Project Identification

1. **Project Title:** Haskap Agronomy and Variety Trial
2. **Project Number:** 20180423 SFP
3. **Contractor Undertaking 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):** January 18, 2019 to February 15, 2023
6. **Project Contact Person & Contact Details of Project Manager:**
   Robin Lokken AAg
   Manager
   Box 1903
   Prince Albert, SK
   S6V 6J9
   info@conservationlearningcentre.com
   306-960-1834

Objectives and Rationale

7. Project objectives:

To determine best management practices for production of Haskap in Saskatchewan including irrigation, fertilization and mulch covers.

8. Project Rationale:

Haskap production is the most rapidly expanding component of the fruit industry, but agronomics are poorly defined. This crop is high value and lends itself well to value added processing. It has strong appeal to local and export markets. It therefore fit the provinces growth strategy very well.

Methodology and Results

9. Methodology:

Experimental design:

2019 was year 1 of the 4-year haskap agronomy project. Three blocks, each with 20 varieties of Haskap were planted in randomized fashion. Four plants of each variety were planted per row, resulting in each row having 80 plants. Haskap cultivars are randomized within the block in subgroups that have overlapping cross-pollination and blossom windows. In this way, varieties with the same blossom periods that can provide cross-pollination to one another are retained in groups (organized in similar colour groupings in Figure 1). Colour groupings are featured as shades of green, blue, ochre, brown/red, grey/yellow. There are blossom and cross-pollination overlaps from some colours to others, but all varieties cannot be completely randomized within this block without it having a significant impact on fruit yield CV. Plants were spaced 1 meter apart within the row, and 4 meters apart between the rows.

The “Mulch Treatment” block will test black plastic, white plastic, 8 cm wood chip, and landscape fabric (“mulches” that cover soil, prevent weed competition, reduce evapotranspiration, and modify root temperature microenvironments) against a control treatment (where weeds will be controlled strictly using herbicides including dichlobenil, trifluralin, Fluazifop-P-butyl, Sethoxydim, paraquat, et cetera). The same benchmark fertilizer and irrigation rates will be applied to all treatments in this block (depending on results of soil tests that will determine specific fertilizer and irrigation rates). An additional wood chip mulch treatment was added to replace the raised bed treatment.

The second “Fertilizer Treatment” block is designed to test the effect of fertilizer rates. Haskap varieties were randomized in the same way as the “Mulch Treatment”, and rates will be applied in split applications according to Eric Gerbrandt & Andrew Hammermeister specified benchmarks (example 18-12-12 N-P-K +n1 Ca, 0.5 Mg, with 5S and micronutrients (at a rough minimum equivalent of 47 g/plant in mid-April, and 78 g/plant in late-May or prior to full fruit-set). The

minimum is expressed as “2x” in the attached plot plan (Figure 1). The “3x” treatment will include an additional 78g fertilizer application prior to leaf senescence in late summer. Three other treatments will be tested in which water soluble 20-20-20 + micronutrient (Plant-Prod) fertilizer will be applied via drip irrigation at rough equivalence of 40g/plant per treatment application. The lowest-rate fertigation treatment will occur 4x whereas, higher rates will also be trialed with 6x and 7x applications at the 40/g per plant rate. Haskap are shallow rooted, and some research has suggested they benefit from more frequent low-level fertilizer applications. Fertigation treatments may also receive foliar application of iron and zinc if deficiencies are noticed, or if soil test results indicate poor availability.

The third “Irrigation Treatment” block will start with lower irrigation rates when the plants are young, and increase as the plants grow through the four-year project lifespan. Irrigation need is partially soil and climate dependent, but it is anticipated the plants will need an additional 300-400 mm of water with higher rate applications occurring during hot dry periods in the summer. The first treatment in this block will see irrigation applied 2x per week along one drip line and up to a level just below soil saturation according to tensiometer readings (if for example it rains and soil is already near saturation, no application will be applied at that time). The second treatment will use one drip line and run at a lower rate (length of time of application and lower tensiometer reading) 3x per week. These drip lines deliver water directly to the centre of the plant’s crown. The third treatment will use 2 drip lines (at the same rate as the 2x single drip line treatment) so that delivery of water will be more spread out. In this way the shallow spreading haskap roots may be better served via more widespread water availability at the root growth initials. The fourth treatment will do the same as the third treatment, (at corresponding rates to 3x/week treatment applications from 1 dripline found in the second treatment) but 3 x per week. The final treatment in the irrigation block will rely on 2 drip lines applying water to a level below saturation entirely set by tensiometer readings. So, the fifth treatment could require watering at low levels more than 5 times per week, or not at all if soil moisture is well retained.

