Project Identification

1. **Project Title:** Haskap Agronomy and Cultivar 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 (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 the production of Haskap in Saskatchewan, including irrigation, fertilization, and mulch covers.

8. Project Rationale:

In recent years, the production of Haskaps has been the most rapidly expanding component of the fruit industry. The Haskap *(Lonicera caerulea)* is a circumpolar species native to northern boreal forests in Asia, Europe, and North America (Bors n.d.). Haskaps have been utilized on the Japanese island of Hokkaido for hundreds of years. While Haskap breeding programs were established throughout the former Soviet Union in the 1950s. In the 1990s, Dr. Maxine Thompson and Jim Gilbert from the University of Oregon started their breeding program (Bors n.d.). The University of Oregon has produced Haskap cultivars that are now well-established industry cultivars. The University of Saskatchewan planted its first four Haskap cultivars in 1998. Currently, the U of S has the world's largest haskap breeding program and one of the most diverse germplasm collections (Bors et al., 2011). The Saskatchewan breeding program has focused on the hybridization of plants, bringing together the best traits from around the world to produce fast-growing, large plants, with large fruit (Bors et al., 2011). The U of S has been working towards producing Haskaps adapted for mechanical harvesting, while still maintaining a mid to late-season maturity and great-tasting berries (Kostuik et al. 2015).

Haskaps are a cool-season fruiting shrub, and berries can be produced mid to late June; they are one of the earliest fruiting berry plants. Haskaps tolerate spring frosts very well. Open Haskap flowers have been observed in temperatures down to -7^0C without damage (Bors, n.d.). Haskaps are extremely hardy and well-suited for the Canadian climate. They are also very versatile plants and can be grown successfully on slightly acidic to slightly alkaline soils (Halifax Seed Company Inc., n.d.).

Vitalaberry Farms is a cooperative venture made up of 12 Western Canadian farmers who produce Haskaps and sell what they grow as finished products (Risom, 2020). In 2018, Vitalaberry Farms estimated there were around 350 Haskap acres in western Canada with growth in the next few years projected to reach 750 acres (Alde, 2018). There is estimated to be well over 500 Haskap acres in Western Canada presently. Haskaps are considered a superfood because they contain high levels of vitamin C, vitamin A, flavonoids, and polyphenols (Risom, 2020). The Vitalaberry Farms partnered with the Alberta Food Development Centre to develop new Haskap products for the Canadian Foodservice Industry (Alde, 2018). The corporation also announced a partnership with Gordon Food Service to distribute 3 new innovative food products to western Canadian markets (Alde, 2018). Haskaps have the potential to become a major fruit export for Saskatchewan producers.

However, the agronomics of the crop have been poorly defined. The Haskap is more closely related to potatoes and tomatoes than other fruit crops such as blueberries, or currants (Bors, n.d.). Fertilizer and irrigation rates have not been well studied in Haskaps; neither have

insecticide or herbicide applications. With more farmers looking to produce the fruit, there is a growing need for better-defined Haskap agronomics. Haskaps are a high-value crop that receives increased value in added processing. Further studies on Haskaps in Western Canada will benefit producers. Haskaps have a strong appeal to local and export markets and therefore fit the province's growth strategy very well.

References

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9. Methodology:

Experimental design:

2021 was year 3 of the 4-year haskap agronomy project. Three blocks were planted in 2019: mulch treatment, fertilizer treatment, and irrigation treatment. Twenty cultivars were chosen, and four plants of each cultivar were planted per row, resulting in each row having 80 plants. Haskap cultivars were randomized within the block in subgroups that have overlapping cross-pollination and blossom windows. Plants were spaced 1 meter apart within the row; with treatment rows being spaced 4 meters apart. A complete list of treatment blocks (Table 1) and cultivars used in the trial (Table 2) may be found below.

Table 1. Mulch, fertilizer, and irrigation treatments used in the haskap agronomy project

Treatment Block	Trial Row	Treatment
Mulch	1	Black Plastic
	2	White Plastic
	3	Red Mulch
	4	Landscape Fabric
	5	Control
Fertilizer	6	2x Granular Fertilizer
	7	3x Granular Fertilizer
	8	4x Fertigation
	9	6x Fertigation
	10	7x Fertigation
Irrigation	11	1 dripline 2x/week
	12	1 dripline 3x/week
	13	2 driplines 2x/week
	14	2 driplines 3x/week
	15	Tensiometer
		(2 driplines ?x/week)
Mulch	16	Natural Mulch

Table 2. Haskap cultivars evaluated in the trial

Cultivar Subgroup	Cultivar #	Cultivar
U of S	1	'Honeybee'
	2	'Tundra'
	3	'Blue Treasure'
	4	'Indigo Treat'
	5	'Indigo Yum'
	6	'Indigo Gem'
	7	'Aurora'
	8	'Boreal Beast'
	9	'Boreal Beauty'
	10	'Boreal Blizzard'
Russian	11	'Blue Banana'
	12	'Happy Giant'
	13	'Blue Diamond'
	14	'Blue Jewel'
	15	'Blue Moose'
Polish	16	'Evie'
	17	'Larissa'
	18	'Rebecca'
	19	'Sveta'
Oregon X	20	'Kawai'

Table 3. Additional information for the haskap agronomy trial.

Legal Land Location:	SE-20-46-26-W2 RM 461
Coordinates of Corners:	N53°01.448' W105°45.795'
	N53°01.498' W105°45.783'
	N53°01.453' W105°45.835'
	N53°01.503' W105°45.821'
Soil Zone and Texture:	Black Clay loam

The "Mulch Treatment" block is testing black plastic, white plastic, sierra redwood chip, and landscape fabric against a control treatment (where weeds were controlled using mechanical weed control methods such as mowing and hand-weeding, and herbicides including dichlobenil, trifluralin, Fluazifop-P-butyl, Sethoxydim, paraquat, et cetera). The same benchmark fertilizer and irrigation rates were applied to all treatments in this block (soil tests determined specific fertilizer and irrigation rates). An additional natural wood chip mulch treatment was added to replace the raised bed treatment.

The second "Fertilizer Treatment" block will evaluate the effect of fertilizer rates. Haskap cultivars were randomized in the same way as the "Mulch Treatment" and the fertilizer was 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 the first application, and a total of 78 g/plant after the second application). The minimum is expressed as "2x", and the "3x" treatment included an additional application for a total of 78g of fertilizer applied before leaf senescence in late summer. Three other treatments were tested in which water-soluble 20-20-20 + micronutrient (Plant-Prod) fertilizer was applied via drip irrigation at a rough equivalence of 40g/plant per treatment application. The lowest-rate fertigation treatment will occur 4x, whereas higher rates will be 6x and 7x the fertilizer applications at 40/g per plant rate. Haskaps are shallow-rooted, and some research has suggested they benefit from more frequent low-level fertilizer applications.

The third "Irrigation Treatment" block started with lower irrigation rates as the plants are young and will increase as the plants grow through the four-year project lifespan. Irrigation need is partially soil and climate-dependent. Still, it is anticipated the plants 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 saw 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 rained and the soil was already near saturation, no irrigation occurred at that time). The second treatment used one drip line and ran at a lower rate (length of time of application and lower tensiometer reading) 3x per week. These drip lines deliver water directly to the center of the plant's crown. The third treatment used 2 drip lines (at the same rate as the 2x single drip line treatment) so that delivery of water was more spread out. In this way, the shallow spreading haskap roots may be better served via more widespread water availability. The fourth treatment did 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 irrigation block's final treatment relied on 2 drip lines applying water to a level below saturation, set by the tensiometer readings. 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, measurements of growth, yield, labour demand, and fruit quality were recorded and analyzed. Winter-hardiness and genotype-by-environment parameters were also measured (like blossom and harvest windows, and winter-kill). Soil quality parameters have been tested throughout the project's lifespan. Growth characteristics of each plant were recorded in late summer. Plant growth was described as either horizontal (prostrate) or vertical. Plant fullness was recorded as either bushy or leggy/spindly. Vigour was rated on a scale of 0-5, with 0=dead and 5=most vigorous. For flowering observations, a plant could either be flowering or not flowering. Similarly, for berry observations, a plant could either have berries or not have berries. For the haskap harvests, staff worked their way down treatment rows collecting berries from each plant in each cultivar. Plastic bags were labeled with treatment row and cultivar name (ex. Row 16, Natural Mulch, 'Honeybee'). All berries were collected from the plants regardless of their colour or marketability. For ease of collection, berries were picked from each haskap plant and put into individual bags. The bags for each cultivar were then combined (ex. If all four 'Honeybee' Haskaps in Row 16 produced berries, then there would be four individual plastic bags that would need to be combined to calculate the total yield for the 'Honeybee' cultivar in that particular treatment). The combined berries were then sorted into marketable and unmarketable categories, and weighed. Ripe and firm berries were categorized as marketable; while mushy, green, and dried berries were unmarketable. Any stems or leaves were removed before weighing. The total weight of berries produced was calculated by adding the unmarketable and marketable weights. On July 6, stress ratings were recorded for all plants within each treatment row. Stress ratings were rated on a scale from 0-10. With a 0-rating meaning that there was no stress in the plant and 10 equating to 100% of the plant being affected from stress. Dormancy observations began on the week of September 21. When cultivars started to show leaf yellowing, the plant was marked down as beginning dormancy. Some cultivars did not have any yellowing, they simply dropped leaves. For plants that dropped leaves without yellowing, the beginning of dormancy was marked down on the day that there was significant leaf loss. Plant heights were recorded in the fall of 2021 by measuring each Haskap in each treatment row to the nearest centimeter. Disease pressure was extremely low in 2021 and was not recorded.

