). Figures 11 and 12 are examples of L105 and Radiance plants harvested from the high tunnel. Harvest took place on October 5, 2021.
Dr. Jazeem Wahab ran ANOVA statistical analysis of these three studies, the results are in Tables 5, 6, and 7.

Table 1. Sweet Potato Study 1, Field, L105

									Tubers		
Location	**Variety**	**Rep**	**Row Cover**	**Irrigation**	**Spacing**	**# Plants Planted**	**# Plants Harvested**	**Bulk Weight**	**Diameter < 35 mm**	**Diameter 35-50 mm**	**Diameter > 50 mm**
								Kg	**Count**		
Field 7	**L105 Study 1**	1	YES	100 ET	60 cm	5	4	5.215	25	17	2
					30 cm	9	9	5.745	68	21	0
				50 ET	60 cm	5	5	4.285	28	20	1
					30 cm	9	9	8.07	38	30	1
		2	NO	100 ET	60 cm	5	5	3.14	35	12	0
					30 cm	9	9	6.645	58	23	0
				50 ET	60 cm	5	5	4.9	39	19	0
					30 cm	9	9	4.575	51	14	0
		3	NO	100 ET	60 cm	5	5	5.965	33	25	0
					30 cm	9	8	7.195	46	30	0
				50 ET	60 cm	5	5	5.175	63	12	1
					30 cm	9	9	4.375	48	15	0
		4	NO	100 ET	60 cm	5	5	1.545	33	6	0
					30 cm	9	8	2.24	46	6	0
				50 ET	60 cm	5	4	0.915	26	2	0
					30 cm	9	9	1.22	41	1	0

Table 2. Sweet Potato Study 1, Field, Radiance

										Tubers	
Location	**Variety**	**Rep**	**Row Cover**	**Irrigation**	**Spacing**	**# Plants Planted**	**# Plants Harvested**	**Bulk Weight**	**Diameter < 35 mm**	**Diameter 35-50 mm**	**Diameter > 50 mm**
								Kg		**Count**	
Field 7	**Radiance Study 1**	1	YES	100 ET	60 cm	5	4	1.41	22	3	0
					30 cm	9	6	1.83	13	7	0
					60 cm	5	5	1.52	18	6	0
					30 cm	9	8	3.36	29	11	0
				50 ET	60 cm	5	5	3.14	16	15	0
					30 cm	9	8	3.82	40	13	0
					60 cm	5	8	4.12	38	16	0
					30 cm	9	5	2.81	11	14	0
		2	NO	100 ET	60 cm	5	6	1.06	16	2	0
					30 cm	9	9	1.85	47	3	0
					60 cm	5	5	0.55	19	0	0
					30 cm	9	9	1.47	36	2	0
				50 ET	60 cm	5	5	1.09	11	4	0
					30 cm	9	9	0.81	20	1	0
					60 cm	5	5	1.12	16	2	0
					30 cm	9	8	1.52	27	5	0
		3	NO	100 ET	60 cm	5	5	1.59	31	4	0
					30 cm	9	8	2.01	39	2	0
					60 cm	5	5	1.46	34	2	0
					30 cm	9	9	1.85	44	2	0
				50 ET	60 cm	5	4	0.99	19	2	0
					30 cm	9	8	1.42	20	6	0
					60 cm	5	6	1.61	25	6	0
					30 cm	9	9	2.79	39	6	0
		4	NO	100 ET	60 cm	5	4	1.23	9	7	0
					30 cm	9	9	0.91	26	1	0
					60 cm	5	5	0.12	23	4	0
					30 cm	9	9	1.39	16	7	0
				50 ET	60 cm	5	4	0.78	24	1	0
					30 cm	9	7	0.65	26	0	0
					60 cm	5	4	0.04	2	0	0
					30 cm	9	7	1.01	20	1	0

