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FINAL REPORT

# ADF

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**HASKAP BERRY BREEDING AND PRODUCTION (FOLLOW UP TO ADF GRANT 20060140)**

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# Haskap Breeding & Production
## Final Report, January 2012

**ADF** Grant 2008-0042

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## Introduction

Haskap, also known as blue honeysuckles, is a new fruit crop for North America. It has been receiving much interest from consumers, farmers, and the press because this fruit:

+Can have a wonderful blueberry/raspberry flavour (best cultivars)
+It is the earliest fruit to ripen (Mid June)
+Has extreme winter hardiness
+High in antioxidants and vitamins
+Can be mechanically harvested
+Has few pests and could be grown organically or pesticide free on the Prairies
+Has strong potential markets in Japan
+Has a natural adaptation to northern climates, so it may may be difficult for potential competitors in warmer regions to grow it
+There is much interest in food processors, especially those developing dairy products

A small planting of 4 Haskap varieties were planted in the fall of 1998. By 2001 we became interested in this crop and began building a collection of cultivars and doing limited breeding funded in part by ADF grants for the "Dometic Fruit Program". By 2006 we had the largest collection of Russian Haskap Germplasm in North America and were beginning to acquire material from Japan. In 2007, we received a 2 year grant from Saskatchewan Agriculture (**ADF** Grant 2006-0140) to specifically breed and develop this crop. New germplasm was acquired and extensive evaluations of Russian germplasm was started. An important aspect of that project was gaining an understanding of the different types of Haskap germplasm and the traits useful for developing varieties with potential for mechanical harvesting. A general breeding strategy was implimented that involved hybridizing different types of Haskap. This resulted in a 10 fold increase of Haskap seedlings from controlled crosses, but also allowed us to greatly increase our knowledge of this crop and to add many more accessions to our collection.

**ADF** Grant 2008-0042, allowed us to continue breeding and developing this crop. Much more germplasm was acquired and established from Russia, Japan and across Canada. A 3 year, rigourous evaluation of 17 Russian varieties was completed in 2009. Evaluations of hundreds of Japanese-Type seedlings and about 40 clones from Maxine Thompson program occurred throughout this grant and was completed in 2011. Evaluation of Kuril hybrids and wild Canadian germplasm started in 2011 and these began to be used in crosses. Each year more promising germplasm has been used in crosses.

Perhaps 25,000 seedlings were raised during this ADF Project, with the most vigourous 50% planted at the U of SK and another vigourous 10% planted at cooperator sites. In 2010, the Plant Sciences Department aquired a Johanna Berry harvester for the program which assisted us in field evaluations and demonstrations for growers. By 2011, thousand of seedlings from controlled crosses in 2007 and 2008 began fruiting on bushes large enough to be evaluated. A new pollinator variety, 'Honey Bee' was released in 2011 and 18 advanced selections were

identified of which a few are likely to be released in 2012. This new generation of Haskap varieties give every indication of having larger fruit, and being faster growing than our first Haskap varieties released a few years ago. Faster growing will mean production will come in a year or two earlier.

This project has laid the groundwork for future varieties. Over the next four years Haskap seedlings arising from the previousthe crosses done under ADF Grant 2006-0140 and this grant will begin to bear fruit and can be evaluated for fruit quality and production. Introgression of Canadain and newer Japanese material baegan with this projects as well as introgression of noably vigourous lines.

At the beginning of this project we had the best collection of Haskap in Canada. Now it seems we have the best program worldwide. Leading Haskap researchers, breeders, and producers in Russia and Japan have told us that our program is the leading Haskap program worldwide and that we have the largest collection of germplasm. We also have the largest network of growers who are trying Haskap and have the only network where growers are utilizing mechanical harvesting.

Throughout this project we have shared fruit with various scientists doing nutritional studies. We have taken on a graduate student who is getting preliminary results on six neutraceuticals found in Haskap. All preliminary research points to Haskap being a superfruit likely to replace blueberries as the highest antioxidant fruit that tastes good that can be grown in Canada!

We have also shared fruit with many business interested in experimenting with Haskap, thus help to build future markets for our growers. Haskap is receiving rave reviews from businesses manufacturing dairy products, wine, liquers, and jams. We have also done some of our own investigations on value added Haskap.

Our commitment to growers has been very strong. We have been publishing our observations and experimental results on our website (www.fruit.usask.ca) . Each year we have held a Haskap Days event consisting of talks and tours. On average 75 growers have attended this event with the great majority of attendees from Saskatchewan. We have also hosted the Haskap Canada Annual meeting and have presented results both at that meeting and the Saskatchewan fruit growers annual conference. We also provide strong support by answering phone calls and email. Photographs of our plants, fruit and Haskap products have been shared with growers and propagators who are using them in promotional material. Our photos and information about Haskap make up most of the information on this crop in Wikipedia and have even made it into posters made by Agriculture Canada. Growers are certain to get a burst of public interest in 2012 when a segment of David Suzuki's 'The Nature of Things' airs on Haskap. Their TV crew spent 1 ½ days at the U of SK and ½ day at Saskatchewan growers filming the episode! This film crew had been filming various fruit projects around the world and our program was their last stop. The lead photographer told us that Haskap was now his favourite fruit based on taste! The entire crew was happily munching on the fruit in the field throughout their shoot.

