Project Identification

1. **Project Title:** Canola salt tolerance of varying seed size vs barley
2. **Project Number:** 20190448
3. **Producer Group Sponsoring the Project:** Conservation Learning Centre
4. **Project Location(s):** SW 20-46-26 W2 RM #461 (Prince Albert)
5. **Project Start and End Dates (Month & Year):** April 2020 to February 2021
6. **Project Contact Person & Contact Details:**

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Objectives and Rationale

7. Project objectives:

To demonstrate how hybrid canola of increasing seed size performs in moderately saline soils, with a focus on germination, establishment and seed yield compared to a more commonly used barley variety.

8. Project Rationale:

Comparing hybrid canola to barley in salinity has been done by the Salt Testing Facility located at AAFC in Swift Current, by Dr. Harold Steppuhn and Wheatland Conservation Area in a previous ADOPT project (2012-2014) carried out in Hodgeville, SK. Problems with growth in certain areas of a hybrid canola seed field caught Jack Payne's attention in Olds, AB, who obtained the help of Dr. Steppuhn. Dr. Steppuhn compared the growth of three varieties of canola to Harrington barley, which was the most salinity tolerant of several crops he tested some years ago. InVigor Canola varieties demonstrated a similar tolerance to salinity as barley and competed well with weeds under moderately saline conditions. Barley appeared to have a slight advantage in relatively high salt concentrations, although this resulted in little grain production due to very low emergence and survival rates. It is important for producers to be aware of canola as a salt-resistant non-cereal grain crop alternative as hybrid canola varieties continue to improve. This study will also help inform producers on how canola's varying seed size can affect germination, establishment, and yield.

Nybo, B., Steppuhn, H. 2014. Demonstrating the Salt Tolerance of Hybrid Canola as an Alternative to Barley. https://iharf.ca/wp-content/uploads/2014/11/Salt-Tolerance-of-Hybrid-Canola.pdf

Bybordi, A. and J., Tabatabaei. Effect of Salinity Stress on Germination and Seedling Properties in Canola Cultivars (Brassica napus L.) Not. Bot. Hort. Agrobot. Cluj 37 (2) 2009, 71-76. www.notulaebotanicae.ro

Steppuhn, H., Volkmar, K.M. and Miller, P.R. 2001. Comparing Canola, Field Pea, Dry Bean, and Durum Wheat Crops Grown in Saline Media. Crop Science. 41:1827-1833.

Methodology and Results

9. Methodology:

This trial was arranged as a randomized complete block design of 3 replicates arranged side by side over an area of varying salinity. The treatments were made up of varying seed sizes of canola compared to a standard barley variety. A complete treatment list can be found in Table 1. All data was collected for each treatment at four levels of salinity: low, medium, high, severe.

Table 1. Treatment list of crops grown in the canola salinity trial.

Treatment #	Crop	Average TKW (g)
1	DKTF 92SC Check	4.72
2	A DTKF 92SC	3.64
3	B DTKF 92SC	4.68
4	C DTKF 92SC	5.44
5	Dekalb 75- 65 (average seed size)	5.92
6	Barley CDC Austenson	57.8

Table 2. Location of soybean seeding date and variety trial and additional information.

Legal Land Location	SE-20-46-26-W2 RM 461
Coordinates of Corners	N53°01.466' W105°46.376' N53°01.532' W105°46.355' N53°01.468' W105°46.404' N53°01.536' W105°46.385'
Soil Type	Clay loam
Soil Zone	Black
Emergence	June 10, 2020

Before seeding the trial was rototilled because the area was heavily covered by foxtail barley. There was limited time and options for spraying the foxtail barley prior to seeding because of the foxtail barley's advanced stage. The trial's proposed area was mapped out using EM38 on May 18, 2020 prior to seeding. Each plot was 2m by 150m seeded into canola stubble by a Fabro plot seeder with 10-inch row spacing on June 3, 2020. The barley was seeded at a rate of 200 seeds/m^2 at 1.25 inches in depth, and the canola was seeded 0.75 inches deep at a rate of 100 seeds/m^2. The barley had no seed treatment, and the canola came pre-treated. For the barley, nitrogen was put down at 39 kg/ha (side-banded) and phosphorous at 28 kg/ha (seed-placed). Canola was put down with nitrogen at a rate of 73 kg/ha (side-banded) and phosphorous at 28 kg/ha (seed-placed). No pre-emergent herbicide was used.