Table 3. Sweet Potato Study 2, Field, Radiance

Location	Study	Rep	Row Cover	Mulch	Spacing	# Plants Planted	# Plants Harvested	Tubers: Diameter < 35 mm	Tubers: Diameter 35-50 mm	Tubers: Diameter > 50 mm	Tubers after Curing: Diameter 35-50 mm	Tubers after Curing: Diameter > 50 mm	Tubers after Curing: Diameter > 35 mm
								Count			Weight Kg		
Field 7	Radiance Study 2	1	YES	Bare Soil	60 cm	7	6	11	2	0	0.21	NA	NA
					30 cm	13	8	13	4	0	0	NA	NA
				Mulch	60 cm	7	7	15	5	0	0.472	NA	NA
					30 cm	13	14	41	5	0	0.51	NA	NA
			NO	Bare Soil	60 cm	7	4	5	1	0	0.116	NA	NA
					30 cm	13	9	18	2	0	0.178	NA	NA
				Mulch	60 cm	7	6	22	1	0	0.098	NA	NA
					30 cm	13	12	30	3	0	0.242	NA	NA
		2	YES	Bare Soil	60 cm	7	6	8	2	0	0	NA	NA
					30 cm	13	0	0	0	0	0	0	0
				Mulch	60 cm	7	8	15	3	0	0.407	NA	NA
					30 cm	13	11	43	3	0	0.543	NA	NA
			NO	Bare Soil	60 cm	7	5	9	0	0	0	NA	NA
					30 cm	13	9	27	2	0	0	NA	NA
				Mulch	60 cm	7	6	9	4	0	0.452	NA	NA
					30 cm	13	13	37	8	0	0.677	NA	NA
		3	YES	Bare Soil	60 cm	7	6	16	4	0	0.187	NA	NA
					30 cm	13	6	14	1	0	0.086	NA	NA
				Mulch	60 cm	7	8	24	4	0	0	NA	NA
					30 cm	13	12	43	2	0	0.369	NA	NA
			No	Bare Soil	60 cm	7	6	14	5	0	0.422	NA	NA
					30 cm	13	9	25	2	0	0.156	NA	NA
				Mulch	60 cm	7	6	20	1	0	0.069	NA	NA
					30 cm	13	12	32	6	0	0.444	NA	NA
		4	YES	Bare Soil	60 cm	7	4	27	2	0	0.131	NA	NA
					30 cm	13	10	27	4	0	0.878	NA	NA
				Mulch	60 cm	7	6	8	1	0	0	NA	NA
					30 cm	13	10	25	1	0	0.069	NA	NA
			NO	Bare Soil	60 cm	7	4	10	1	0	0.126	NA	NA
					30 cm	13	8	26	0	0	0	NA	NA
				Mulch	60 cm	7	7	7	1	0	0.094	NA	NA
					30 cm	13	10	13	1	0	0.065	NA	NA

Table 4. Sweet Potato Study 3, High Tunnel, Radiance and L105

Location	Rep	Irrigation	Soil Cover	Cultivar	# Plants Planted	# Plants Harvested	Tubers Diameter < 35 mm	Tubers Diameter 35-50 mm	Tubers Diameter > 50 mm	Tubers after Curing Diameter 35-50 mm	Tubers after Curing Diameter > 50 mm
							Count			Weight Kg	
High Tunnel	1	100 ET	Bare Soil	L105	6	5	12	4	0	0.1	0
				Radiance	6	3	3	1	0	0	0
			Mulch	L105	6	6	18	26	5	1.62	1.71
				Radiance	6	3	8	6	6	0.18	0
		50 ET	Bare Soil	L105	6	4	4	2	0	0.11	0
				Radiance	6	4	10	2	0	0	0
			Mulch	L105	6	6	19	9	4	1.23	0.22
				Radiance	6	5	17	26	2	2.67	0.61
	2	100 ET	Bare Soil	L105	6	5	33	13	0	0.95	0
				Radiance	6	6	8	7	0	0.29	0
			Mulch	L105	6	6	21	25	6	2.3	0.42
				Radiance	6	5	8	16	1	1.21	0.66
		50 ET	Bare Soil	L105	6	3	18	10	0	0	0
				Radiance	6	4	19	0	0	0	0
			Mulch	L105	6	6	26	23	7	2.49	0.68
				Radiance	6	2	6	4	1	0.13	0.14
	3	100 ET	Bare Soil	L105	6	4	13	5	0	0.22	0
				Radiance	6	2	11	0	0	0	0
			Mulch	L105	6	6	39	29	5	2.12	1.89
				Radiance	6	5	12	12	0	0.73	0
		50 ET	Bare Soil	L105	6	5	17	2	0	0.21	0
				Radiance	6	4	16	1	0	0.06	0
			Mulch	L105	6	6	30	21	12	1.82	3.55
				Radiance	6	5	15	11	4	0.61	0

Table 5. Study 1, Yield characteristics of L-105 sweet potato as influenced by in-row spacing, and crop cover under field production

Crop Cover	Plant spacing	Small tuber number / plant	Marketable tuber Number / plant	Total fresh root yield (t/ha)	Marketable Cured root yield (t/ha)
Open	30 cm	5.80	2.38	8.18	3.45
	60 cm	8.50	3.45	5.38	2.57
Cover	30 cm	5.89	2.89	9.55	3.34
	60 cm	5.93	4.48	6.05	3.24

Study 1, Yield characteristics Radiance sweet potato as influenced by in-row spacing under field production

Spacing	Small tuber number / plant	Marketable tuber Number / plant	Marketable fresh root yield (t/ha)	Marketable Cured root yield / m (kg)
30 cm	3.56	0.35	1.81	0.40
60 cm	3.97	0.59	1.20	0.36
ANOVA				
Source:				
Spacing	ns	ns	ns	ns

ns indicates non-significant treatment effect.