Haskaps were scouted periodically throughout the growing season to monitor survival, disease, and flowering. Berries were harvested for the first time from July 7 to July 9, 2021. A second harvest started on August 9 and was completed on August 12, 2021. Soil samples were taken from all treatments in the fertilizer block on September 27th, 2021. Samples were collected from the base of several Haskaps from each of the fertilizer treatment rows. A full list of data collection, weeding, and fertilizer applications by date can be found in Table 3 below.

Numerical data was analyzed by Statistix 10. Data was determined to not meet the assumptions for ANOVA and nonparametric data was analyzed using Kruskal Wallis test. Pair wise comparisons were made at the $p<0.05$, unless otherwise stated, using the Dunn test.

Table 3. Schedule of data collection, weeding, and fertilizer applications in year 3 of the haskap agronomy trial.

Date	Data Collection/Weeding/Fertilizer Applications
May 17, 2021 - May 18, 2021	Fertigation in all treatments
May 25, 2021	Flowering and survival observations, vigor ratings.
May 26, 2021	Granular fertilizer applied to 2x and 3x fertilizer treatments
June 3, 2021	Weeding in rows 1 to 7
June 4, 2021	Weeding in rows 7 to 10
June 8, 2021	Flowering, berry, and vigor ratings.
June 9, 2021	Weeding in rows 10 to 16
June 14, 2021	Fertigation in rows 1 to 12
June 15, 2021 - June 16, 2021	Fertigation started and had to be paused due to issues with the fertigation pump
June 17, 2021	Mulch was spread in row 3
June 21, 2021	Granular fertilizer applied to 2x and 3x fertilizer treatments. Weed whacking in all treatments
June 22, 2021	Haskap disease observations were recorded. The remainder of the mulch was spread in row 3
June 24, 2021	Untreated natural wood mulch was spread on row 16
June 29, 2021 - June 30, 2021	Fertigation was resumed and completed
July 7, 2021 - July 9, 2021	Berry harvest and data collection
July 20, 2021	Fertigation in the 4x, 6x, 7x, and all mulch treatments
July 27, 2021	Fertigation in the 6x and 7x fertilizer treatments
August 3, 2021	Flowering, berry, and vigor ratings started. Fertigation in the 6x and 7x treatments
August 4, 2021	Flowering, berry, and vigour ratings completed
August 9, 2021	Berry harvest started
August 10, 2021	Fertigation in the 4x, 6x, and 7x treatments. Berry harvest continued
August 11, 2021	Berry harvest continued
August 12, 2021	Berry harvest completed and data recorded
August 16, 2021	Granular fertilizer applied to 3x treatment
August 19, 2021	Fertigation in the 4x and 7x treatment
August 23, 2021	Fertigation in 6x treatment
August 24, 2021 - August 31, 2021	Fertigation in all treatments, and additional application in 7x treatment
September 20, 2021	Irrigation stopped to promote winter dormancy
September 21, 2021	Growth characteristics and plant heights recorded
Began on September 21, 2021 – October 12, 2021	Date of leaf loss recorded

Year 3 (2021):

Irrigation Block Details

Irrigation began on May 25 after there was no longer a risk of freezing overnight temperatures. Treatments with single driplines were irrigated two at a time for 1 hour. Treatments with double lines were irrigated one at a time for 30 minutes. When single lines were irrigated alone, they were also irrigated for 30 minutes. The mulch and fertilizer treatments, as well as the 2x irrigation treatments, were irrigated on Tuesday and Thursday each week. The 3x irrigation treatments were watered additionally on Friday each week. Irrigation was stopped on September 20, to promote winter dormancy.

Row 11 (1 drip line 2x/week) was irrigated on Tuesdays and Thursdays for a total of 60 minutes/week. Row 12 (1 drip line 3x/week) saw irrigation on Tuesdays, Thursdays, and Fridays for a total of 90 minutes/week. Irrigation in row 13 (2 drip lines 2x/week) occurred on Tuesdays and Thursdays for a total of 60 minutes/week. Row 14 (2 drip lines 3x/week) received irrigation on Tuesdays, Thursdays, and Fridays for a total of 90 minutes/week. In 2021, the haskaps were under irrigation for a total of 19 weeks (from May 25 to September 20). Rows 11 and 13 were irrigated for a total of 1140 minutes; while rows 12 and 14 were irrigated for a total of 1440 minutes throughout the 2021 season. Row 15 (tensiometer-2 driplines ?x/week) was irrigated when the tensiometer was found to be measuring at about 50 kpa (kilopascals). Tensiometer readings of 20-40kpa indicated that there was available water and aeration for plant growth. In row 15, tensiometer readings of greater than 50kpa sometimes occurred multiple times in a week, leading to multiple rounds of irrigation. When the soil was well-saturated, row 15 did not receive any irrigation. During the 2021 growing season, row 15 was irrigated for a total of 1126 minutes.

Early in May, tensiometers and moisture meters were installed throughout the haskap trial. A 12-inch tensiometer and moisture meter were installed halfway down row 9. In row 12, a 12-inch and a 24-inch tensiometer were put in alongside a 12-inch and 24-inch moisture meter. Row 15 had a 12-inch tensiometer and moisture meter as well. Most moisture meter and tensiometer readings were taken in the early morning before irrigation or fertigation occurred.

Fertilizer Block Details

Protocol states that all treatments are to be given Plant Prod 20-20-20 liquid fertilizer by way of fertigation at a rate of 40g/plant. Each plant is to receive a minimum of 80g of Plant Prod during two rounds of fertigation throughout the season.

During an August inventory of the haskap fertilizer, it was determined that due to the issues with the fertigation pump and water pressure, the rate of Plant Prod applied to the haskaps did not meet the protocol requirements. At the beginning of the season, there was about 82.5 kg of Plant Prod 20-20-20 in the CLC's shop. In July, the CLC purchased an additional 75 kg of Plant Prod, in total, the CLC had 157.5 kg of haskap fertilizer. The total requirement for Plant Prod use in the trial was 137.6 kg. However, from May to August only 82.5 kg of liquid fertilizer was applied to the trial. It was determined that another 55.1 kg of Plant Prod needed to be applied to the haskaps (137.6 kg–82.5 kg=55.1 kg). All treatments received an additional round of fertigation from August 24 to August 31. This third round of fertigation used up 51.2 kg of fertilizer. The 7x

fertigation treatment also required an additional application of 3.2 kg of Plant Prod. The CLC should have used 137.6 kg of Plant Prod in the 2021 season, however, 136.9 kg of fertilizer was applied to the trial. The difference in fertilizer applications equated to an excess of 0.7 kg of plant prod not used in 2021 (137.6 kg-136.9 kg=0.7 kg). In 2021, each individual haskap received an estimated 78.17g of fertilizer, instead of 80g of fertilizer. Each Haskap in the trial missed out on an estimated 1.83 g of Plant Prod.