In all blocks, measurement of growth, yield, labour demand, and fruit quality will be taken and analyzed. Winter-hardiness and genotype-by-environment parameters will also be measured (like blossom and harvest windows, winter-kill, et cetera). Soil quality parameters will be measured throughout the four-year project lifespan.

The major goal of the first year of the trial was the establishment of the haskap orchard. Due to later than desired arrival of equipment, certain tasks were not completed in the time frames outlined in the project proposal, such as using different sources of fertilizer and the timing of fertilization. Minimal data was collected in year 1 of the trial since fruit production has yet to occur. Observations were made regarding plant height, survival and mildew disease presence. Survivability was determined on August 30, 2019 by recording the number of haskaps plants per plot that had foliage present. On the same date, % disease was determined by recording the number of plants per plot that had visual symptoms of mildew. Disease severity used a rank of 0-5. No presence of disease received a ranking of 0, and 5 was assigned if all leaves had mildew present.

Year 1 (2019):

Preplant

An area approximately 120 m x 26 m that has been under annual crop production was selected and rototilled to try and create a smooth bed. Dry conditions made this somewhat difficult and caused the soil to clump together. Multiple passes with the rototiller were made to reduce clump size. A composite soil test was completed of the area and sent to Agvise Laboratories for analysis (Table 1). The CLC is located within a non stony hummocky landscape in the Black Soil zone. The dominant soil texture is a fine sandy loam to silty loam. The soil has a high organic matter (6.2%) and a pH between 5.7-6.8. Soluble salts are low.

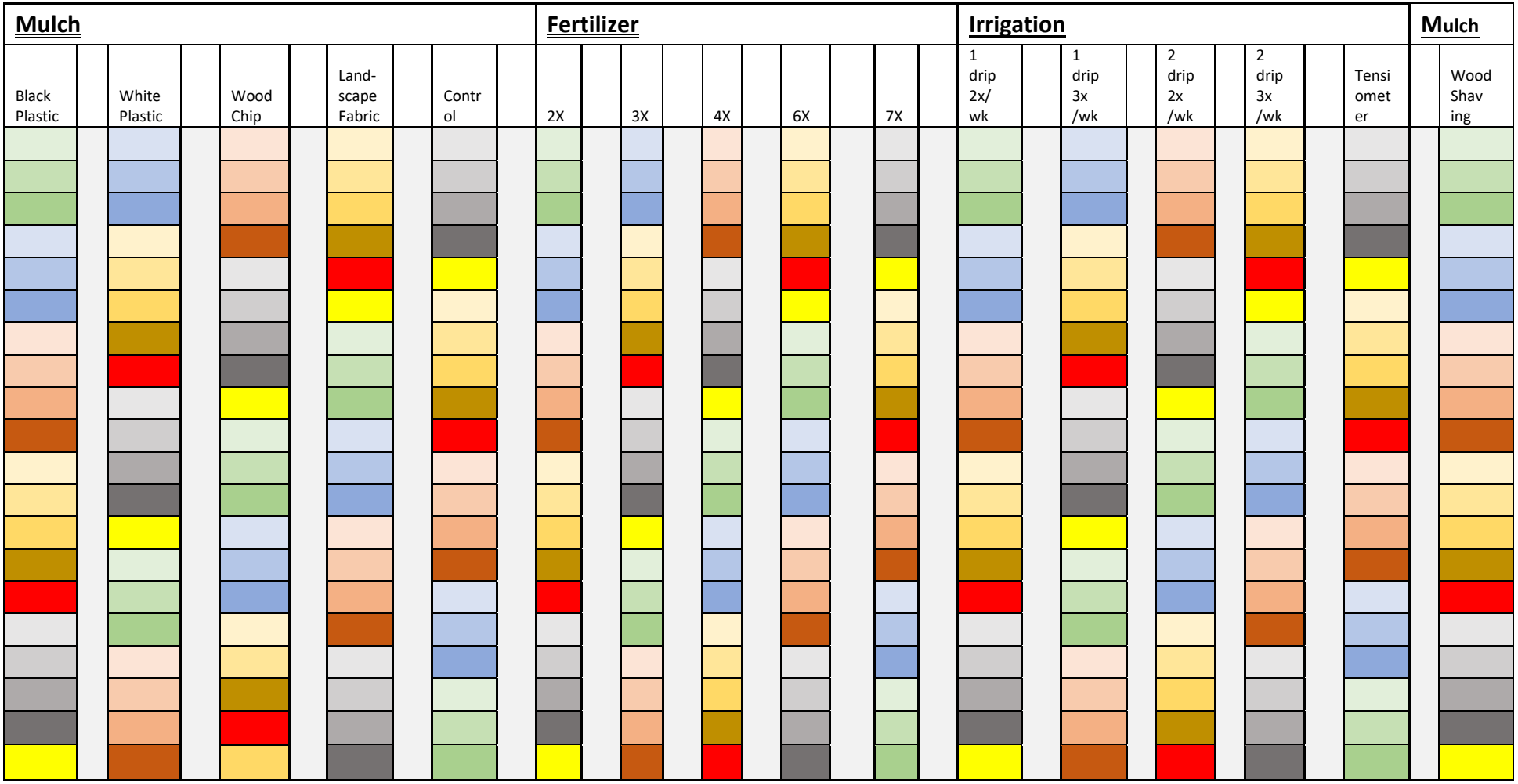
Table 1. Soil test results (2019) for haskap agronomy trial at the CLC, near Prince Albert.