Table 6. Study 2, Yield characteristics Radiance sweet potato as influenced by soil mulch, in-row spacing, and crop cover under field production

Category	Small tuber number / plant	Marketable tuber Number / plant	Marketable fresh root yield (t/ha)	Marketable Cured root yield / m (kg)
Soil mulch:				
Bare soil	2.56	0.39	1.21	0.29
Mulch	2.33	0.25	1.21	0.18
Crop cover:				
Open	2.34	0.28	1.03	0.20
Cover	2.55	0.35	1.39	0.20
Spacing:				
30 cm	2.29	0.16	1.14	0.14
60 cm	2.60	0.48	1.28	0.34
ANOVA				
Source:				
Soil mulch (M)	ns	ns	ns	ns
Crop cover (C)	ns	ns	ns	ns
Spacing (S)	ns	***	ns	ns
M x C	ns	ns	ns	ns
M x S	ns	ns	ns	ns
C x S	ns	ns	ns	ns
M x C x S	ns	ns	ns	ns

*** and ns indicate significance at P < 0.001 level of probability and not significant, respectively.

Table 7. Study 3, Yield characteristics of L-105 and Radiance sweet potato as influenced by soil mulch and irrigation under High tunnel production

Category	Vine fresh weight / m (kg)	Small tuber number / m	Marketable tuber Number / m	Cured - Mark. tuber weight / m (kg)
Irrigation:				
Optimum	3.61	10.33	9.28	0.54
Mild stress	2.84	10.94	7.83	0.52
Soil mulch:				
Bare soil	1.48	9.11	2.61	0.11
Mulch	4.96	12.17	14.50	0.95
Cultivar:				
L-105	3.97	13.89	11.56	0.73
Radiance	2.48	7.39	5.56	0.33
ANOVA				
Source:				
Irrigation (I)	ns	ns	ns	ns
Soil mulch (M)	***	ns	***	***
Cultivar (C)	**	*	**	*
I x M	ns	ns	ns	ns
I x C	ns	ns	ns	ns
M x C	ns	ns	ns	ns
I x M x C	ns	ns	ns	ns

***, **, *, and ns indicate significance at P < 0.001, 0.01, 0.05 levels of probability and not significant, respectively.

Conclusions and Recommendations

This project demonstrated that there is potential to grow short season sweet potatoes in Saskatchewan. The survival rate of plants in Study 1 were found to be the highest of the three studies (Table 8). It is interesting that the plants in the field studies had a higher survival rate than the plants in the protected environment of the high tunnel. This is likely due more to a small sample size, than an indication that sweet potato survival is diminished in high tunnel settings.

Table 8. Survival rate of sweet potato plants, across all studies.

Study	Variety	Plants Planted	Plants Harvested	Survival Rate %
1	L105	112	108	96.4
	Radiance	224	208	92.9
2	Radiance	320	248	77.5
3	L105	72	62	86.1
	Radiance	72	48	66.7

For this project we are putting a higher value on the survival of the plants, than the yield of the plants due to the late planting date (June 24-25). Tuber yields were found to be low for all studies. It is speculated that if these plants would have had a timelier planting date (mid-May) the yields would be much improved. As it stands, Study 3 was found to produce the highest yields, with L105 winning over Radiance; but these yields were still lower than what is projected to be achievable.

Reviewing the results of the ANOVA analysis for Study 1 and Study 2, they found no significant differences in yield from any treatment: soil mulch, crop cover, spacing. The ANOVA analysis of Study 3 found increased vine growth for plants growing in the black plastic mulch, compared to plants in bare soil. It was also found that L105 produced more vines, small tubers and marketable tubers than Radiance, while grown in a high tunnel setting.

Further research on short season sweet potato production in Saskatchewan is recommended. Exploration of other short season varieties and techniques to start planting material in province are of the most importance. This trial attests to the difficulties of relying on spring planting material from other provinces.

Acknowledgements

Dr. Jazeem Wahab, Ken Achtymichuk and Greg Larson from AAFC for their work and collaboration on this project.

ICDC staff for their attention and labour contributions

Abstract/Summary

This project demonstrated the potential to produce short season varieties of sweet potato in Saskatchewan. Due to limited available land and resources this project partnered with a larger, federally funded study on short season sweet potato production, led by Dr. Jazeem Wahab.