The first round of fertigation began on May 17 and was completed on May 18. The second round began on June 14. On June 15, the second round of fertigation was stopped as the Dema Mix-Rite fertigation pump would not produce any suction. This lack of suction led to the decreased intake of liquid Plant Prod. A replacement check-value and seal kit were ordered on June 16, and the CLC received the parts on June 23. However, the wrong-sized check-valve was sent to the CLC. On June 29, the correct check-value came in. The pump was taken apart and the issue was determined to be with the check-value. The seal that sat upon the small piston in the valve was not sealing. The new check-value was put on to the pump and plumbing grease was applied to all seals. Within the main chamber of the pump, a large black piston was also found to be seized. The application of grease allowed staff to un-seize the large piston and the pump was re-installed on June 29. The second round of fertigation was resumed on June 29, and was completed by June 30.

The Dema Mix-Rite fertigation pump is powered by water pressure and flow. For one Haskap row to receive an application of Plant Prod 20-20-20 it should have taken about an hour. However, some applications took well over 3 hours to distribute, due to low suction and slow pump movements. Throughout the season there were continued issues with the fertigation pump.

Due to these issues with the pump, the 4x, 6x, and 7x fertigation treatments were fertilized at half rates. This issue was caught and the treatments were fertilized again with half rates to correct this mistake. Despite issues with the fertigation pump, the 4x, 6x, and 7x treatments received the correct fertilizer applications in 2021. The 4x fertigation treatment received fertilizer on July 20, August 10, and August 19. The 6x fertigation treatment was fertilized on July 20, July 27, August 3, August 10, and August 23. The 7x fertigation treatment saw applications on July 20, July 27, August 3, August 10, August 19, and August 31.

There were no issues with the applications of granular fertilizer. For the applications, the black plastic coverings were cut near the crown of the plant and the granular fertilizer was spread around the base of the Haskaps. On May 26, the granular fertilizer treatments 2x and 3x were given 40g/plant of Tercio 25-10-10 granular fertilizer. The 3x granular fertilizer treatment received an additional 35 g/plant on August 16. In total, the 2x treatment received 40g of Tercio per plant, and the 3x row received a total of 75g of Terio per plant.

Mulch Block Details

At the beginning of May, large holes in rows 1 (black plastic) and 2 (white plastic) were patched with duct tape. Some holes re-opened throughout the season. In the third year of the trial, both

wood mulch treatments received new mulch to widen the row and add mulch to thin or missing portions due to deterioration/wind. On June 16, 20 bags of Sierra red mulch were spread in row 3. On June 22, 12 additional bags of red mulch were purchased and spread in row 3. The mulch was purchased for $4.78 (tax included) per bag. In total, 32 bags of Sierra redwood mulch were purchased in the 2021 season. In 2021, row 3 incurred the additional expense of $153.00 for the purchase of mulch (not including the labour to spread it). On June 24, natural wood mulch was spread on row 16. The cost of natural wood mulch was $50.00 for truck box full (not including the labour to spread it). In both rows 3 and 16, additional mulch was needed because of deterioration and carry-off due to wind. The control treatment was extensively hand-weeded throughout the growing season. The landscape fabric did not need any patching.

Crop Protection

Weeds were controlled mechanically throughout the growing season by mowing, whipper snipping, and hand pulling. In the fall of 2021, glyphosate was spot applied to perennial weeds throughout the trial by weed wiping.

Due to high lumber costs and the relatively low berry production anticipated in year 3, bird netting has yet to be purchased and installed. There were no observations or evidence of birds feeding on the haskap berries in 2021.

10. Observations and Results:

Weather

Spring and summer conditions at the CLC were hotter and drier compared to past years (Tables 4a and 4b). Temperatures in June, July, September, and October were all higher than the historical averages for the area (the historical average is calculated through data recorded from 2012 to 2020). The average temperature for the entire growing season was nearly 1˚C warmer than the long-term average. May, July, September, and October had less precipitation than the historical average. The recorded precipitation in July 2021 was only 8.6 mm; with the historical average of precipitation in July being 84.6 mm. July was also exceptionally hot, with 10 days above 30˚C. Precipitation in August was slightly higher than average. However, both September and October saw levels of precipitation lower than the historical averages. Overall, the precipitation in the 2021 growing season was 97.1 mm lower than the long-term average. Higher than average precipitation in June and August likely mitigated some drought-related losses. The first fall frost occurred on October 2 (-0.9˚C). The complete monthly weather summaries can be downloaded from src.sk.ca/download-weather-summaries.

Table 4a. Weather conditions in the 2021 growing season at the Saskatchewan Conservation Learning Centre from the onsite SRC weather station

	May	June	July	August	September	October	Average/Total
				--- Mean Temperature (°C) ---			
2021	10.1	18.3	20.3	17.0	13.5	4.9	14.0
2012-2020	11.4	15.9	18.5	17.1	11.4	2.9	12.9
				--- Precipitation (mm) ---			
2021	29.8	84.0	9.6	57.0	9.5	13.9	202.3
2012-2020	40.4	79.6	84.6	42.9	31.2	20.7	299.4

Overall, growing degree days were higher in 2021 than the historical average (Table 4b). Growing degree days in June, July, August, September, and October were higher than the historical average. Growing degree days were slightly lower in May 2021 than the historical average (calculated by average growing degree days from 2012-2020).

Table 4b. Growing Degree Days (base 5°C) in the 2021 season (GDD calculated through data collected at the onsite SRC weather station)

--- Growing Degree Days (base 5°C) ---							**Total Growing Degree Days (base 5°C)**
Year	**May**	**June**	**July**	**August**	**September**	**October**	
2021	168.9	398.6	473.8	370.9	255.2	55.3	1722.7
2020	143.7	252.4	391.0	342.9	178.8	38.6	1347.4
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

Soil Test Results

On September 27th Soil tests for each fertilizer treatment were collected and sent to Agvise Laboratories for analysis. Soil sample results can be found in Table 5a. Soil test results indicated that Nitrogen levels were high in all treatments. The Phosphorus level in treatment 2x granular was very low. In the 3x granular, and 7x fertigation treatments the Phosphorus levels were low. Phosphorus was high in the 4x and 6x fertigation treatments. Results showed all treatments had high levels of Potassium. Sulfur levels in treatment 2x granular and 6x fertigation were low. The percentage of organic matter in the 3x granular and 4x fertigation treatments was lower than the other fertilizer treatments. Salinity is not a concern as salts are low across all treatments.

Table 5a. September 27, 2021 basic soil test results

Treatment	Depth (cm)	N (lb/ac)	P (ppm)	K (ppm)	S (lb/ac)	Zn (ppm)	OM (%)	pH	Salts (mmho/cm)
Granular 2x	*0 – 15*	30	4	182	12	1.37	5.2	5.6	0.23
	15 – 30	47			16			5.8	0.28
Granular 3x	*0 – 15*	47	5	199	18	1.04	4.4	5.6	0.29
	15 – 30	51			16			6.1	0.31
Fertigation 4x	*0 – 15*	32	15	229	20	1.18	4.6	5.8	0.23
	15 – 30	58			22			6.5	0.45
Fertigation 6x	*0 – 15*	33	26	299	8	1.44	4.8	5.9	0.27
	15 – 30	47			10			7.1	0.58
Fertigation 7x	*0 – 15*	26	8	219	14	1.23	5	6.0	0.19
	15 – 30	35			20			7.4	0.33

The mineral analysis results can be found in table 5b. Chloride, boron, copper and sodium was very low to low in all treatments. Iron, manganese, magnesium and calcium levels were high in all treatments. Cation Exchange Capacity was fairly similar across treatments being lowest in the 3x granular treatment and highest in the 7x fertigation treatment (table 5c).

Table 5b. September 27, 2021 soil test mineral analysis results at 0-15 cm depth.

Treatment	Cl (lb/ac)	B (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Mg (ppm)	Ca (ppm)	Na (ppm)
Granular 2x	9	0.4	72.7	11.1	0.45	400	2418	14
Granular 3x	11	0.4	60.9	8.9	0.44	436	2365	15
Fertigation 4x	11	0.5	60.6	9.8	0.47	388	2367	17
Fertigation 6x	7	0.5	58.8	11.2	0.46	387	2595	14
Fertigation 7x	8	0.4	56.8	8.2	0.44	321	2540	14

Table 5c. September 27, 2021 soil test CEC and base saturation results at a 0-15 cm depth.

