Project Identification

1. **Project Title:** Cover Crop Variety and Seeding Date trial for Weed Suppression Under Organic Management System
2. **Project Number:** 20190427
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):** June 2020 to February 2022
6. **Project Contact Person & Contact Details:**

A. Brooke Howat*
Manager
Box 1903
Prince Albert, SK
S6V 6J9
info@conservationlearningcentre.com
306-960-1834
*The manager Robin Lokken is on maternity leave.

B. Ryan Scragg
BOD Chair
ryan_scragg@hotmail.com
306-961-2240

Objectives and Rationale

7. Project objectives:
To demonstrate cover crop options for the region and to assess how seeding date could affect their success. In year 2, direct seeding into the cover crop variety trial will showcase how no till management works in an organic setting.

8. Project Rationale:

Sustainable cropping practices, such as cover crops, can improve soil health and suppress weeds. Cover crops are increasing in popularity throughout the United States and Europe, thanks in part to their benefits and agricultural producers' continuing efforts to farm more sustainably. Studies conducted in these regions have found that cover crops reduce soil erosion and add organic matter and carbon to the soil, which improves soil structure, tilth and water permeability (Dabney et al., 2007; Hartwig and Ammon, 2002; Teasdale, 1996). Crops in northern latitudes can benefit from winter cover crops, as they have been shown to act as a snow trap and provide soil cover in the spring, which slows water runoff and allows water to infiltrate, increasing soil moisture. Additionally, many cover crop varieties have annual and perennial weed-suppressing capabilities. For example, sudangrass has been shown to reduce Canada thistle by up to 20%, as it can quickly emerge and outcompete late-season weeds when planted in the fall (Bicksler and Masiunas, 2017). Sudangrass quickly produces a large amount of biomass and naturally terminates in the fall, forming a thick mat that covers the ground, reduces weed seed germination in the spring and helps to conserve moisture. Sudangrass can also help reduce soil compaction thanks to its extensive root system, just like many other cover crops. Other large biomass producing cover crops such as winter and spring oats have demonstrated similar benefits (Brennan and Smith, 2005). Legume cover crops add nitrogen to the soil for subsequent crops to use and are often excellent green manures. When grown together with fast-growing, slowly decomposing, competitive cereals, legumes help to close the canopy and further suppress weed growth.

Bicksler, A., and Masiunas, J. 2009. Canada Thistle (*Cirsium arvense*) Suppression with Buckwheat or Sudangrass Cover Crops and Mowing. Weed Technology. 23(4), 556-563. doi:10.1614/WT-09-050.1

Brennan, R.B., and R.F. Smith. 2005. Winter Cover Crop Growth and Weed Suppression on the Central Coast of California. Weed Technology. 19:1017-1024.

Dabney, S.M., J.A. Delgado, and D.W. Reeves. 2001. Using winter cover crops to improve soil and water quality. Communications in Soil Science and Plant Analysys. 32:7-8, 1221-1250. doi:10.1081/CSS-100104110

Hartwif, N.L., and H.U. Ammon. 2002. Cover crops and living mulches. Weed Science. 50: 688-699.

Teasdale, J.R. 1996. Contribution of Cover Crops to Weed Management in Sustainable Agricultural Systems. J. Prod. Agric. 9:475-479. doi:10.2134/jpa1996.0475

Methodology and Results

9. Methodology:

This trial was set up as a randomized complete block design with four replicates. The seeding dates were organized in blocks, but the treatments were randomized within those blocks. A list of treatments can be found in table 1.

Table 1. Treatments in the "Cover crop variety and seeding date trail for weed suppression under organic management system" trial.

Trt #	Crop	Seeding Date
1	Spring forage oats	July 20, 2020
2	Spring forage oats 2x seeding rate	July 20, 2020
3	Silage peas	July 20, 2020
4	Spring forage oats with silage peas	July 20, 2020
5	Sudan grass	July 20, 2020
6	Sudan grass with silage peas	July 20, 2020
7	Spring forage oats	Aug 4, 2020
8	Spring forage oats 2x seeding rate	Aug 4, 2020
9	Silage peas	Aug 4, 2020
10	Spring forage oats with silage peas	Aug 4, 2020
11	Sudan grass	Aug 4, 2020
12	Sudan grass with silage peas	Aug 4, 2020

Table 2. Additional information for the organic cover cropping trial.