Using the EM38 readings, 1 m sections in each plot were flagged out for each of the four salinity levels: low, medium, high and severe. Plots were staged and scouted weekly for disease and pests. Glyphosate was applied on June 30, 2020 to the canola plots and Infinity was applied June 3, 2020 to the barley plots. Plant counts were completed at each of the salinity level pin flags (2 x 1m) throughout the season to determine the survivability of the plants. These plant counts occurred on July 6, 2020, August 19, 2020, and September 16, 2020. EM38 readings were recorded again mid-season on August 10, 2020, but was not completed due to technical issues. Plant height was measured at each salinity level flag on Sept 3, 2020. Biomass was collected by cutting the crop by hand at the two 1-meter rows of each flagged out salinity level and putting it into a paper bag to dry. These samples were then threshed using a Wintersteiger plot combine to collect yield data. Post-harvest EM38 readings were completed on Oct 7, 2020.

Data was analyzed by ANOVA using IBM SPSS software. Any non-parametric data was analyzed using the Kruskal-Wallis test.

10. Results

Weather

Table 3. Weather conditions in the 2020 growing season at the Saskatchewan Conservation Learning Centre.

	May	June	July	August	September	October	Average/Total
				--- Temperature (°C) ---			
2020	9.2	13.4	17.6	16.1	10.9	1.0	11.4
2019	9.5	15.8	17.4	15.1	11.6	1.0	11.7
2012-2018	11.8	16.1	18.5	17.3	11.6	3.5	13.1
				--- Precipitation (mm) ---			
2020	68.4	91.4	32.2	33.2	31.6	10.1	266.9
2019	30.0	54.4	57.4	16.8	59.6	11.6	229.8
2012-2018	36.4	80.6	96.1	48.0	25.8	26.0	310.5

The spring and summer at the CLC saw good precipitation compared to past years (Table 3). Temperatures throughout the growing season were slightly cooler than in past years, but similar to 2019. The first fall frost occurred earlier than normal on September 8th (-3.6°C), and another hard frost occurred until September 16th (-5.3°C). Precipitation was lower in the fall months relative to the 2019 growing season.

Soil Test Results

Soil test results in the saline area indicated that N was high and P was low (Table 4). Sulfur was high with 120+ lb/ac available in the top 15 cm. Magnesium and calcium were high but sodium was low. Soluble salts levels were medium with 0.75 mmho/cm available in the top 15 cm.

Spring soil test results of the slope area (transition between saline and non-saline zones) indicated that N was high and P was medium (Table 4). Sulfur was low with 16 lb/ac available in the top 15 cm. Magnesium and calcium were high but sodium was low. Soluble salts were low with 0.29 mmho/cm available in the top 15 cm.

According to spring soil test results, the non-saline area was high in N and P (Table 4). Sulfur was medium with 28 lb/ac available in the top 15 cm. Soluble salts were very low with 0.27 mmho/cm available in the top 15 cm.

Table 4. Soil test results from June 2, 2020.

Area	Depth	N	P	K	S	Zn	OM	pH	Salts	Mg	Ca	Na
	(cm)	(lb/ac)	(ppm)	(ppm)	(lb/ac)	(ppm)	(%)		(mmho/cm)	(ppm)	(ppm)	(ppm)
Saline	0 – 15	36	7	199	120+	1.22	4.6	6.8	0.75	1002	3203	54
	15 – 60	39			360+			7.5	1.59			
	0 – 60	75										
Slope	0 – 15	17	12	148	16	0.41	1.8	7.8	0.29	277	3001	12
	15 – 60	42			42			8.1	0.26			
	0 – 60	59										
Non-Saline	0 – 15	26	13	195	28	1.61	3.8	6.3	0.27	413	2530	24
	15 – 60	42			336			7.6	0.60			
	0 – 60	68										

The Cation Exchange Capacity (CEC) of the saline area was 26.0 meq (Table 5). The % base saturation of Ca, K, Na and H were within the typical range, but Mg was high.