Treatment	**Cation Exchange Capacity** (meq)	**% Base Saturation**				
		% Ca	**% Mg**	**% K**	**% Na**	**% H**
Granular 2x	18.2	66.5	18.3	2.6	0.3	12.2
Granular 3x	17.1	69.0	21.2	3.0	0.4	6.5
Fertigation 4x	16.8	70.3	19.2	3.5	0.4	6.6
Fertigation 6x	17.4	74.5	18.5	4.4	0.3	2.3
Fertigation 7x	20.5	62.1	13.1	2.7	0.3	21.8
Typical Range		***65-75***	***15-20***	***1-7***	***0-5***	***0-5***

Pests

Weed growth was significant in the control treatment, along the sides of the mulches, and at the base of each plant. Additionally, deer, coyotes, and moose punched holes in the plastic mulch, resulting in even more holes that required weeding. Throughout the trial, an unknown insect laid eggs on some of the stems and leaves of the Haskaps. There was no observable damage to any of the plants. The eggs may have belonged to a beneficial wasp species. Photos of the eggs can be found in the appendix (A6). Weeds in the holes and around the plants were hand-weeded, and weeds along the sides of the mulch and in the control were whipper snipped or mowed where possible. Despite thickening and widening the mulch in the wood mulch treatments, weeds were still growing through the mulch and needed to be weeded or whipper snipped fairly frequently.

Stress Observations

On June 22, it was noted that some Haskap leaves were turning brown and branches were drooping Initially, there were concerns that this was a disease, but after discussions with the provincial fruit specialist and other haskap growers, it was determined this was likely stress due to excessively hot conditions. On July 6, data was collected on this Haskap stress. There were some cultivars of Haskap that were more affected by this unknown stress than others. 'Sveta', 'Kawai', 'Blue Banana', and 'Blue Treasure' showed to be the most affected; while 'Rebecca', 'Indigo Yum', 'Larissa', and 'Evie' showed the most tolerance. The stress did not appear to impact berry production. Photos of stress can be found in the appendix (A7, A8).

Vigour, Berry Production, Plant Height, Heat Stress and Dormancy

While there does not appear to be a treatment effect on plant vigor across all three dates ($p>0.05$), the mulch treatments were the only treatments that had vigour ratings of 4.0 and greater (Table 8). Both unripe and ripe berries were harvested from each plant and included in the berry harvest weights. Although there appear to be large differences in berry yields across treatments, these differences are likely not significant due to the large variability amongst cultivars. However, some differences between treatments exist for the August berry harvest ($p<0.0001$). The 2 drip 3x treatment was the only treatment that had no additional yield data for the second harvest. Although not statistically significant, the control, red and natural mulch were the total lowest yielding treatments. Landscape fabric, and treatments that received greater irrigation or liquid fertilizer yielded better than mulch treatments and granular fertilizer. Across all treatments and blocks, plant height was lowest in the control and in the natural mulch treatments (Table 8). Heat stress caused the least amount of damage with the black plastic treatment and the most for the tensiometer treatment ($p=0.043$). However, all rows closest to the woodlot appear to have slightly less damage. The 7x fertigation treatment went dormant 5 days earlier than the 2x granular treatment ($p<0.0001$). The mean range of dormancy across treatments was 264-269 Julian date a difference of 5 days.

Table 8. Summary of statistical analysis and means of main effects for haskap agronomy trial by treatment in 2021.

Row	Treatment	Vigour Rating			Berry Harvest†			Plant Height	Plants Affected by Heat Stress	Dormancy
		May 25	June 8	August 3	July 7	August 9	Total			
		0-5			g/4 plant set			Cm	%	Julian date
1	Black Plastic	3.8‡	4.0	4.2	33.7	1.5 ab	35.3	66 abc	3.0 b	265 def
2	White Plastic	3.9	4.0	4.1	25.3	1.9 a	27.1	68 ab	5.2 ab	265 ef
3	Red Mulch	4.0	4.2	4.0	19.2	3.1 a	22.3	67 ab	5.0 ab	266 cdef
4	Landscape Fabric	3.9	4.3	4.0	45.8	1.5 ab	47.3	70 ab	5.8 ab	267 abcde
5	Control	3.6	3.6	4.0	15.1	1.3 ab	16.4	56 bc	6.9 ab	266 bcdef
6	2x Granular Fert	3.8	4.2	3.8	40.9	1.6 a	42.5	67 ab	8.3 ab	264 f
7	3x Granular Fert	3.6	3.5	3.5	32.2	0.7 abc	32.9	62 abc	6.4 ab	266 abcd
8	4x Fertigation	3.7	3.7	3.4	53.2	2.8 a	55.9	69 ab	6.7 ab	266 abcd
9	6x Fertigation	3.7	3.8	3.4	44.5	3.3 a	47.8	65 abc	7.7 ab	268 ab
10	7x Fertigation	3.3	3.6	3.4	42.8	1.2 ab	44.0	65 abc	7.1 ab	269 a
11	1 drip 2x	3.5	3.9	3.4	40.2	1.5 ab	41.6	65 abc	6.4 ab	268 ab
12	1 drip 3x	3.7	3.6	3.4	44.3	3.2 a	47.5	65 abc	7.3 ab	266 abcd
13	2 drip 2x	3.2	3.7	3.3	62.0	2.5 a	64.5	62 abc	7.9 ab	267 abcd
14	2 drip 3x	3.9	3.8	3.1	50.1	0.0 c	50.1	66 abc	8.6 ab	267 abcd
15	Tensiometer	3.6	3.5	3.1	27.7	0.8 bc	28.6	60 abc	8.4 a	267 abc
16	Natural Mulch	3.5	3.5	3.1	20.1	0.6 abc	20.7	55 c	7.2 ab	266 abcd
	P value	**0.3578**	**0.0100§**	**0.5768**	**0.3785**	**<0.0001**	**0.3255**	**<0.0001**	**0.0430**	**<0.0001**

†Berry harvest data was collected as total weight for 4 plants/cultivar and includes individual plants that did not produce berries or were dead (n=20 cultivars)

‡Means with the same letter are not significantly different (P>0.05).

§Although p value indicates significance according to Kruskal-Wallis, Dunn pairwise comparisons did not detect a difference at p=0.05. Plants affected by stress Dunn pairwise comparison completed at p=0.1 level

Differences ($p<0.0001$) in vigour, berry production and plant height were greatly influence by haskap cultivar (Table 9). ‘Blue Moose’, ‘Blue Jewel’ and ‘Indigo Gem’ had the highest vigor ratings throughout the growing season. Although ‘Rebecca’ had low vigour initially in the season, the vigour improved over time. ‘Indigo Treat’ and ‘Larissa’ had ratings above 4 for the duration of the 2021 growing season, while ‘Honeybee’, ‘Blue Treasure’, ‘Boreal Beauty’, ‘Rebecca’ and ‘Kawai’i had ratings below 3 at some point of the growing season. Highest yielding haskap cultivars from the July harvest were ‘Boreal Beauty’, ‘Boreal Blizzard’ and ‘Kawai’i with 161.2, 132.1, and 141.4 g/plant respectively. The lowest yielding with less than 10g/plant were ‘Honeybee’, ‘Tundra’, ‘Indigo Yum’, ‘Blue Banana’, ‘Happy Giant’, ‘Blue Diamond’, ‘Blue Moose’, ‘Evie’ and ‘Larissa’. August yields were much lower than the first harvest, however some cultivars like ‘Aurora’, ‘Boreal Beast’ and ‘Sveta’, had second yields that were greater than poorer performing cultivars first harvest. ‘Boreal Beast’, ‘Aurora’ and ‘Sveta’ were the higher yielding cultivars during the second harvest and ‘Blue Banana’, ‘Happy Giant’, and ‘Evie’ were the lowest yielding. When dates were recorded for dormancy, it was noted that ‘Blue Treasure’ had lots of berries present on the plants into October that were not weighed or included in total yields. ‘Blue Jewel’ is the tallest haskap cultivar at 76 cm and ‘Rebecca’ is the shortest at 43 cm. ‘Sveta’ and ‘Kawai’ appear to be the most sensitive to heat throughout the 2021 growing season due to a higher percentage of leaf damage ($p<0.0001$). ‘Indigo Gem’, ‘Indigo Yum’ and ‘Rebecca’ had the lowest amount of damage due to heat. The range of dormancy was greater when analyzed by cultivar. Dormancy ranged between 265 – 273 Julian date, a difference of 8 days. The cultivar that had the third berry production in the same growing season, ‘Blue Treasure’, also had the latest date for dormancy.

Table 9. Summary of statistical analysis and means of main effects for haskap agronomy trial by cultivar in 2021.