*Note on the term 'Haskap'*: Growers of our new varieties will be marketing their fruit under the name 'Haskap' to help set them apart from the many poorer quality cultivars, many of which have commonly been called 'honeyberries', 'sweet berry honeysuckles' or 'blue honeysuckles'. For the purposes of reducing confusion for this report I will refer to all cultivars and wild plants as 'Haskap'.

## Germplasm Development

Haskap used in our breeding program originates from 4 major sources: Japan, Kurile Islands, Russia and Canada. Throughout this project we gathered, established evaluated, and inter-crossed germplasm as seen in table 1.

**Table 1. Mainstream Haskap breeding; the differences between early generations.**

| ***Base Population **** |
|---|
| **J K R C** |
| ***1st Generation Hybrids*** |
| **J K JR KR JC KC RC** |
| ***2nd Generation Hybrids*** |
| **J K x R JR x K KR x J**<br>**J K x RK JR x KR KR x JR**<br>**J K x JK JR x JR KR x JR etc.** |
| ***(J= Japan; K=Kurile; R=Russia; C=Canada)** |

Through observation and experimentation we have come to recognize positive and negative attributes of the base population. While there is much variability within each type, general conclusions can be made about the relative value of each type for breeding (Table 2). Russia and Japan germplasm are the most important for variety development in the short term. Both are productive and have reasonably good size fruit and have been improved by previous breeding efforts. The biggest drawback for most Russian varieties was the cylindrical fruit shape which often clogged in the sides of sorting lines. Also cylindrical shaped fruit dehydrated quicker in the field, usually by mid or late July. The fruit shape problem could be resolved by crossing with any of the other 3 groups.

Table 2. General characteristics of Lonicera caerulea germplasm as observed in Saskatchewan, Oregon and Hokkaido. Traits important for breeding a crop adapted for mechanized harvesting are included.

| Advantages | Disadvantages |
|---|---|

| Russia | |
|---|---|
| Uniform ripening | Tubular and flat fruit shape |
| Most can be harvested by shaking | Fruit usually 0.6 to 1.0g |
| Many have upright plants | Many have leaf diseases |
| Some are very productive | Many are tart, some bitter |
| Very early bloom and ripening | Many drop fruit when ripe |
| Many have good flavor and aroma | |
| **Japan** | |
| Fruits can be up 1 to 1.5g | Uneven ripening which leads to poor flavour |
| Fruit shape usually oval | |
| Longer period of active growth | Most plants hold onto fruit too tightly |
| Many are productive | |
| Late blooming and ripening | Many susceptible to leaf diseases |
| Tends to be resistant to leaf diseases | |
| Upright plants | |
| Some have good flavor and aroma | |
| **Kurile Islands** | |
| Uniform ripening | Low productivity |
| Very late blooming and ripening | Short plants |
| Sweet, round-oval fruit | Most plants hold onto fruit too tightly |
| Fruit can be 1.25 to 1.7g. | |
| Highly resistant to leaf diseases | Less aroma and flavor than other types |
| Leaves are highly resistant to leaf diseases and sunburn | |
| Most good traits are dominant in crosses | |
| Hybrids usually are sturdy | |
| **Canada** | |
| Early ripening | Fruit 0.3 to 0.6g |
| Most are sweet pleasant flavoured | Most plants have drooping branches |
| Good, slightly different flavor from Russia and Japan types, potential to improve flavor of future varieties | Most get mildew in mid-summer |
| Mostly round fruit | Evaluations have only recently begun on these plants |
| Did not get iron chlorosis during flooding of 2010 | |

The major defect with Japanese germplasm was the common trait of uneven ripening which lead to poor flavours and additional problems for mechanical harvesting. Haskap fruit turns blue on the outside before it is fully ripe on the inside. When unripe, berries taste grassy and sometimes bitter. Unripe berries tend to bleed when picked too. Haskap fruit that has juice coming out makes for a stick mess on the sorting line and that fruit easily becomes infected with botrytis. Our first varieties were the result of crossing a Russian variety with a Kurile Island variety. But crosses between Russian and Japanese are likely to be more productive but it seems likely that breeding could benefit by crosses with Kurile Varieties for leaf disease resistance and large fruit size while Canadian germplasm may have advantages for adaptability and flavours.

Throughout this project new germplasm was obtained, established and utilized in breeding. In depth germplasm evaluations was done on named varieties from Russia and Japanese selections from Maxine Thompson. Other germplasm is in the processes of being evaluated. The following sections describe in more detail the various acquisitions and evaluations of the base populations of the four germplasm groups.

## Russian Germplasm

All Russian germplasm obtained during this project was given to us from the Vavilov Institute by Dr. Artem Sorokin (Tables 3 & 4). We had obtained a grant from the federal government to have Dr. Sorokin visit us for 4 weeks in 2008 whereby we developed a good relationship and he helped gather wild *Lonicera caerulea* in Canada. In exchange we gave the Vavilov Institute seeds of Saskatoon berries and assorted wild fruits.