The CEC of the slope area was 17.7 meq. The % base saturation of K, Na and H were within typical levels, but Ca was high, and Mg was low.

The CEC of the non-saline area was 19.1 meq. The % base saturation of Ca, Mg, K and Na were within the typical range, but H was high.

Table 5. Soil characteristics from June 2, 2020 soil test.

Area	**Cation Exchange Capacity** (meq)	% Base Saturation				
		% Ca	**% Mg**	**% K**	**% Na**	**% H**
Saline	26.0	61.6	32.1	2.0	0.9	3.4
Slope	17.7	84.6	13.0	2.1	0.3	0.0
Non-Saline	19.1	66.4	18.1	2.6	0.5	12.4
Typical Range		65-75	15-20	1-7	0-5	0-5

Barley had higher mean plant densities averaged across all the salinity levels than the canola throughout the growing season (Table 6). Barley plant counts were lower in the fall than in the spring, indicating that salinity may have affected survival. Barley plant counts may also have been negatively impacted by overspray of glyphosate on the third replicate of barley when spraying the canola on June 30.

There were no significant differences in plant counts between the canola treatments on July 6 or on August 19 (Table 6). Plant density on September 16 was significantly higher in the DKTF 92SC check treatment than in the A DKTF 92SC treatment (smallest seed size) according to a multivariate ANOVA ($F(5,55)=119.471$, $p<0.0005$). This lower plant density could indicate that the smaller sized seeds have lower survivability than seeds of an average size across all salinity levels. Mean plant density decreased in all treatments between July 6 and September 16.

Overall, there were no significant differences in height between canola treatments (Table 6). Observably, DKTF 92SC check was the tallest of all canola treatments, and Dekalb 75-65 was the shortest. As expected, all canola treatments were taller than the barley.

Mean biomass did not differ significantly between treatments (Table 6). Of the canola treatments, biomass was observably the highest in the A DKTF 92SC treatment (smallest seed size) and lowest in the B DKTF 92SC treatment (second smallest seed size).

Overall, yield was low for both barley and canola treatments (Table 6). There were no significant differences in yield between the canola treatments. Canola yield was observably the lowest in the C DKTF 92SC treatment and highest in the check. Yield in the canola plots may have suffered some losses from early shattering, especially in the high salinity areas where the canola tended to be more stressed and more mature.

Table 6. Analysis of means for canola salinity trial by treatment.

	Treatment	**Mean Plant Density on July 6**	**Mean Plant Density on August 19**	**Mean Plant Density on September 16**	**Mean Height**	**Mean Biomass**	**Mean Yield**
		plants/m^2	plants/m^2	plants/m^2	cm	g/2 rows x 1 m	bu/ac
1	DKTF 92SC Check	28.6	25.3	24.3 A	80.0	369.0	21.3
2	A DTKF 92SC	19.9	19.2	15.2 B	76.3	385.9	18.5
3	B DTKF 92SC	27.7	19.8	22.5 AB	76.7	334.6	18.1
4	C DTKF 92SC	28.1	25.5	22.6 AB	72.5	345.6	16.8
5	Dekalb 75- 65	26.1	24.3	21.0 AB	77.1	349.7	20.5
	P value	0.126	0.099	<0.0005	0.720	0.452	0.691
6	Barley CDC Austenson	48.1	111.7*	26.9	60.0	394.6	38.3

Values with the same letter are not statistically different (P<0.05).
*Barley plant counts on August 19 represent the number of tillers. Individual plants were too hard to distinguish.