Depth (cm)	N (lb/ac)	P (ppm)	K (ppm)	S (lb/ac)	Zn (ppm)	OM (%)	pH	Salts (mm ho/cm)
0 – 15	17	9	265	16	1.90	6.2	5.7	0.2
15 – 30	11			16			6.8	0.25
0 – 30	28							

Planting

Drip irrigation was laid out and interrow pathways seeded with a forage mixture using a plot combine. The forage mixture includes grasses and clover and was seeded June 6, 2019. One irrigation line was laid out per row, except for the treatments that required 2 drip lines. Plastic mulches were applied June 5-6th and haskap plants were planted every 1 m by hand June 11-13th, 2019. All rows were planted at this date, except for the eastern-most wood chip treatment. All fertilizer and irrigation treatment rows were covered with black mulch. At time of planting a hole was cut into the mulch and an irrigation emitter installed into each irrigation line by the haskap plant. Planting involved using a trowel to dig a hole deep enough to place the haskap plant and ensure that all root mass was covered. Wood mulches were applied at a later date on June 26th. It was decided to change the raised bed treatment (row 16) to an additional wood mulch treatment since it was deemed too expensive to secure the raised bed equipment. The second wood mulch row was planted June 26th. Row 3 wood mulch treatment used a dyed red colour cedar mulch and the second mulch treatment was a lighter kiln dried softwood shaving.

Figure 1. Haskap trial plot plan.



*4 plants per plot

Haskap Legend

Source	Variety	Source	Variety	Source	Variety	Source	Variety	Source	Variety
U of SK	Honey Bee	U of SK	Indigo Yum	U of SK	Boreal Beauty	Russian	Blue Diamond	Polish	Larisa (Wojtek)
U of SK	Tundra	U of SK	Indigo Gem	U of SK	Boreal Blizzard	Russian	Blue Jewel	Polish	Rebecca (Rebekka)
U of SK	Blue Treasure	U of SK	Aurora	Russian	Blue Banana	Russian	Blue Moose	Polish	Svetta
U of SK	Indigo Treat	U of SK	Boreal Beast	Russian	Happy Giant	Polish	Evie (Jolanta)	Oregon X	Kawai

N

Irrigation

Immediately after planting, all treatments received the same amount of irrigation in order to help with plant establishment. Although the spring and summer were drier than usual, timely rains came after planting. Haskap irrigation treatments began July 3, 2019 and are described in Table 2. For single drip lines, the line runs from plant trunk to the next plant trunk with the emitter positioned close to the plant. For 2 drip line treatments, drip lines run 20 cm on either side of the plant trunks. Typical weekly irrigation occurred on Mondays and Thursdays. Every row was irrigated twice a week, 2 rows at a time for 1h. Rows 12 and 14, the 3X irrigation treatments were irrigated a third time on Fridays. Each irrigation was approximately equivalent to the application of 100mL/plant. Tensiometers were installed July 26th. Two tensiometers were installed in the tensiometer treatment row 15 at 12" and 24". An additional tensiometer was installed mid orchard in row 9, the 6X fertilizer treatment. The tensiometer readings were recorded almost daily from July 29 – Sept 9th. After July 29, the tensiometer treatment was irrigated twice (Aug, 13 and Aug, 22) due to a reading greater than 50 kpa. The final irrigation date for the haskaps was September 20, 2019. Irrigation lines were cleared and shut down for winter on September 27th.