**Table 3. Seeds of Lonicera caerulea donated by the Vavilov Institute in 2009.**

| Code | Lineage | subspecies |
|---|---|---|
| R1 | free pollination cv.'Pervenec' | *Lonicera caerulea* |
| R2 | 807-4 x Pervenec | *Lonicera caerulea* |
| R3 | 807-4 x 639-2 | *Lonicera caerulea* |
| R4 | 639-11 x Gulik | *Lonicera caerulea* |
| R5 | 807-4 x Erakingra | *Lonicera caerulea* |
| R6 | Kamchadalka x Gulik -2 | *Lonicera caerulea* |
| R7 | Pervenec x Gulik -2 | *Lonicera caerulea* |
| R8 | 639-2 x Первенец | *Lonicera caerulea* |
| R9 | 807-4 x Gulik -2 | *Lonicera caerulea* |
| R10 | free pollination seeds form plants from Amur region(2n) $F_{1-3}$ | *Lonicera edulis* |
| R11 | free pollination seeds form plants from Kachatka (4n) $F_{1-5}$ | *Lonicera caerulea subsp. Kamtchatika* |
| R12 | free pollination seeds form plants from Primorye (2n) $F_{2-3}$ | *Lonicera edulis* |
| R13 | free pollination seeds form plants from Altay (4n) $F_{1-3}$ | *Lonicera caerulea subsp. altaica* |
| R14 | free pollination seeds form plants from Kuril ilands (4n) $F_{1-2}$ | *Lonicera caerulea subsp. emphyllocalyx* |
| R15 | free pollination seeds form plants from Primorye (4n) $F_{1-4}$ | *Lonicera caerulea subsp. venulosa* |
| R16 | free pollination seeds form plants from Middle Asia (2n) $F_{2-3}$ | *Lonicera caerulea subsp. stenantha* |

**Table 4. Seeds of Lonicera caerulea donated by the Vavilov Institute in 2010.**

| Code | | Lineage | Subspecies |
|---|---|---|---|
| AS | 1 | 807-7 x Morena | *Lonicera caerulea* |
| AS | 2 | 807-2 x Regel iz Chuguevki | *Lonicera caerulea* |
| AS | 3 | 807-7 x Regel iz Chuguevki | *Lonicera caerulea* |
| AS | 4 | 807-9 x 322-17 | *Lonicera caerulea* |
| AS | 5 | 807-5 x 322-17 | *Lonicera caerulea* |
| AS | 6 | 807-7 x 322-17 | *Lonicera caerulea* |
| AS | 7 | 807-5 x Regel iz Chuguevki | *Lonicera caerulea* |
| AS | 8 | 807-9 x Regel iz Chuguevki | *Lonicera caerulea* |
| AS | 9 | 807-5 x 615-1 | *Lonicera caerulea* |
| AS | 10 | 807-2 x Morena | *Lonicera caerulea* |
| AS | 11 | 169-3 x Morena | *Lonicera caerulea* |
| AS | 12 | 639-2 x 322-17 | *Lonicera caerulea* |
| AS | 13 | 639-7 x Morena | *Lonicera caerulea* |
| AS | 14 | 639-11 x Morena | *Lonicera caerulea* |
| AS | 15 | 639-2 x Morena | *Lonicera caerulea* |
| AS | 16 | 639-11 x 322-17 | *Lonicera caerulea* |
| AS | 17 | 639-11 x 615-1 | *Lonicera caerulea* |
| AS | 18 | 639-2 x 615-1 | *Lonicera caerulea* |
| AS | 19 | 169-3 x 615-1 | *Lonicera caerulea* |
| AS | 20 | 807-5 x Morena | *Lonicera caerulea* |
| AS | 21 | 639-2 x Regel iz Chuguevki | *Lonicera caerulea* |
| AS | 22 | 807-9 x Morena | *Lonicera caerulea* |
| AS | 23 | free pollination seeds form plants from Kachatka (4n) F1-5 | *Lonicera caerulea subsp. Kamtchatika* |
| AS | 24 | k-37882 (2n) | *Lonicera edulis 'Gulik-1'* |
| AS | 25 | free pollination seeds form plants from Altay (4n) F1-3 | *Lonicera caerulea subsp. altaica* |
| AS | 26 | free pollination seeds form plants from Kuril islands (4n) F1-2 | *Lonicera caerulea subsp. emphyllocalyx* |
| AS | 27 | free pollination seeds form plants from Primorye (4n) F1-4 | *Lonicera caerulea subsp. venulosa* |
| AS | 28 | free pollination seeds form plants from Middle Asia (2n) F2-3 | *Lonicera caerulea subsp. stenantha* |
| AS | 29 | k-37882 (2n) | *Lonicera boczkarnikovae 'Iz Chuguevki'* |
| AS | 30 | k-32412 (2n) | *Lonicera boczkarnikovae '673-6'* |
| AS | 31 | k-37881 (2n) | *Lonicera edulis 'Erakingra'* |
| AS | 32 | k-32408 (2n) | *Lonicera edulis '754-30'* |
| AS | 33 | free pollination seeds form plants from White Sea region (4n) F1-3 | *Lonicera caerulea subsp. pallasii* |
| AS | 34 | free pollination seeds form plants from Canada | *Lonicera caerulea subsp. villosa* |

In total we obtained 50 seed lines with about 90% of them having successful germination. Dr. Sorokin had been making crosses to better understand cross compatibility so we were fortunate

that half of the seeds sent to us were F1 hybrids! Seedlings were quite variable in growth rates and healthy appearance. We did not have enough field space to field plant every seedling so we screened them; planting on average the best 20 from each line. Wet conditions in 2010 caused a delay in planting for the 2009 seedlings but all were planted in 2011.