Cultivar	Vigour Rating			Berry Harvest†			Plant Height	Plants Affected by Heat Stress	Dormancy
	May 25	June 8	August 3	July 7	August 9	Total			
	0-5			g/4 plant set			Cm	%	Julian date
'Honeybee'	2.7 cd‡	3.5 abc	2.9 abcd	7.7 def	0.7 abcd	8.4 fgh	61 abcdefg	6.8 abcd	265 ab
'Tundra'	3.3 abcd	3.3 c	3.1 abcd	2.9 ef	0.5 bcd	3.4 gh	53 gh	4.5 bcd	266 ab
'Blue Treasure'	2.9 bcd	2.8 c	3.4 abcd	19.5 bcdef	1.4 abcd	20.9 bcdefg	67 abcdef	10.2 abc	273 a
'Indigo Treat'	4.0 abc	4.4 ab	4.1 ab	12.9 cdef	1.3 abcd	14.2 defgh	70 abcde	4.9 bcd	266 ab
'Indigo Yum'	3.5 abcd	4.0 abc	3.8 abc	5.1 def	0.9 abcd	6.0 efgh	58 efgh	3.1 cd	265 b
'Indigo Gem'	4.1 ab	3.9 abc	4.2 a	23.8 abcde	2.4 abc	26.2 abcdefg	56 fgh	4.2 cd	266 ab
'Aurora'	3.6 abcd	3.6 bc	3.4 abcd	45.6 abc	4.0 ab	49.6 abcd	69 abcde	6.0 abcd	266 ab
'Boreal Beast'	3.7 abcd	3.3 c	3.1 abcd	35.4 abcd	4.6 a	40.0 abcde	75 ab	6.0 abcd	266 ab
'Boreal Beauty'	3.9 abcd	3.8 abc	2.8 cd	161.2 a	3.0 abc	164.2 a	71 abc	7.5 abc	267 ab
'Boreal Blizzard'	3.9 abcd	3.8 abc	3.1 bcd	132.1 a	2.9 abc	135.0 ab	68 abcde	6.0 abcd	268 ab
'Blue Banana'	3.6 abcd	3.8 abc	3.0 bcd	3.3 f	0.1 d	3.4 h	60 cdefgh	10.7 ab	266 ab
'Happy Giant'	3.5 abcd	3.7 abc	3.4 abcd	3.1 ef	0.1 d	3.2 gh	60 cdefgh	5.9 abcd	265 ab
'Blue Diamond'	3.9 abcd	3.8 abc	3.4 abcd	3.2 ef	0.5 bcd	3.7 gh	60 defgh	6.7 abcd	265 b
'Blue Jewel'	3.8 abcd	4.7 a	4.0 ab	12.8 bcdef	2.1 abcd	14.9 cdefgh	76 a	4.6 abcd	266 ab
'Blue Moose'	4.1 a	3.5 bc	3.5 abcd	6.8 ef	0.6 cd	7.4 gh	71 abcd	7.6 abc	265 b
'Evie'	3.8 abcd	3.9 abc	3.3 abcd	3.3 ef	0.2 bcd	3.5 gh	68 abcdef	4.2 bcd	266 ab
'Larissa'	4.1 ab	4.5 ab	4.0 ab	8.5 cdef	1.0 abcd	9.6 defgh	64 abcdefg	3.8 bcd	266 ab
'Rebecca'	2.9 d	3.9 abc	4.0 ab	43.8 abcd	1.2 abcd	45.0 abcdef	43 h	2.0 d	268 ab
'Sveta'	4.0 abc	4.1 abc	3.4 abcd	73.7 abc	3.9 a	77.6 abcd	71 abc	17.3 a	266 ab
'Kawai'	3.4 abcd	3.5 bc	2.7 d	141.4 ab	3.0 abc	144.5 abc	63 bcdefg	13.0 a	267 ab
P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

†Berry harvest data was collected as total weight for 4 plants/cultivar and includes individual plants that did not produce berries or were dead(n=16 treatments)

‡Means with the same letter are not significantly different (P>0.05).

Survivability

Counts of dead plants at the end of the growing season by treatment and the end of season % survival can be found in Table 10 below. A plant was described as dead during the survey when it was missing or completely brown and leafless. The number of dead plants occasionally decreased throughout the growing season when a dead-looking plant sprouted leaves or when a new shoot grew. There were no visible trends in the number of dead plants in each treatment throughout the growing season. End of season percent survival was high in all treatments. The % survival is consistent with 2020 results. There were decreases in haskaps of more than 1% in the natural mulch, 2x granular fertilizer and the control treatments.

Table 10. Percent survival and count of deceased plants by treatment.

Row	Treatment	Number of Dead Plants	End of Season % Survival	
		2021	2021	2020
1	Black Plastic	4	95	95
2	White Plastic	3	96	96
3	Red Mulch	6	93	93
4	Landscape Fabric	5	94	93
5	Control	7	91	93
6	2x Granular Fert	3	96	98
7	3x Granular Fert	6	93	93
8	4x Fertigation	8	90	91
9	6x Fertigation	6	93	93
10	7x Fertigation	8	90	91
11	1 drip 2x	7	91	91
12	1 drip 3x	2	98	98
13	2 drip 2x	3	96	96
14	2 drip 3x	4	95	95
15	Tensiometer	4	95	95
16	Natural Mulch	8	90	93
	Mean	5	93	94
	Std. Deviation	2	2	2

A summary of the number of dead plants of each cultivar of haskap, and the end of season percent survival, can be found in Table 11 below. ‘Honeybee’ had high mortality, with only 52% of the plants surviving at the end of the season. Percent survival was high for most other cultivars, though slightly lower at 84%, 86%, and 89% for ‘Blue Banana’, ‘Boreal Beauty’, and ‘Happy Giant’ respectively. Compared to 2020 survival rates, ‘Honeybee’, ‘Blue Treasure’ and ‘Indigo Treat’ were the only cultivars that experienced losses in 2021.

Table 11. Count of deceased plants and percent of survivability by cultivar.

Cultivar	Number of Dead Plants	End of Season % Survival	
		2021	2020
'Honeybee'	31	52	56
'Tundra'	1	98	98
'Blue Treasure'	1	98	100
'Indigo Treat'	1	98	100
'Indigo Yum'	2	97	97
'Indigo Gem'	0	100	100
'Aurora'	5	92	92
'Boreal Beast'	4	94	94
'Boreal Beauty'	9	86	86
'Boreal Blizzard'	1	98	98
'Blue Banana'	10	84	84
'Happy Giant'	7	89	89
'Blue Diamond'	1	98	98
'Blue Jewel'	0	100	100
'Blue Moose'	1	98	98
'Evie'	0	100	100
'Larissa'	6	91	91
'Rebecca'	0	100	100
'Sveta'	2	97	97
'Kawai'	2	97	97
Mean	4	93	94
Std. Deviation	7	11	10

Growth Characteristics

A summary of growth characteristics by treatment can be found in Table 12 below. The irrigation block appears to have a greater proportion of vertical plants compared to the mulch and fertilizer treatments. The fertilizer treatments appear to produce a greater proportion of leggy plants than the mulch and irrigation treatments. This high proportion of leggy plants in these treatments could indicate that greater available nutrients led to rapid, spindly growth.

Table 12. Proportion of plants displaying different growth characteristics by treatment.

Row	Treatment	% Horizontal	% Vertical	% Bushy	% Leggy
1	Black Plastic	26	74	86	14
2	White Plastic	21	79	81	19
3	Red Mulch	28	72	82	18
4	Landscape Fabric	21	79	76	24
5	Control	18	82	67	33
6	2x Granular Fert	23	77	75	25
7	3x Granular Fert	26	74	59	41
8	4x Fertigation	22	78	51	49
9	6x Fertigation	22	78	68	32
10	7x Fertigation	22	78	63	32
11	1 drip 2x	16	84	81	19
12	1 drip 3x	19	81	86	14
13	2 drip 2x	17	83	81	19
14	2 drip 3x	17	83	89	11
15	Tensiometer	17	83	84	16
16	Natural Mulch	18	82	78	22
	Mean	21	79	75	24
	Std. Deviation	4	4	10	10

A summary of growth characteristics by haskap cultivar can be found below in Table 13 and Figure A5 in appendix. ‘Rebecca’, ‘Indigo Yum’, ‘Indigo Gem’, and ‘Tundra’ all displayed primarily prostrate growth. ‘Larissa’ also had a high number of plants growing horizontally. ‘Blue Moose’ had the highest proportion of plants displaying leggy growth of all tested cultivars. Cultivars ‘Honeybee’, ‘Blue Treasure’, ‘Indigo Treat’, ‘Aurora’, ‘Boreal Beast’, ‘Boreal Beauty’, ‘Blue Banana’, ‘Happy Giant’, ‘Blue Diamond’, ‘Blue Jewel’, ‘Blue Moose’, and ‘Sveta’ all have 100% vertical growth. All cultivars but ‘Blue Moose’ and ‘Tundra’ have primarily bushy growth. ‘Blue Jewel’ was the only cultivar with 100% bushy plants.