There were no significant differences in barley plant counts, height, biomass or yield between salinity levels (Table 7). Plant density decreased at every salinity level by the end of the growing season. Plants were tallest in the low salinity area and shortest in the severely saline area. There were no clear trends in biomass at different salinity levels. Yield was low at all salinity levels. Yield was 44.7 bu/ac in the low salinity treatment, and 30.2 bu/ac in the severe salinity treatment.

Emergence was not statistically different between canola seed sizes and salinity levels (Table 7). The canola treatment with the smallest seed size, A DKTF 92SC, had the lowest plant density of all treatments at every salinity level. Plant density on July 6 was lowest in the A DKTF 92SC high salinity treatment, and highest in the B DKTF 92SC low salinity treatment.

Differences in August 19 plant density were not statistically significant between canola treatments and salinity levels (Table 7). Plant density decreased in most treatments between July 6 and August 19. Plant density increased in several treatments by August 19, perhaps due to volunteer canola.

September 16 plant density was not statistically different between canola treatments at different salinity levels (Table 7). Plant density was lower on September 16 compared to July 6 in all treatments, with the exception of the high salinity B DKTF 92SC treatment which stayed virtually the same.

Height was statistically different between canola treatments and salinity levels according to a Kruskal-Wallis H test ($F(19)=39.852$, $p=0.003$) (Table 7). Mean height was lowest in all severely saline areas, with the exception of the A DKTF 92SC treatment. The tallest mean height occurred in the DKTF 92SC check high salinity treatment. Of the severely saline areas, A DKTF 92SC had the tallest mean plant height. Plants in the severely saline C DKTF 92SC treatment were the shortest.

Mean biomass was not statistically different between treatments (Table 7). Biomass was lowest in the severely saline areas for all canola treatments, except for the DKTF 92SC check. Mean biomass was highest in the A DKTF 92SC low salinity treatment.

Mean yield was not statistically different between canola treatments (Table 7). Canola yield was low overall. Mean yield was lowest in the C DKTF 92SC severe salinity treatment at 10.1 bu/ac, and highest in the A DKTF 92SC low salinity treatment at 28.7 bu/ac. The A DKTF 92SC treatment, with the smallest seed size, displayed the largest yield losses with increasing salinity of all the canola treatments.

Table 7. Analysis of means for canola salinity trial by treatment and salinity level.

Trt	Salinity	Mean Plant Density on July 6	Mean Plant Density on August 19	Mean Plant Density on September 16	Height	Biomass	Yield
		plants/m^2	plants/m^2	plants/m^2	cm	g/	bu/ac
DKTF 92SC Check	Low	31.3	25.5	24.0	83.3	335.5	18.2
	Medium	30.8	25.0	27.5	76.7	412.8	19.8
	High	22.3	25.5	20.3	93.3	372.3	20.6
	Severe	30.0	25.3	25.3	66.7	355.4	26.8
A DTKF 92SC	Low	26.2	19.3	16.8	75.0	425.5	28.7
	Medium	21.3	24.7	19.5	70.0	419.4	14.5
	High	15.3	19.7	11.3	90.0	354.0	19.3
	Severe	16.7	13.0	13.0	70.0	344.8	11.7
B DTKF 92SC	Low	34.3	19.2	23.7	85.0	364.7	17.9
	Medium	25.7	19.0	22.5	71.7	342.2	18.8
	High	21.3	20.3	21.7	83.3	359.6	21.3
	Severe	29.3	20.7	22.3	66.7	272.1	14.5
C DTKF 92SC	Low	30.8	26.8	23.3	85.0	363.2	17.4
	Medium	26.5	23.5	22.5	73.3	411.9	21.4
	High	33.0	28.0	26.3	78.3	335.4	18.5
	Severe	22.0	23.5	18.3	53.3	272.0	10.1
Dekalb 75- 65	Low	30.3	26.2	22.0	78.3	370.6	20.5
	Medium	26.3	22.5	22.0	78.3	375.1	20.0
	High	22.3	25.3	19.0	83.3	335.0	20.4
	Severe	25.5	23.2	20.8	68.3	317.9	21.1
P value		0.563	0.408	0.472	0.003	0.591	0.753
Barley CDC Austenson	Low	46.2	136.8*	32.5	65.0	341.4	44.7
	Medium	48.5	98.8*	27.3	60.0	414.6	37.2
	High	50.3	103.3*	25.8	61.7	444.9	41.3
	Severe	47.5	107.7*	22.0	53.3	377.4	30.2
P value		0.723	0.321	0.158	0.484	0.871	0.462