## Field Evaluations of Russian breeding stock:

2009 was the third and final year for the field evaluation of seventeen Russian cultivars for twenty one characteristics (Table 5). Tyler Kaban has been the key person involved in the field evaluations for all three years of the field study which gave consistency from year to year of the study.

In 2003, 15 Russian cultivars were obtained from Dr. Maria Plenkhanova of the N.I. Vavilov Institute of Plant Industry (Vavilov Institute). These varieties were propagated along with two other Russian varieties obtained from Jim Gilbert of One Green World Nursery in Oregon. In 2005 a variety trial was established consisting of 5 plants x 2 reps x 17 cultivars at the University of Saskatchewan. This field was also used for making crosses and was unsuitable for yield trials as covering plants to exclude bees caused drastic reduction of fruit set. When a variety was used in crosses, usually 2 or 3 remained uncovered to be evaluated as a whole for this trial. Additionally, we wanted to observe fruit retention force and whether some varieties would drop their fruits. Productivity was estimated on a visual scale as was other quality-based characteristics. Fruit samples were also gathered for study in the lab.

Means for each trait for each cultivar are summarized in table 6. With this chart one can see the relative strengths and weaknesses of each cultivar. The averages give a general impression of our entire collection of Russian varieties. Most of the Russian varieties in this study had reasonably good shaped canopies, berries that didn't bleed too much when picked, had minimal openings at the bloom end of the fruit and rarely had bitterness. Areas that need improvements are plant vigour, fruit size and shape, sweetness, sour and aroma. While the average scores for all varieties are similar, there is a wide range of variability for individual traits, except for bitterness.

Data was further analyzed for suitability for mechanical harvesting, fruit appearance, taste, and a combined breeder's index (Table 7). The breeder's index is useful for choosing the best parents in a general way. However, we need to be mindful that there are different categories of end users of our varieties. A grower who is mechanically harvesting fruit to use in processing is likely to consider mechanical harvesting and taste very important and likely wouldn't care about appearance of the fruit. A u-pick or fresh produce operation may care more about appearances. Perhaps home owners would want the best possible flavour.

**Table 5. Haskap evaluation sheet.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Accession** | _____ | **Evaluators** | | | | | |
| **Bush** | **vigour** | Low(1) | Slight(2) | Average(3) | More(4) | Very(5) | |
| | **canopy** | Weeping (1) | (2) | Spreading (3) | (4) | Upright (5) | |
| | **productivity** | Low(1) | Slight(2) | Average(3) | More(4) | Very(5) | |
| **Fruit Retention** | | holds on Tightly(1) | holds on Slightly (3) | Optimum (5) | detaches Easily(3) | falls Off(1) | |
| **Scar wetness** | | Skin Tears (1) | oozing without Squishing(2) | oozing with Squishing(3) | slight oozing with Squishing(4) | Dry(5) | |
| **Frequency of wetness** | | 0% (5) | 25% (4) | 50% (3) | 75% (2) | 100% (1) | |
| **Fruit size** | | very small (1) | Small (2) | Average (3) | Large (4) | very large (5) | |
| **shape** | Football (1) | Cylinder (1) | Bullet (1) | Oval (4) | long oval (3) | Square (4) | Round (5) |
| **side view** | | Flattened (1) | (2) | slightly flattened(3) | (4) | not flattened (5) | |
| **length** | | Short(1) | (2) | Medium(3) | (4) | Long(5) | |
| **texture (in hand)** | | very soft(1) | Soft(2) | Average(3) | Firm(4) | Hard(5) | |
| **Distal end** | **shape** | Pointed (1) | (2) | belly button(3) | (4) | Rounded (5) | |
| | **opening** | Small(5) | (4) | Medium(3) | (2) | Large(1) | |
| | **hairs** | very heavy(1) | Heavy(2) | Some(3) | Slight(4) | None(5) | |
| **Skin texture** | | Smooth (5) | (4) | Irregular(3) | (2) | Bumpy (1) | |
| **Bloom** | | None(1) | Some(2) | Moderate(3) | above avg(4) | Heavy(5) | |
| **Sweetness** | | None(1) | Slight(2) | Moderate(3) | above avg(4) | Heavy(5) | |
| **Sour** | | None(1) | Slight(3) | Moderate(5) | above avg(3) | Heavy(1) | |
| **Bitterness** | | None(5) | Slight(4) | Moderate(3) | above avg(2) | Heavy(1) | |
| **Aroma** | | None(1) | Slight(2) | Moderate(3) | above avg(4) | Heavy(5) | |
| **Texture (in mouth)** | | very soft(1) | Soft(2) | Average(5) | Crisp(4) | Chewy(3) | |
| **Overall** | Worst(1) | Bad(2) | Poor(3) | Bland(4) | Good(5) | Excellent (6) | Best (7) |

Table 6. Summary of field evaluations of Russian Cultivars for 2007, 2008 and 2009. Based on a 1 to 5 based scale with 5 being the best score.