Table 2. Explanation of the method used to apply irrigation to haskaps depending on the treatment.

Irrigation Treatments	**Description**
2X per week 1 drip line	1 drip line to deliver irrigation water two time (2X) per week in an amount sufficient to bring soil moisture level just below saturation.
3X per week 1 drip line	1 drip line will deliver irrigation 3X per week in an amount sufficient to bring soil moisture level just below saturation.
2X per week 2 drip lines	2 drip lines will deliver irrigation 2X per week in an amount sufficient to bring soil moisture level just below saturation.
3X per week 2 drip lines	2 drip lines will deliver irrigation 3X per week in an amount sufficient to bring soil moisture level just below saturation.
? X per week 2 drip lines	2 drip lines will deliver irrigation ?X per week in amount to ensure soil stays adequately wet. Irrigation was applied when tensiometer reading was 50 kpa.
All remaining treatments	1 drip line to deliver irrigation water two time (2X) per week in an amount sufficient to bring soil moisture level just below saturation.

Fertilizer rate details

All haskaps were fertilized beginning July 17 using Plantprod 20-20-20 soluble fertilizer with micronutrients through the irrigation lines. The guaranteed minimum analysis of the fertilizer used is provided in Table 3. The 1X rate of soluble fertilizer used is equivalent to 40 g/plant. The fertilizer was applied in split applications that are described in Table 4. During fertilizer applications 3.2 kg of 20-20-20 was dissolved into a 5-gallon pail and used to irrigate each row. No granular or foliar fertilizer was added in year 1. Adjustments were made to the total fertilizer applied in year 1. All treatments received at least a 2X rate (80 g/plant). The 4X, 6X and 7X fertigation specific treatments received 3X, 3.5X and 4X respectively.

Table 3. Minimum analysis of nutrients of nutrients used in fertilizer.

Nutrient	**Minimum analysis %**
Total N	20
Phosphoric acid (P_2O_5)	20
Soluble potash (K_2O)	20
Boron (B)	0.02
Chelated copper (Cu)	0.05
Chelated iron (Fe)	0.1
Chelated manganese (Mn)	0.05
Molybdenum (Mo)	0.0005
Chelated zinc (Zn)	0.05

Table 4. Description of the application timing and rates of fertilizer used for all haskap treatments in 2019, the establishment year of the trial.

Treatments	**1st years application timing**	**Total fertilizer in Year 1**
All mulch (rows 1-5 and 16)	1x rate July 16th and July 26th	2x rate = 80 g/plant
All irrigation (rows 11-15)	1x rate July 16th and July 26th	2x rate = 80 g/plant
2 X annum (row 6)	1x rate July 16th and July 26th	2x rate = 80 g/plant
3 X annum (row 7)	1x rate July 16th and July 26th	2x rate = 80 g/plant
4X + Foliar (row 8)	1x rate July 16th, July 26th, and Aug. 15th	3x rate = 120 g/plant
6X + Foliar (row 9)	1x rate July 16th, July 26th, and Aug. 15th, and 0.5x rate on Aug. 19th.	3.5x rate = 140 g/plant
7X + Foliar (row 10)	1x rate July 16th, July 26th, and Aug. 15th, and 0.5x rate on Aug. 19th and Sept. 3.	4x rate = 160 g/plant

Crop Protection

Due to the lack of in-season foliar herbicide options for haskaps, weeds were controlled mechanically by mowing, whipper snipping and hand pulling. The control treatment was excessively weedy. Spot treatments of glyphosate were applied August 26 with a weed wiper to attempt to reduce problem weeds in the control treatment. Bravo fungicide was applied at a rate of 6L/ha using a hand held boom on August 29th to control mildew. No other crop protection products were applied.