The ADOPT project planned to compare three different varieties grown in a high tunnel, low tunnel and field conditions. The resulting project consisted of three studies, each with

multiple variables. Study 1 took place in field conditions, the variables explored were variety, irrigation, row spacing and row cover. Study 2 also took place in field, its variables included variety, mulch, row cover and row spacing. Study 3 was conducted in a high tunnel and explored the variables of variety, irrigation, mulch and row spacing.

The project experienced trouble with timely sourcing of planting material. This resulted in the use of only two sweet potato varieties and a late planting date of June 24-25. Tuber yields were found to be low for all studies. It is speculated that if these plants would have had a timelier planting date (mid-May) the yields would be much improved. As it stands, Study 3 was found to produce the highest yields, with L105 winning over Radiance; but these yields were still lower than what is projected to be achievable.

Extension

This project was presented at the CSIDC virtual field day, with a recording of the presentation on ICDC's YouTube channel. Leafy greens and sweet potato production in the field and high tunnel - YouTube

This project was presented at the 2021 Saskatchewan Irrigation Projects Association AGM.

Growing Methods to Assist in the Expansion of the Garlic Industry in SK

Funding

This trial is funded by the Strategic Field Program (SFP), through the Canadian Agricultural Partnership (CAP).

Principal Investigator

- Connie Achtymichuk, PAg, Provincial Vegetable Specialist, Ministry of Agriculture
- Dr. Doug Waterer, PAg, Judd Street Associates

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Canada-Saskatchewan Irrigation Diversification Centre (CSIDC)
- Saskatchewan Vegetable Growers' Association (SVGA)
- Conservation Learning Centre (CLC)

Objectives

The objectives of this trial include:

(1) To compare appropriate varieties of garlic for fresh market and for processing.
(2) To try to control bulb size through different management techniques.
(3) To evaluate agronomic protocols for establishment of garlic from bulbils.
(4) To compare processing quality of garlic rounds compared to standard bulbs.

Abstract

To help develop better production practices for garlic in Saskatchewan, trials were conducted in 2019, 2020 and 2021. The results from the 2019 and 2020 trials have been reported elsewhere. A cultivar evaluation trial was established in the fall of 2020 at an irrigated site on the CSIDC station in Outlook, SK. All aspects of trial establishment followed standard practices, except that a storm on Nov 7, 2020 covered the plot with snow before straw mulch could be applied to protect the fall-planted crop from winter damage. The test plot was covered by more than 30 cm of snow over the entire winter period and good overwintering survival was expected. However, emergence of the garlic crop in spring of 2021 was slow and very spotty. Ultimately only about 10% of the fall-planted crop emerged. Many of the plants that emerged were weak and eventually died. The problem with emergence was consistent across the replicate blocks of the trial and occurred in all of the varieties tested. When the dead or dying garlic plants were dug up, the cloves used to establish the crop were found to be decayed and heavily infested with wireworms. The crop planted as bulbils and as rounds had a greater % overwinter survival than when standard cloves were used as planting material. However, by mid-June the bulbil-planted crop also started to die off. When the bulbil crop was dug up, it too was heavily infested with wireworms. The few bulbs that reached harvest maturity showed extensive scarring from wireworm feeding and none would have been marketable.

Damage to garlic caused by wireworm feeding

Trials were established in the fall of 2021 to explore potential reasons for the failure of the 2020/2021 crop**.**

The full report for this project will be available on request from the SVGA in early 2022.

Identification of Onion Cultivars Suited to Saskatchewan Production Conditions and Market Requirements

Funding

This trial is funded by the Strategic Field Program (SFP), through the Canadian Agricultural Partnership (CAP).

Principal Investigator

- Connie Achtymichuk, PAg, Provincial Vegetable Specialist, Ministry of Agriculture
- Dr. Doug Waterer, PAg, Judd Street Associates

Organizations

- Irrigation Crop Diversification Corporation (ICDC)
- Canada-Saskatchewan Irrigation Diversification Centre (CSIDC)
- Saskatchewan Vegetable Growers' Association (SVGA)
- Conservation Learning Centre (CLC)