| Accession Code | vigour | canopy | productivity | Fruit Retention | Scar wetness | wetness Freq. | Fruit size | shape | side view | length | texture (in hand) | Distal end shape | opening | hairs | Skin texture | Bloom | Sweetness | Sour | Bitterness | Aroma | Texture (in mouth) | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 204 | 2.5 | 5.0 | 2.2 | 2.8 | 3.0 | 3.3 | 2.4 | 3.8 | 4.7 | 2.2 | 2.5 | 4.5 | 4.7 | 2.7 | 4.8 | 3.2 | 2.5 | 3.3 | 5.0 | 2.2 | 3.5 | 3.4 |
| 205 | 3.0 | 4.4 | 2.9 | 3.2 | 4.4 | 4.2 | 3.0 | 4.0 | 3.4 | 2.8 | 2.4 | 5.0 | 5.0 | 2.0 | 5.0 | 3.0 | 3.0 | 2.2 | 5.0 | 2.7 | 3.8 | 3.5 |
| 206 | 2.4 | 3.4 | 3.3 | 3.2 | 3.9 | 4.4 | 4.6 | 1.8 | 3.6 | 5.0 | 1.9 | 3.6 | 4.6 | 4.2 | 2.2 | 4.3 | 3.1 | 1.8 | 5.0 | 3.6 | 3.3 | 3.5 |
| 207 | 2.5 | 3.7 | 2.5 | 3.8 | 4.8 | 4.8 | 3.5 | 2.2 | 3.5 | 4.8 | 2.7 | 2.0 | 5.0 | 3.7 | 2.0 | 3.3 | 2.3 | 3.2 | 4.8 | 1.9 | 3.9 | 3.4 |
| 208 | 3.0 | 2.3 | 3.3 | 4.3 | 3.9 | 3.6 | 3.7 | 3.0 | 4.0 | 4.0 | 3.1 | 2.5 | 3.7 | 4.3 | 2.8 | 3.2 | 2.2 | 3.3 | 5.0 | 2.5 | 4.8 | 3.4 |
| 209 | 2.9 | 3.6 | 3.1 | 2.8 | 3.3 | 3.1 | 2.7 | 4.0 | 4.0 | 2.8 | 2.9 | 5.0 | 5.0 | 3.8 | 4.6 | 3.0 | 3.6 | 1.8 | 4.8 | 2.8 | 4.2 | 3.5 |
| 210 | 2.8 | 4.3 | 3.3 | 3.3 | 5.0 | 5.0 | 3.3 | 2.7 | 4.3 | 3.3 | 4.1 | 3.5 | 5.0 | 4.2 | 3.3 | 2.9 | 3.4 | 2.2 | 5.0 | 3.6 | 4.2 | 3.8 |
| 211 | 3.0 | 4.2 | 4.3 | 3.8 | 4.2 | 4.4 | 3.8 | 2.6 | 2.7 | 4.7 | 2.3 | 4.5 | 4.7 | 4.5 | 3.0 | 3.3 | 2.8 | 3.7 | 5.0 | 3.1 | 4.8 | 3.8 |
| 212 | 3.0 | 3.3 | 3.8 | 4.7 | 5.0 | 4.9 | 3.2 | 3.3 | 2.8 | 3.8 | 2.5 | 4.2 | 4.7 | 4.9 | 2.5 | 3.4 | 2.7 | 2.8 | 5.0 | 2.5 | 3.5 | 3.6 |
| 213 | 3.1 | 5.0 | 3.0 | 3.0 | 4.8 | 4.8 | 2.6 | 3.3 | 2.5 | 3.3 | 3.0 | 5.0 | 5.0 | 3.8 | 2.0 | 3.5 | 2.8 | 3.3 | 5.0 | 3.3 | 3.8 | 3.6 |
| 214 | 3.1 | 5.0 | 2.8 | 2.8 | 5.0 | 5.0 | 3.7 | 2.8 | 3.0 | 4.8 | 3.4 | 2.5 | 4.7 | 4.1 | 2.2 | 3.8 | 3.3 | 2.7 | 4.9 | 2.6 | 4.8 | 3.7 |
| 215 | 2.7 | 3.8 | 3.7 | 3.2 | 4.8 | 4.8 | 2.9 | 1.9 | 3.3 | 3.0 | 2.3 | 2.8 | 5.0 | 4.9 | 2.8 | 3.6 | 2.7 | 3.0 | 5.0 | 2.8 | 4.5 | 3.5 |
| 216 | 3.0 | 4.8 | 3.2 | 4.5 | 5.0 | 5.0 | 3.8 | 2.3 | 3.3 | 4.7 | 3.2 | 3.8 | 4.3 | 3.7 | 3.2 | 3.3 | 4.0 | 1.5 | 5.0 | 3.7 | 4.3 | 3.8 |
| 217 | 2.8 | 4.7 | 2.8 | 3.2 | 4.7 | 4.9 | 2.2 | 3.5 | 4.5 | 1.7 | 3.6 | 5.0 | 4.7 | 4.1 | 4.8 | 3.8 | 2.5 | 3.7 | 5.0 | 2.8 | 4.8 | 3.8 |
| 220 | 1.7 | 2.8 | 2.9 | 4.0 | 4.5 | 4.4 | 2.2 | 2.3 | 4.3 | 1.8 | 3.3 | 2.0 | 4.7 | 4.5 | 3.8 | 2.9 | 2.2 | 3.3 | 4.9 | 2.0 | 4.2 | 3.3 |
| 9809 | 4.2 | 4.6 | 4.1 | 3.8 | 4.2 | 4.3 | 2.8 | 3.9 | 3.8 | 2.2 | 3.4 | 5.0 | 5.0 | 4.8 | 4.8 | 3.6 | 2.3 | 3.0 | 4.5 | 2.4 | 4.1 | 3.8 |
| 9811 | 2.2 | 4.0 | 3.5 | 3.6 | 4.6 | 4.2 | 2.8 | 3.6 | 2.2 | 2.8 | 2.8 | 4.4 | 5.0 | 5.0 | 3.2 | 3.4 | 2.4 | 3.0 | 4.6 | 2.7 | 3.7 | 3.5 |
| Average | 2.8 | 4.1 | 3.2 | 3.5 | 4.4 | 4.4 | 3.1 | 3.0 | 3.5 | 3.4 | 2.9 | 3.8 | 4.7 | 4.1 | 3.4 | 3.4 | 2.8 | 2.8 | 4.9 | 2.8 | 4.1 | 3.6 |
| Range | 1.7 | 2.3 | 2.2 | 2.8 | 3.0 | 3.1 | 2.2 | 1.8 | 2.2 | 1.7 | 1.9 | 2.0 | 3.7 | 2.0 | 2.0 | 2.9 | 2.2 | 1.5 | 4.5 | 1.9 | 3.3 | 3.3 |
|  | 4.2 | 5.0 | 4.3 | 4.7 | 5.0 | 5.0 | 4.6 | 4.0 | 4.7 | 5.0 | 4.1 | 5.0 | 5.0 | 5.0 | 5.0 | 4.3 | 4.0 | 3.7 | 5.0 | 3.7 | 4.8 | 3.8 |