Soil Type	Clay loam
Soil Zone	Black
Soil Temperature at Seeding (July)	25.8˚C
Soil Temperature at Seeding (August)	20.7°C
Emergence (July)	Forage oats: July 31 2x Seeding rate forage oats: August 1 Silage peas: August 3 Forage oats and silage peas: July 31 Sudan grass: July 31 Sudan grass and silage peas: July 31
Emergence (August)	Forage oats: August 13 2x Seeding rate forage oats: August 13 Silage peas: August 16 Forage oats and silage peas: August 16 Sudan grass: August 13 Sudan grass and silage peas: August 13

Each plot was 5.25 m by 7 m seeded by a Fabro plot seeder with 10-inch row spacing. It was seeded into an alfalfa and brome grass field that had been disced several times. The peas were inoculated with nodulator EL LQ prior to seeding. The peas and oats were seeded at a depth of 1.5 inches and the sudan grass at a depth of 0.75 inches. No pre-emergent or post-emergent herbicides were used.

Spring plant densities were completed on August 12 for the grasses and August 19 for the peas by counting two 1-meter sections from the front and back of each plot. Weed species and quantities were counted using ¼ m^2 from the front and back of each plot on Aug 12, 2020 for the first seeding date and Sept 3, 2020 for the second seeding date. Plant height was measured to the nearest cm in the front and back of each plot on September 8, 2020. Biomass data was collected by clipping everything in ¼ m^2 from the front and back of each plot and then hand-sorting the cover crop and weeds, on September 8-9, 2020.

All data was non-parametric and was analyzed by Kruskal-Wallis test using IBM SPSS software.

10. Results

Weather

The spring and early summer at the CLC saw good precipitation compared to past years (Table 3). Precipitation dropped in August compared to the historical average, and there was very little precipitation in September. This drop in precipitation contributed to poor emergence and growth in the cover crops. 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 did not occur until September 16th (-5.3°C). The early frost limited cover crop biomass.

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

<u>Soil Test Results</u>

Soil test results indicated that N and P were low (Table 4). Sulfur was high with 50 lb/ac available in the top 15 cm.

Table 4. July 7, 2020 basic soil test results.

Depth (cm)	N (lb/ac)	P (ppm)	K (ppm)	S (lb/ac)	Zn (ppm)	OM (%)	pH	Salts (mm ho/cm)
0 – 15	19	5	293	50	3.26	6.5	6.8	0.57
15 – 30	13			30			7.4	0.47
0 – 30	32							

Iron, manganese, magnesium and calcium levels were high (Table 5). Boron and copper levels were medium, and chloride and sodium were low.

Table 5. July 7, 2020 soil test mineral analysis results.

Depth (cm)	Cl (lb/ac)	B (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Mg (ppm)	Ca (ppm)	Na (ppm)
0 – 15	10	0.9	116.1	4.8	0.74	891	4216	31
15 – 30	5							

Cation exchange capacity was high at 30.4 meq (Table 6). Base saturation was within the typical range for Ca, Mg, K, Na, and H, but was slightly higher than normal for Mg.

Table 6. July 7, 2020 soil test CEC and base saturation results.

Carbonate (CCE %)	Cation Exchange Capacity (meq)	% Base Saturation (Typical Range)				
		% Ca	% Mg	% K	% Na	% H
3.4	30.4	69.3 (65-75)	24.4 (15-20)	2.5 (1-7)	0.4 (0-5)	3.4 (0-5)

There was a significant difference in crop density between treatments according to Kruskal-Wallis H test (F(11)=40.973, p<0.0005) (Table 7). Plant density was highest in the spring forage oats 2x seeding rate treatments, and lowest in the silage pea, sudan grass, and silage pea and sudan grass treatments. Emergence was limited by low soil moisture for both seeding dates.

There was a significant difference in weed density between treatments according to Kruskal-Wallis H test (F(11)=28.015, p=0.003) (Table 7). Weed plant density was highest in the later-seeded treatments, likely due to poor emergence and low biomass of the cover crop. In both seeding date treatments, the silage pea treatments had the highest weed density. The spring forage oats 2x seeding rate and spring forage oats with silage peas treatments had the lowest weed density in both the earlier and later seeded treatments.

Crop biomass was significantly lower in the August seeded sudangrass and sudangrass and silage pea treatments according to Kruskal-Wallis H test (F(11)=30.918, p=0.001) (Table 7). The early September frost killed the sudangrass, but the forage oats were not killed at the early September frost, but instead killed the forage oats on the second frost on September 16. Crop biomass was highest in the earlier-seeded treatments and in the spring forage oat treatments. In the July seeding date, the forage oat and forage oat 2x seeding rate treatments had virtually the same biomass, perhaps due to self-thinning. In the August seeding date, the forage oat 2x seeding rate treatment had about 1.5x more biomass than the regular seeding rate of oats. Biomass of all crops across both seeding dates was lower than expected, likely due to a lack of sufficient precipitation in August.

There was a significant difference in weed biomass between treatments according to Kruskal-Wallis H test (F(11)=23.849, p=0.013) (Table 7). Weed biomass was lowest in the later-seeding date treatment, likely due to low levels of precipitation in August. Weed biomass was especially low in the later-seeded spring forage oats treatment. In the early-seeded treatments, weed biomass was lowest in the spring forage oat crops, and highest in the silage pea, sudan grass, and silage pea and sudan grass crops.