10. Observations and Results:

Weather

Similar to 2018, the spring and summer of 2019 was relatively dry (Table 4). CLC and producers in the area struggled with poor crop emergence due to dry soil conditions. Dry conditions during soil preparation resulted in a clumpier than desired seed bed. Fortunately, immediately following haskap planting (June 10-13, 2019), the CLC received 17.6 mm of precipitation over June 14-15th and an additional 17.4 mm on June 22. The remainder of the growing season was very dry and haskaps were irrigated regularly. Tensiometer readings at 12" soil depth indicated that irrigation was maintaining soil moisture conditions below 20 kpa (appendix). The first frost did not occur until September 27th (-0.5°C), and the first hard frost occurred on October 9th (-7.2°C). September had a higher than average precipitation and October was colder than average (Table 4). Growing degree days were lower than average in 2019 at the CLC.

Table 4. Weather conditions over the 2019 growing season at the Conservation Learning Centre.

	May	**June**	**July**	**August**	**September**	**October**	**Average/Total**
	--- Temperature (°C) ---						
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) ---						
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
	--- Growing Degree Days (base 5°C) ---						
2019	164.7	322.7	383.5	314.1	207.3	13.1	1405.4
2012-2018	211.1	332.7	419.0	381.6	203.2	38.2	1585.9

Pests

The interrow forage mixture had good establishment, but since this is the year of establishment of the forages, weed species were also present. These pathways were mowed to help control the weeds. Plastic mulch helped suppress weeds, however a gap existed between the seeded forages and the plastic mulch that allowed for weed growth. These edges that were not reached by the mower were clipped with a whipper snipper. Weeds that emerged from the holes in the mulch were hand weeded. The wood mulches were not as successful at reducing weed pressure as the plastic mulch. This is largely a result of the later application of the mulch, which allowed for weeds to become established before being covered. Weeds were then able to grow through the wood mulch. Ensuring the wood mulch is applied thicker and wider would help with weed control. The wood shaving mulch also needed to be replaced due to losses associated with the wind. There has been some damage to the thinner black plastic mulch that has been used on most treatments. In some locations the wind had ripped the mulch, which has been repaired as best as possible by recovering with soil. There are many deer, coyote and even moose tracks punched into the plastic mulch. The landscape fabric that is made of a stronger material has no damage. Some animal browsing of new growth was noticed on some haskap plants and will be monitored in the future.

Haskap observations

Three varieties including Blue Diamond, Evie, and Rebecca had 100% survivability over the course of the 2019 growing season (Table 5). Honeybee had the lowest survivability. The use of plastic mulches had better survivability and the control treatment had the poorest survivability of 77.5%, likely due to the greater weed pressure (Table 6). Boreal Beast had the highest mean height of almost 40 cm, while Tundra was ranked the shortest at 25 cm. The treatment that received the greatest irrigation had the highest mean height, while the control treatment had the lowest. However, growth measurements were quite variable amongst reps, which is likely a result of sporadic top loss by wildlife foraging, uneven diseases susceptibility and uneven condition (from supplier) at time of planting. Mildew was present across all treatments and varieties of haskaps (Table 5 and 6). Severity was lowest with Kawai and Sveta varieties. The control treatment had the highest severity of mildew.

Table 5. Year of establishment mean height, survivability, and mildew disease on various varieties of haskaps in 2019 near Prince Albert, SK.

Variety	Survivability	Plant height	Disease	
	%	Cm	Plants affected %	Severity rank (0-5)
Aurora	90.6	31.8	76.6	2.6
Blue banana	82.8	32.4	57.8	1.6
Blue diamond	100.0	31.4	95.3	3.1
Blue Jewel	98.4	34.5	71.9	1.4
Blue moose	84.4	34.3	64.1	2.1
Blue treasure	98.4	31.8	67.2	1.7
Boreal beast	95.3	39.7	73.4	1.6
Boreal beauty	90.6	37.0	48.4	1.1
Boreal blizzard	95.3	33.4	71.9	1.6
Evie	100.0	30.9	62.5	1.3
Happy giant	87.5	27.0	90.0	2.7
Honeybee	60.0	27.6	36.7	1.4
Indigo gem	98.4	33.3	64.1	1.3
Indigo treat	84.4	30.2	57.8	2.7
Indigo yum	95.3	31.6	75.0	1.9
Kawai	96.9	37.5	54.7	0.9
Larissa	89.1	35.5	81.3	2.1
Rebecca	100.0	34.0	93.8	2.7
Sveta	93.8	37.3	48.4	0.8
Tundra	91.7	25.1	67.9	2.5

Table 6. Year of establishment mean height, survivability, and mildew disease on 20 haskap varieties under different agronomic management practices in 2019 near Prince Albert, SK.