Mechanical harvesting traits

Berry Appearance traits

Taste Traits

Not used in indices

Table 7. Ranking of 17 Russian varieties for mechanical harvesting, appearance, taste, and a weighted index. **The scale goes from 1 to 5 with 5 being the best possible score. Although based on 21 different characteristics, a general interpretation of the scale for the indices is 1=bad, 2=poor, 3=ok, 4=good, and 5=excellent. Groupings are based on LSmeans at $p < 0.05$.**

**The mechanical harvesting index is based on: plant vigour, canopy shape, productivity, fruit retention strength, whether the scar when detached bleeds, amount of juice wetness after harvesting, fruit size, fruit shape, berry flatness or roundness, berry firmness, and shape of the distal end of the berries.**

**The appearance index is based on: type of opening at distal end, hairs on the fruit, smoothness or roughness of skin, and amount of bloom (can make fruit look brighter blue).**

**The taste index is based on: sweetness, optimum levels of sour, low bitterness, aroma, and texture in mouth.**

**The weighted index ranks combines the previous three indices with equal weight.**

| Mechanical Harvesting | | | Appearance | | | Taste | | | Weighted Index | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cultivar | Rating | Grouping | Cultivar | Rating | Grouping | Cultivar | Rating | Grouping | Cultivar | Rating | Grouping |
| 9809 | 4.1 | A | 9809 | 4.6 | A | 211 | 3.9 | A | 9809 | 4.0 | A |
| 217 | 3.8 | B A | 217 | 4.4 | B A | 217 | 3.8 | B A | 217 | 4.0 | A |
| 216 | 3.8 | B A C | 9811 | 4.1 | B A C | 216 | 3.7 | B A C | 211 | 3.8 | B A |
| 210 | 3.8 | B A C | 209 | 4.1 | B A C | 210 | 3.7 | B A C | 210 | 3.8 | B A |
| 212 | 3.7 | B A C | 215 | 4.1 | B A C | 214 | 3.6 | B D A C | 216 | 3.7 | B A C |
| 205 | 3.6 | B D C | 220 | 4.0 | B D C | 215 | 3.6 | B D A C | 215 | 3.7 | B C |
| 213 | 3.6 | B E D C | 211 | 3.9 | B E D C | 208 | 3.6 | B D A C | 9811 | 3.6 | B C |
| 211 | 3.6 | B E D C | 210 | 3.9 | B E D C | 213 | 3.5 | B D A C | 209 | 3.6 | B D C |
| 214 | 3.6 | B E D C | 204 | 3.9 | E D C | 209 | 3.5 | B D A C | 212 | 3.6 | B D C |
| 9811 | 3.5 | F E D C | 212 | 3.9 | E D C | 206 | 3.4 | B D C | 214 | 3.6 | B D C |
| 209 | 3.4 | F E D | 206 | 3.8 | E D C | 9809 | 3.3 | B D C | 213 | 3.6 | B D C |
| 204 | 3.4 | F E D | 205 | 3.7 | E D C | 9811 | 3.3 | B D C | 205 | 3.6 | B D C |
| 208 | 3.3 | F E D | 214 | 3.7 | E D C | 220 | 3.3 | B D C | 204 | 3.5 | D C |
| 215 | 3.3 | F E D | 213 | 3.7 | E D C | 205 | 3.3 | B D C | 220 | 3.5 | D C |
| 207 | 3.3 | F E | 216 | 3.6 | E D C | 212 | 3.3 | D C | 206 | 3.5 | D C |
| 206 | 3.3 | F E | 208 | 3.6 | E D | 204 | 3.3 | D C | 208 | 3.5 | D C |
| 220 | 3.1 | F | 207 | 3.5 | E | 207 | 3.2 | D | 207 | 3.3 | D |

In this document, we are presenting only the U of SK accession numbers because we are in the process of getting this information published. Once our paper is published we can revise this document and fill in the names, but even then it is unlikely to have much impact for growers. Only two of these Russian varieties have been sold in Canada and we are under agreements not to distribute any of these varieties, but we can use them for breeding.