Table 13. Proportion of plants displaying different growth characteristics by cultivar.

Row	Cultivar	% Horizontal	% Vertical	% Bushy	% Leggy
1	'Honeybee'	0	100	88	12
2	'Tundra'	75	25	41	59
3	'Blue Treasure'	0	100	81	19
4	'Indigo Treat'	0	100	94	6
5	'Indigo Yum'	87	13	63	37
6	'Indigo Gem'	81	19	95	5
7	'Aurora'	0	100	66	34
8	'Boreal Beast'	0	100	82	18
9	'Boreal Beauty'	0	100	87	13
10	'Boreal Blizzard'	3	97	81	19
11	'Blue Banana'	0	100	61	39
12	'Happy Giant'	0	100	75	25
13	'Blue Diamond'	0	100	59	41
14	'Blue Jewel'	0	100	100	0
15	'Blue Moose'	0	100	44	56
16	'Evie'	6	94	56	44
17	'Larissa'	47	53	97	3
18	'Rebecca'	98	2	84	16
19	'Sveta'	0	100	95	5
20	'Kawai'	2	98	68	32
	Mean	20	80	76	24
	Std. Deviation	34	34	17	17

Observations on presence of berries were made on June 8 and August 3, 2021 (Table 14). The June 8 date of collection is not representative of the percent of plants that produced berries for the first harvest date of July 7. June 8 observations indicated that within the mulch block, the Landscape Fabric had the greatest presence of plants with berries and the White Plastic treatment had the least. In the fertilizer block, the greatest plants with berries occurred in the 6x fertigation row; and the 2x and 3x granular treatments had the lowest percentage of plants with berries. In the irrigation block, the 2 drip 2x/week had berries on 100% of its plants. Higher rates of irrigation and fertilizer may be speeding up maturity/fruit production. However, the mulch block is closest to a wooded lot, which may be influencing these results, as the natural mulch located farthest from the woodlot had greater plants with berries than all other mulch treatments. The woodlot may be influencing results due to shading effects, or may even be offering shelter to birds that may have been feeding on the berries. Birds were not observed feeding on the haskap trial in 2021. The August 3 observations occurred close to the second harvest date of August 9 and therefore provide an estimate of the percentage of plants that produced berries recorded at harvest. Fewer plants produced an additional berry yield in August. The 6x fertigation treatment had the greatest percentage of plants with berries and 3x granular fertilizer and black plastic had the fewest plants with berries.

Table 14. The proportion of plants producing berries by treatment.

Row	Treatment	% Plants with berries	
		June 8	August 3
1	Black Plastic	40	22
2	White Plastic	30	29
3	Red Mulch	50	45
4	Landscape Fabric	80	39
5	Control	45	27
6	2x Granular Fert	75	43
7	3x Granular Fert	75	20
8	4x Fertigation	90	43
9	6x Fertigation	95	51
10	7x Fertigation	85	21
11	1 drip 2x	85	25
12	1 drip 3x	95	41
13	2 drip 2x	100	40
14	2 drip 3x	90	45
15	Tensiometer	95	41
16	Natural Mulch	85	33
	Mean	76	35
	Std. Deviation	21	10

The precent of plants by treatment with any presence of berries, regardless of ripeness, is described in Table 15. ‘Honeybee’ had the highest proportion of plants with berries and ‘Blue Treasure’ had the lowest on June 8. ‘Boreal Beauty’, ‘Boreal Blizzard’, and ‘Sveta’ had the highest proportion of plants with berries on August 3; and ‘Rebecca’ and ‘Evie’ had the lowest proportion of plants with berries.

Table 15. The proportion of plants producing berries by cultivar.

Row	Cultivar	% Plants with berries	
		June 8	Aug 3
1	'Honeybee'	33	42
2	'Tundra'	19	16
3	'Blue Treasure'	13	27
4	'Indigo Treat'	14	19
5	'Indigo Yum'	18	23
6	'Indigo Gem'	17	41
7	'Aurora'	27	58
8	'Boreal Beast'	27	52
9	'Boreal Beauty'	27	62
10	'Boreal Blizzard'	21	62
11	'Blue Banana'	17	35
12	'Happy Giant'	19	21
13	'Blue Diamond'	22	27
14	'Blue Jewel'	20	23
15	'Blue Moose'	19	32
16	'Evie'	20	11
17	'Larissa'	19	40
18	'Rebecca'	20	13
19	'Sveta'	16	60
20	'Kawai'	23	55
Mean		21	36
Std. Deviation		5	17

The date of plants beginning leaf loss or hardening off was recorded over a period of several weeks in the fall. A summary table of the proportion of plants beginning leaf loss by treatment is described in Table 16 and days to dormancy are summarized in Table 8. Overall, rows 1-5 of the mulch treatment block had leaf loss begin sooner than the other treatments. This again may be due to the proximity of the mulch block to the woodlot. Within the mulch block, the White Plastic treatment had greater plants beginning leaf loss on September 21. While the lowest proportion of leaf loss was in the Natural Mulch treatment. The 2x Granular treatment was the only Fertilizer block treatment to begin leaf loss on September 21. On September 23, 100% of plants in the 3x Granular treatment had begun leaf loss. On September 29, the 7x and 6x fertigation treatments has the highest proportion of plants showing leaf loss. In the Irrigation block, no treatments had any leaf loss beginning on September 21. On September 23, the 1 drip 3x/week treatment had 100% of plants showing some loss. The other irrigation treatments showed a slightly smaller proportion of plants with leaf loss on September 23. Overall, leaf loss peaked in all treatments on September 29, 2021.

Table 16. Date and proportion of plants beginning leaf loss/hardening off in 2021

Row	Treatment	% Leaf Loss				
		Sep. 21	Sep. 23	Sep. 29	Oct. 5	Oct. 12
1	Black Plastic	60	30	10	0	0
2	White Plastic	75	20	5	0	0
3	Red Mulch	55	35	5	0	5
4	Landscape Fabric	35	45	15	0	5
5	Control	42	47	5	0	5
6	2x Granular Fert	80	20	0	0	0
7	3x Granular Fert	0	100	0	0	0
8	4x Fertigation	0	95	5	0	0
9	6x Fertigation	0	70	25	5	0
10	7x Fertigation	0	63	32	5	0
11	1 drip 2x	0	80	15	5	0
12	1 drip 3x	0	100	0	0	0
13	2 drip 2x	0	95	0	5	0
14	2 drip 3x	0	95	0	5	0
15	Tensiometer	0	90	10	0	0
16	Natural Mulch	0	95	5	0	0
	Mean	22	68	8	2	1
	Std. Deviation	30	29	9	2	2

The proportion of plants beginning leaf loss by cultivar over several weeks is described in Table 17 and days to dormancy in Table 9. ‘Indigo Yum’, ‘Blue Banana’, ‘Blue Diamond’, and ‘Blue Moose’ had the highest proportion of plants beginning leaf loss on September 21. All cultivars except ‘Blue Treasure’ primarily had leaf loss begin on the week of September 23. The cultivar ‘Blue Treasure’ had 31% of leaf loss beginning on October 5 and 19% of plants beginning leaf loss on October 12.

Table 17. Proportion of plants beginning leaf loss/hardening off from September 22 – October 2, 2021 by cultivar of haskap.