Abstract

A trial to assess the performance of onion cultivars potentially suited to Saskatchewan growing conditions was conducted in 2021 at the CSIDC Field Station in Outlook SK. The CSIDC site features an irrigated sandy loam soil well suited to onion production. Twenty-one cultivars of yellow, red, white and Spanish type onions were direct seeded in early May. Ten longer season onion cultivars were also established in late May using greenhouse grown transplants. Standard crop management practices were employed. The direct seeded trial was slow to emerge and weed pressure was intense, despite the application of herbicides. Ultimately this trial was abandoned as the plant stand was too poor to produce any useful performance or yield data. While the transplanted crop initially looked good, plants began to die off within a week of being put into the field. By 6 weeks after the start of the transplanted trial less than 5% of the plants were still surviving - at which time the trial was terminated. A number of factors could have contributed to the failure of the direct seeded trial - deep seeding into dry soil, hot, windy conditions causing rapid drying of the seedbed, sandblasting of the emerging seedlings, intense competition from volunteer cereals leftover from the previous crop and feeding by wireworms. In the transplanted trial, wireworms were likely the main cause of the observed loss of stand. While all of these problems can be dealt with at least to some degree going forward, they illustrate why growing onions in Saskatchewan is challenging.

This project will be repeated in 2022 but with changes in management procedures designed to address the problems encountered in 2021.

The full report for this project is available from the SVGA.

Wireworms damaging onion plants

TECHNOLOGY TRANSFER

ICDC/CSIDC Virtual Irrigation Field Day, Nov 2 & 3

ICDC/CSIDC Virtual Field Day, Nov 2 & 3 – 169 registrants for day 1 field crops and 81 registrants for day 2 horticultural crops

- Mark O' Connor- MC for Day one of Virtual Field Day.
- Graham Parsons – Supplemental pollination in pickling cucumber production
- Dr. Doug Waterer – Sequential Cucumber Planting
- Dr. Doug Waterer – Wireworm control in potato
- Dr. Doug Waterer – Cabbage Root Fly Maggot control in rutabaga
- Connie Achtymichuk – Cantaloupe size profiles
- Garry Hnatowich – Aphanomyces management in pea
- Garry Hnatowich - Nitrogen Fertilizer Recommendations for Corn
- Gursahib Singh – Fusarium Head Blight in Cereals

Workshops

ICDC/Ministry of Ag hosted – Virtual Crop Diagnostic School, July 29, 2021 - > 2000 registrants

Garry Hnatowich

- Phosphorus Fertilizer Rates, Placement and Time of Application

Cara Drury

- Horticulture Production in Saskatchewan

Publications

Crop Varieties for Irrigation, January 2021

Irrigator, March

- Research Directors Corner – Garry Hnatowich
- Building on Success, Overview of new SFP trials- Cara Drury
- Irrigation Funding Opportunities Through the Canadian Agriculture Partnership – Karly Rumple
- Clubroot in the RM of Rudy: What are the next steps? – Kaeley Kindrachuk
- Seeding Hemp: How Late Can You Go? – Joel Peru
- P Fertilization on P Deficient Soils: Rate not Time or Placement Drives Wheat Yield – Erin Karppinen

Irrigator, November

- Research Directors Corner – Garry Hnatowich
- Research Directors Corner – Gursahib Singh
- ICDC Research Program
- Crop Insurance for Vegetables - Cara Drury
- Irrigated Canola Production Survey - Mark O' Connor

2021 ICDC Research and Demonstration Report – March

Fungicide Mitigates Fusarium Head Blight in Durum Wheat When Applied as Late as the End of Flowering in Western Canada. 2021. Gursahib Singh, Garry Hnatowich, Gary Peng and Hadley R. Kutcher. American Phytopathological Society.

Presentations

Mark O' Connor
- 2021 SIPA/ICDC Conference - Irrigated Canola Survey, December 7

Cara Drury
- 2021 SIPA/ICDC Conference– Summary of horticulture projects 2021-2022, December 7

Gursahib Singh

- 2021 SIPA/ICDC Conference – Selected Research Highlights

Garry Hnatowich
- 2021 SIPA/ICDC Conference – Selected Research Highlights
- University of Saskatchewan Plant Science 375 – Dry Bean Agronomy in Saskatchewan

Articles

Garry Hnatowich
- Canadian Dry Beans in Good Position – Northarvest Bean Growers Association
- Reactions to massive irrigation project at Lake Diefenbaker - SaskToday

Crop Production Newsletter

Mark O'Connor
- Crop Production News #2 Benefits of water Scheduling
- Crop Production News #8 Is Your Irrigation System Read for Winter

Social Media
- Effect of tillage Management and Seeding Date on Dry Bean Establishment and yield

2021 Hemp Seeding Date Demonstration
- Twitter

ICDC Followers: 771 followers
Tweets: Average 4-10 per month with around 600-1600 impressions per tweet
- YouTube:

ICDC videos: 100 to date
Average views per video: 30-150
Channel subscribers: 78

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.