It is important to note that even the best rated Russian cultivar only gets a 'good' rating. In the various indices of table 7, there is much overlapping in LS means groups, but four cultivars 9809, 210, 216, and 217 were often in the in top four positions for each category. Two of these have been used extensively in crosses from 2007 to 2009 but all four were used were used in 2009 and 2010.

## Lab Evaluations of Russian breeding stock:

From 2007 to 2009 10 berries in each rep were measured for fruit weight (Figure 1). The average berry weight was only 0.8 grams. Averages ranged from 0.63 to 1.06 with only 2 selections barely heavier than 1 gm. These weights are not impressive. Much heavier fruits were observed by Dr. Bors during visits to Dr. Maxine Thompson's breeding program in Oregon and visits to various growers and researchers in Hokkaido. Better selections from Dr. Thompson's program are often in the range of 1.25 to 1.5g/fruit and a few have been higher. Still, if Russian germplasm is needed in crosses it makes sense to use the largest fruit possible.

Another component measured in the lab was berry length, width and depth using a precision caliper. All of our Russian cultivars are similarly cylindrical (Figures 2 & 3). Most are twice as long as they are wide. They also are slightly flattened with average width being 15% greater than the depth. The cylindrical shape is a disadvantage during hot temperatures days as they have been observed to shrivel by the end of July while larger and more rounded berries can last a month or more longer. In our sorting table, we have observed that cylindrical berries tend to get stuck in corners of the machinery. This is because the fruits will roll in one direction and stop when they get to a side. Round and oval berries will hit a side and roll away.

According to Dr. Sorokin, Russian breeders have been breeding for elongated fruit. Elongated fruit usually have a stretched sheath that can go ½ to 1 cm beyond the ovaries, thus the distal end of the berry may not be as heavy as the end closest to the stem and may actually contain an air pocket. While lighter in weight, cylindrical berries may look as big or bigger than the more solid Japanese or Kurile types. Growers with such berries might be advised to sell their fruit based on volume and not by weight!