Crop height did vary significantly between treatments according to a Kruskal-Wallis H test (F(11)=37.052, p<0.0005) (Table 7). Crops seeded in late-July were taller than those seeded in early-August. Sudan grass treatments were the tallest crops in the earlier-seeded treatments, but the shortest in the later-seeded treatments. This difference in height indicates that the sudangrass was especially susceptible to lack of precipitation in August and freezing in September.

Table 7. Density and biomass of different cover crops by seeding date.

Trt	Seeding Date	Crop	Mean Crop Density	Mean Weed Density	Mean Crop Biomass	Mean Weed Biomass	Mean Crop Height
			plants/meter^2	plants/0.25m^2	g/0.25m^2	g/0.25m^2	cm
1	July 20	Spring forage oats	133.00	10.38	117.43	56.56	33.38
2	July 20	Spring forage oats 2x seeding rate	243.00	7.63	113.46	35.91	35.75
3	July 20	Silage peas	62.50	14.63	33.94	88.26	33.50
4	July 20	Spring forage oats with silage peas	102.50	7.25	72.15	40.35	27.63
5	July 20	Sudan grass	67.50	7.88	99.50	83.09	54.50
6	July 20	Sudan grass with silage peas	59.00	9.50	66.33	76.85	42.25
7	Aug 4	Spring forage oats	148.00	12.00	29.85	12.05	19.00
8	Aug 4	Spring forage oats 2x seeding rate	283.50	17.63	45.08	22.50	20.75
9	Aug 4	Silage peas	83.00	25.25	18.38	13.98	14.25
10	Aug 4	Spring forage oats with silage peas	139.00	17.50	23.91	24.45	14.63
11	Aug 4	Sudan grass	74.50	23.38	3.11	28.08	12.13
12	Aug 4	Sudan grass with silage peas	60.00	23.13	8.73	16.55	9.63
		p value	<0.0005	0.003	0.001	0.013	<0.0005

Most of the weed pressure was due to regrowth of the previous crop of brome grass and alfalfa (Table 8). A full list of the most common weed species surveyed in this trial and their percent frequencies can be found in Table 8. Other weeds identified include barnyard grass, sow thistle, field horsetail, stinkweed, hemp nettle, and lamb's quarters.

Table 8. Most common weed species and their frequency when surveyed in late summer.

Weed Species	% Frequency
Volunteer Brome Grass	52.82
Volunteer Alfalfa	22.13
Dandelion	15.27
Canada Thistle	4.85
Smartweed	1.57
Wild Buckwheat	1.50
Other	1.86

11. Conclusions and Recommendations

None of the cover crops in either seeding date produced enough biomass in the 2020 growing season to act as a weed-suppressing mat. Low soil moisture at the time of seeding, minimal precipitation after seeding, and an early September frost all limited crop biomass. Repeating the first year of the project in 2021 with earlier seeding dates would likely produce better results. Earlier seeding dates would help ensure there is sufficient biomass before the first killing frost.

Overall, the forage oats had high plant density, biomass, and good weed suppression in the first year of the trial. Doubling the seeding rate of forage oats had variable results. This could indicate that a higher seeding rate of forage oats may be beneficial, until the crop fills out more and plants begin self-thinning. The silage peas and sudangrass were the most susceptible to low moisture and cool fall temperatures.

The highest weed pressure in this trial came from the regrowth of the previous alfalfa and bromegrass crop. Additional passes with the discer prior to seeding may have helped kill the previous crop better and reduce weed pressure.

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. The CLC also thanks Garth Beddome, a local producer, for providing the site for this organic cover crop trial, and another local producer for providing some of the inputs used.

13. Abstract:

In its first year, this trial aimed to demonstrate different cover crops and examine the impact of seeding date on mulch biomass. Various treatments of spring forage oats, silage peas and sudangrass were seeded on July 20th and on August 4th. Low soil moisture at seeding, minimal precipitation and an early September frost limited cover crop biomass. Under difficult late summer growing conditions, the forage oats had the highest plant density and biomass. Biomass in all treatments was insufficient to produce a weed-suppressive mulch for a spring crop. Repeating the first year of the experiment with earlier seeding dates would allow for more growth before the first fall frost. Seeding into this trial in the spring with the current level of biomass would likely not produce meaningful results. As a result, the CLC spoke with the project lead, Danielle Stephens, and decided that we would re-seed the cover crops next year earlier in the season, at higher rates, and we will make sure the trial area has been worked up several times and at least a month before seeding to help control weeds. We plan on using the budget that was allotted in year 2 to re-seed, then apply for an ADOPT to fund the 3rd year where we plan on direct seeding into the cover crop mulch.