Treatment		Survivability	Height	Disease	
		%	cm	Plants affected %	Severity rank (0-5)
Mulch	Black plastic mulch	97.5	33.6	35.0	1.1
Mulch	White plastic mulch	95.0	27.0	51.3	1.8
Mulch	Wood chip mulch	88.8	25.1	70.0	1.8
Mulch	Landscape fabric mulch	90.0	31.9	63.8	1.9
Control	Control	77.5	24.5	77.8	2.6
Fertility	2X Fertilizer	100.0	29.7	54.2	1.8
Fertility	2X Fertilizer	92.5	32.4	85.0	1.8
Fertility	3X Fertilizer	88.8	32.8	46.3	2.3
Fertility	3.5X Fertilizer	95.0	35.7	65.0	1.5
Fertility	4X Fertilizer	87.5	38.7	47.5	1.9
Irrigation	1 dripline 2x/wk	90.0	32.3	80.0	1.8
Irrigation	1 dripline 3x/wk	97.5	34.9	90.0	2.1
Irrigation	2 dripline 2x/wk	95.0	37.6	81.3	1.7
Irrigation	2 dripline 3x/wk	91.3	40.6	77.5	2.1
Irrigation	Tensiometer	93.8	37.1	81.3	1.8
Mulch	Wood shaving mulch	88.8	31.7	81.3	2.2

11. Summary:

The focus for Year 1 of the haskap agronomy trial was to successfully establish the haskap orchard. The fertility and irrigation treatments were initiated later in the season in 2019 than originally planned, and some fertility treatments such a granular fertilizer and foliar applications were not applied in year 1. An additional wood mulch treatment was added and replaced the originally proposed raised bed treatment. Approximately 50 people attended the July 2019 Field Day at the CLC, where the haskap trial was featured during the tour. The recorded survivability of haskap plants indicates good establishment leading into the winter. Some varieties have been observed to have more vigorous growth than others and varieties like Blue Diamond, Evie, and Rebecca appear to have established the best in year 1. Year 2 (2020) will be exciting to observe which varieties have the best winter hardiness and growth through the growing season, since plants are currently still small. Original proposed fertility and agronomic treatments will be initiated earlier in season.

12.Acknowledgements:

The Conservation Learning Centre graciously acknowledged the Ministry's support through signage directly in field with the project, verbally during the Field Day and on the Field Day agenda handed out to all visitors. The CLC is very thankful for volunteers who came out to help plant the haskaps by hand including regional Ministry of Agriculture and Saskatchewan Forestry Association employees, and other individuals.

13. Finances:

A detail expenditure statement will be supplied in an excel document. Currently the CLC is under budget of $3,402. The bird netting coverage with supports listed in the project budget for year 1 still needs to be purchased.

Appendix

A 1. Haskap trial tensiometer readings from the 2019 growing season at the CLC, near Prince Albert Saskatchewan.

Date	Tensiometer row 12" (kpa)	Tensiometer row 24" (kpa)	Mid Orchard 12" (kpa)
29-Jul	28	16	14
30-Jul	28	21	11
31-Jul	28	20	12
01-Aug	28	21	13
02-Aug	28	21	13
06-Aug	32	24	16
07-Aug	32	22	13
08-Aug	36	23	14
09-Aug	39	25	13
12-Aug	46	26	16
13-Aug	50	23	14
14-Aug	46	26	14
15-Aug	44	26	16
16-Aug	40	28	14
19-Aug	43	28	16
20-Aug	48	28	15
21-Aug	51	30	16
22-Aug	53	29	18
23-Aug	22	31	14
26-Aug	27	30	16
27-Aug	30	30	12
28-Aug	32	30	13
30-Aug	34	30	11
03-Sep	19	29	12
04-Sep	20	25	12
05-Sep	22	26	12
06-Sep	24	24	10
09-Sep	28	26	13

A 2. Planting of haskaps and installation of irrigation emitters.

A 3. Volunteers and staff planting haskaps and installing emitters.

A 4. Photo of early weed control offered by mulches. The red wood mulch was not as successful as the plastic mulches as seen in the background. It is also possible to see the establishment of the forage in between the mulch rows.

A 5. July 2019 Field Day tour.

A 6. The control treatment was very weedy. Staff needed to hand weed in order to determine the location of the haskap plants prior to mowing and spot treatment by weed wiping with glyphosate.