Row	Cultivar	% Leaf Loss				
		Sep. 21	Sep. 23	Sep. 29	Oct. 5	Oct. 12
1	'Honeybee'	29	71	0	0	0
2	'Tundra'	25	63	13	0	0
3	'Blue Treasure'	13	38	0	31	19
4	'Indigo Treat'	25	75	0	0	0
5	'Indigo Yum'	38	63	0	0	0
6	'Indigo Gem'	19	75	6	0	0
7	'Aurora'	25	75	0	0	0
8	'Boreal Beast'	19	81	0	0	0
9	'Boreal Beauty'	0	81	19	0	0
10	'Boreal Blizzard'	0	69	31	0	0
11	'Blue Banana'	38	56	6	0	0
12	'Happy Giant'	31	69	0	0	0
13	'Blue Diamond'	38	63	0	0	0
14	'Blue Jewel'	13	81	6	0	0
15	'Blue Moose'	38	63	0	0	0
16	'Evie'	25	75	0	0	0
17	'Larissa'	19	69	13	0	0
18	'Rebecca'	13	50	38	0	0
19	'Sveta'	19	75	6	0	0
20	'Kawai'	13	63	25	0	0
	Mean	22	68	8	2	1
	Std. Deviation	11	11	11	7	4

11. Summary:

The 2021 growing season was exceptionally hot and dry. As a result, some haskap cultivars developed heat stress symptoms. 'Sveta' and 'Kawai'i appeared to be more sensitive to the heat and 'Indigo Gem', 'Indigo Yum' and 'Rebecca' the most tolerant. Haskap rows closest to the woodlot may have received some shelter leading to reduced heat damage. Haskap berry yields increased in 2021, and multiple harvests occurred. Wood mulch treatments and the control appear to be the lowest performing agronomic treatments and are the most labour intensive. In 2021, mulch was added to both wood mulch treatments. Additionally, the wood mulch treatments required more hand weeding and whipper snipping than the other treatments. The control was the most time-consuming to weed and often required extra weeding before any data collection to expose the plants. The landscape fabric treatment consistently required the least weeding throughout the growing season and has not required any repairs due to tears from the elements or wildlife.

Some varietal highlights are listed below:

- ‘Blue Moose’, ‘Blue Jewel’, and ‘Indigo Gem’ had the highest vigor ratings
- Highest yielding was ‘Boreal Beauty’, ‘Boreal Blizzard’, and ‘Kawai’i
- ‘Blue Treasure’ had the latest dormancy and produced berries three times throughout the 2021 growing season.
- ‘Indigo Yum’, ‘Blue Banana’, ‘Blue Diamond’, and ‘Blue Moose’ began dormancy the earliest
- ‘Blue Jewel’ is the tallest haskap cultivar at 76 cm and ‘Rebecca’ is the shortest at 43 cm
- ‘Honeybee’ has the highest mortality with 52% of the plants surviving
- Most haskap cultivars have 90% or higher survival after 3 years

As the project develops the opportunity to collect data has been increasing. Berry yields are anticipated to be much higher in 2022 and bird netting will need to be installed in early spring. Some additional and improved data collection plans for 2022 include better record keeping of windows of flowering, quality data collection of fruit (Brix, shape and size of berries) and harvest weight for individual plants.

The haskap agronomy trial was featured in a YouTube video as part of the CLC's Virtual Field Day in 2020. The video has since been viewed over 1200 times. This trial was featured again at the CLC's Annual Field Day in July of 2021, with approximately 36 people in attendance including local producers and commodity group representatives. Attendance was restricted due to COVID-19.

11. Acknowledgements:

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

12. Appendices:

Table A1. The proportion of flowering plants throughout the growing season by treatment.

Row	Treatment	Proportion of Plants Flowering (%)		
		May 25	June 8	August 3
1	Black Plastic	95	20	5
2	White Plastic	100	30	0
3	Red Mulch	100	35	0
4	Landscape Fabric	100	10	0
5	Control	100	5	0
6	2x Granular Fert	100	5	0
7	3x Granular Fert	100	30	0
8	4x Fertigation	90	35	0
9	6x Fertigation	100	20	0
10	7x Fertigation	85	20	0
11	1 drip 2x	85	15	0
12	1 drip 3x	100	30	0
13	2 drip 2x	100	11	0
14	2 drip 3x	90	10	0
15	Tensiometer	89	16	0
16	Natural Mulch	65	20	0
	Mean	94	19	0
	Std. Deviation	9	10	1

Table A2. Proportion of flowering plants throughout the growing season by cultivar

Row	Cultivar	Proportion of Plants Flowering (%)		
		May 25	**June 8**	**August 3**
1	'Honeybee'	81	13	0
2	'Tundra'	81	6	0
3	'Blue Treasure'	73	33	0
4	'Indigo Treat'	94	13	0
5	'Indigo Yum'	100	31	0
6	'Indigo Gem'	94	31	6
7	'Aurora'	94	6	0
8	'Boreal Beast'	100	6	0
9	'Boreal Beauty'	100	31	0
10	'Boreal Blizzard'	94	25	0
11	'Blue Banana'	100	0	0
12	'Happy Giant'	94	13	0
13	'Blue Diamond'	100	19	0
14	'Blue Jewel'	100	13	0
15	'Blue Moose'	93	7	0
16	'Evie'	94	13	0
17	'Larissa'	100	19	0
18	'Rebecca'	94	13	0
19	'Sveta'	100	44	0
20	'Kawai'	88	56	0
	Mean	94	20	0
	Std. Deviation	7	14	1