Values with the same letter are not statistically different (P<0.05).
*Barley plant counts on August 19 represent the number of tillers. Individual plants were too difficult to distinguish.

EM 38 Readings

Spring, mid-season and fall EM 38 readings can be found in the appendix in Tables A-F.. Representative sites of low, medium, high and severe salinity were chosen for each plot based on the spring vertical EM 38 map (Table A). Overall electrical conductivity was lower in the fall relative to the spring.

11. Conclusions and Recommendations

Trends in plant density, height, biomass and yield in the canola treatments were difficult to distinguish. This could be due to the presence of lots of volunteer canola, which made it difficult to determine which plants were the crop. The trial site had been in canola the previous year, which led to quite a bit of canola regrowth, despite being rototilled before seeding. Better management of the volunteers or seeding the trial into cereal or pulse stubble may have helped reduce the amount of volunteer canola.

Yield was low across all canola treatments and salinity levels, and there were no significant differences between the treatments. Overall, mean yield was highest in the DKTF 92SC check and lowest in the C DKTF 92SC treatment. Averaged across all salinity levels, plant density throughout the growing season was lowest in the A DKTF 92SC treatment. Plant density was consistently higher in the check. In the severe salinity areas, yield was lowest in the C DKTF 92SC treatment. In the low salinity areas, yield was highest in the A DKTF 92SC treatment. A DKTF 92SC displayed the largest yield losses with increasing salinity. Due to time constraints, the canola's biomass was taken when the canola was past the swathing stage, which caused it to shatter and reduce the accuracy of the results. Another factor affecting the results was that the non-saline area had sandy soils and was uphill. These factors likely negatively affected canola yield and reduced the likelihood that there would be a significant difference in yield between the treatments.

There were no significant differences in barley plant density, height, biomass or yield between salinity levels. Overall, barley plants were short, and yields were fairly low, but performance did not differ significantly across salinity levels.

12. Acknowledgements:

The Conservation Learning Centre graciously acknowledged the Ministry's support through signage directly in field with the project, verbally during the walking tour and on the walking tour agenda handed out to all visitors.

13. Abstract:

This trial aimed to demonstrate how canola of different seed size performs in saline soils, by examining its effects on germination, establishment and seed yield compared to a more commonly used barley variety. One treatment of barley and five canola treatments were seeded: DKTF 92SC (check), Dekalb 75-65, and three seed sizes of DKTF 92SC (A-TKW 3.64g, B-TKW 4.68g, C-TKW 5.44g). Electrical conductivity was measured using an EM38 in the spring, mid-season, and fall to identify areas of low, medium, high and severe salinity within each plot. Due to canola regrowth, distinguishing the crop from the volunteers was difficult. Emergence was low in all treatments, especially so in the smallest seed size DKTF 92SC treatment. All canola treatments performed poorly but did not differ significantly in yield across salinity levels. The canola of the smallest seed size displayed the largest yield losses with increasing salinity,

indicating there may be a benefit to larger seeds in saline areas. This trial was featured in a walking tour in lieu of the CLC's Annual Field Day in July of 2020. Approximately 10 people attended, including local producers and commodity group representatives. Walking tour attendance was restricted due to COVID-19. A video presentation of the trial was also recorded as part of the CLC's Virtual Field Day and was uploaded to YouTube, reaching over 20 views.