Table A3. The total amount of berries produced by each Haskap cultivar

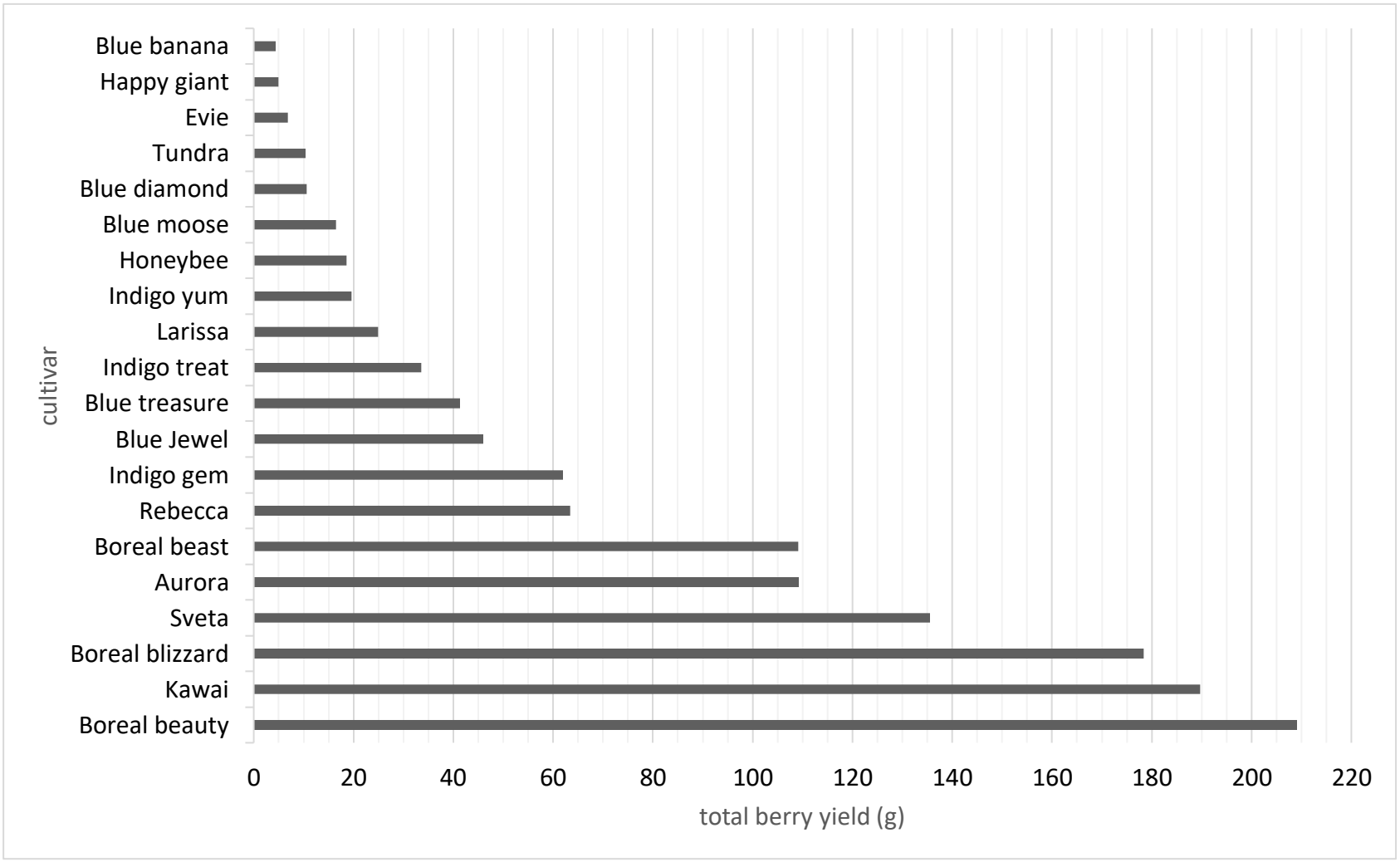

Table A4. The total amount of berries produced in each Haskap treatment

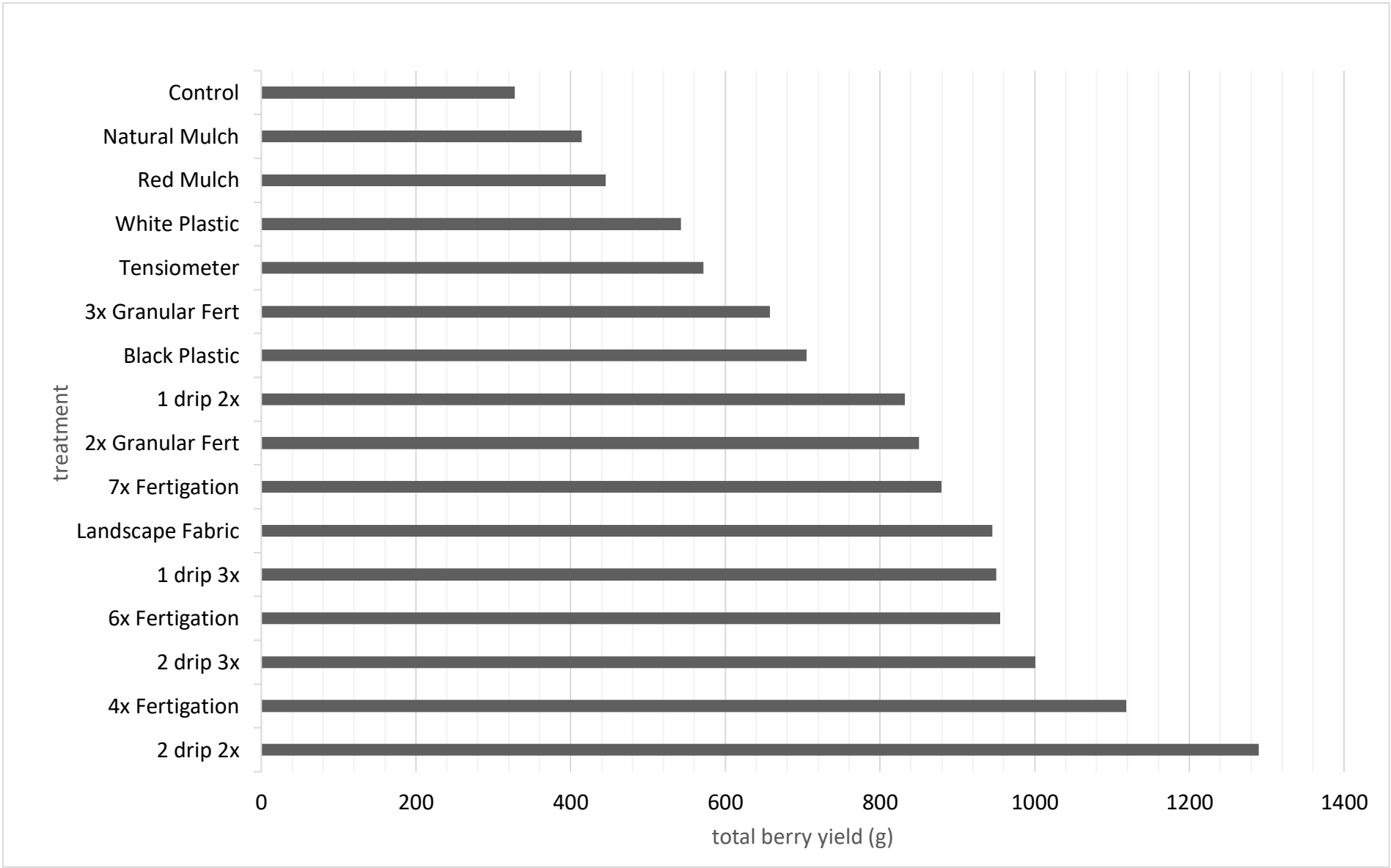

Table A5. Growth characteristics of Haskap cultivars

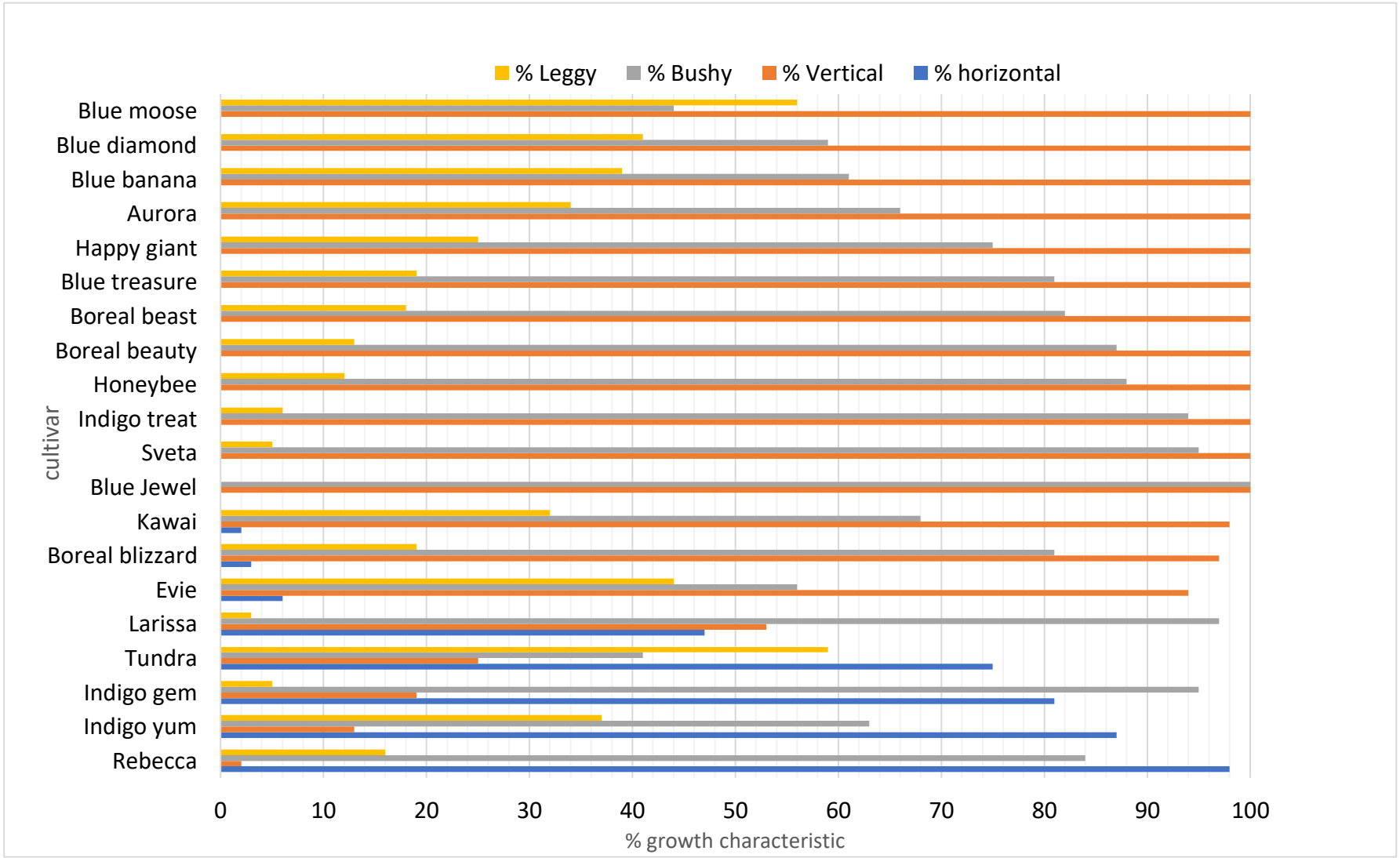

Figure A6. Photos of unknown insect eggs laid on some of the stems and leaves of Haskaps in 2021

Figure A7. Damage due to stress on Haskap leaves

Figure A8. Heat stress in haskap plants, 2021.