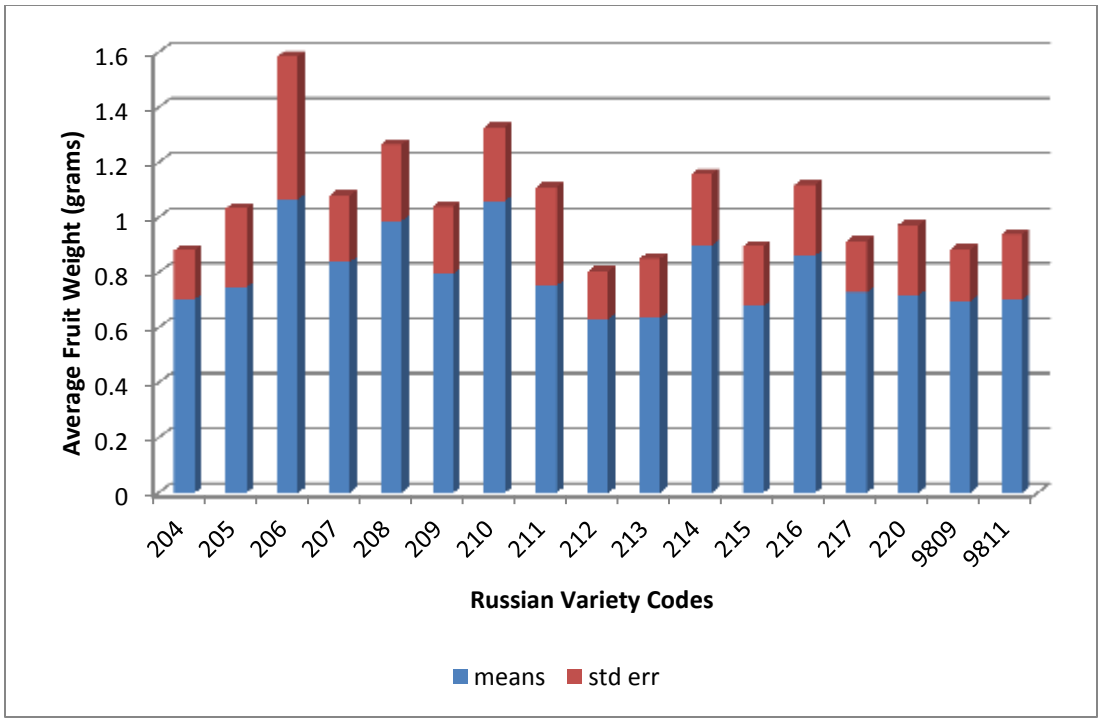


**Figure 1.** Average fruit weight of 17 Russian cultivars grown in Saskatoon during 2007, 2008 and 2009.

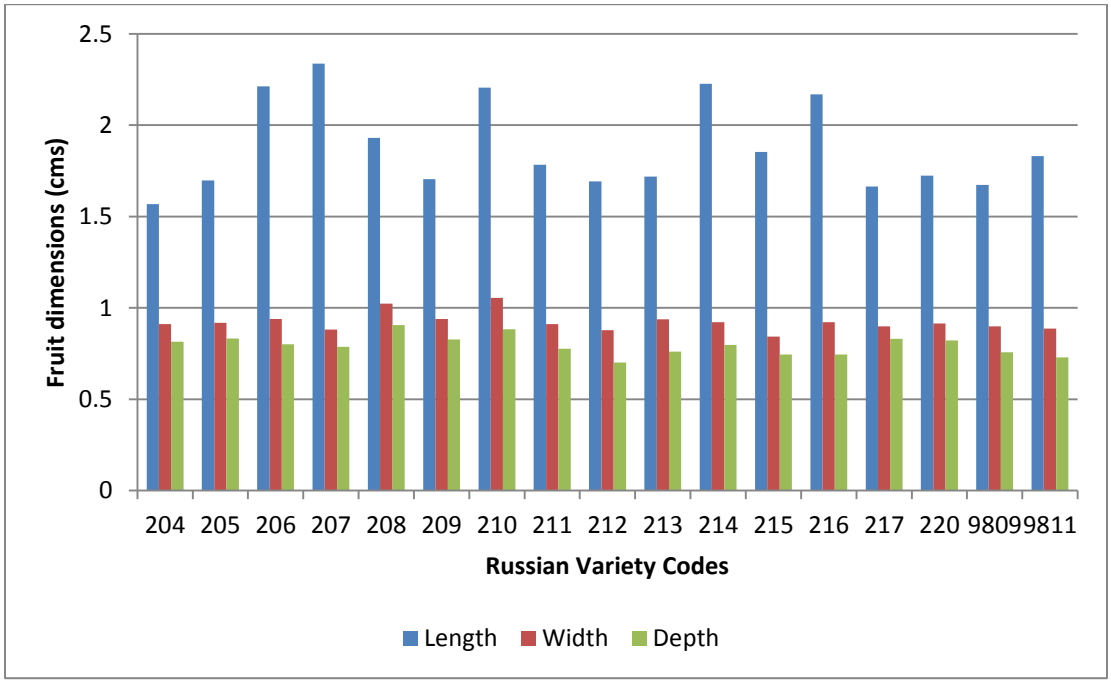


**Figure 2. Average dimensions of 17 Russian cultivars.**

Soluble solids (sugar content) were also measured in the lab but the Analysis of Variance did not find any significant differences between cultivars. Russian cultivars averaged 19.7 Brix and ranged from 18.2 to 22.9 Brix. 2007, 2008 and 2009 had average Brix levels of 21.7, 20.0 and 17.7 respectively.

**Figure 3. Russian cultivars all with cylindrical shape but with different shaped ends. Those with pointed ends are likely to be more easily damaged in machinery.**

For pH there was significant differences between cultivars but only if cultivars 9809 and 9812 were excluded. LS means of those were not estimable due to missing data. It is difficult to access the importance of pH but as a whole the Russian cultivars are rather acidic. Table 10 may be of use to food processors. Usually higher pH would be more desirable for fresh eating but low pH may be of value for processors. Vitamin C also called ascorbic acid is reportedly high in Haskap and is often added to processed products as preservative and to make products tarter. This range is similar to blueberries, blackberries and currents and lower than most apples and cherries. PH was also significantly different from year to year; 2007, 2008 and 2009 had average pH of 3.16, 3.23, and 3.26 respectively.

Table 8. Differences in pH between 15 Russian cultivars. Averages are based on fruit in 2007, 2008, and 2009.

| Variety | pH | Mean grouping |
|---|---|---|
| 209 | 3.34 | B A |
| 213 | 3.29 | B A C |
| 212 | 3.27 | B C |
| 206 | 3.24 | B D C |
| 207 | 3.22 | B E D C |
| 205 | 3.22 | B E D C |
| 211 | 3.22 | B E D C |
| 220 | 3.20 | F E D C |
| 215 | 3.20 | F E D C |
| 208 | 3.15 | F E D |
| 217 | 3.15 | F E D |
| 214 | 3.12 | F E |
| 210 | 3.11 | F E |
| 204 | 3.10 | F |

## Japanese Germplasm

### New Germplasm

Additional germplasm of mostly Japanese origin was obtained from Dr. Thompson's breeding program when Dr. Bors visited her in late May of 2009. Open pollinated seeds were obtained from the following plants in her collection: 74-39, 74-53, 74-58, 74-59, 74-83, 78-75, 78-87, 79-91, 81-69, 88-53, 88-99, 89-46, 93-93, 93-97, 97-58, 100-30, Bulk Row 108, Bulk Row 109, Bulk Row 110, D36+37, F25+26, and G21&22. Many of the parents of these were hybrids between Japanese X Russian or Japanese X Kurile types. Perhaps 90% of Dr. Thompson's seedlings are of Japanese origin so there is a high probability that many of the resulting seedlings will be 75% Japanese Haskap. Unfortunately the USDA Genebank farm where most of Dr. Thompson's seedlings were located was about to be downsized, so it was especially important to gather more material. That season had been unusually cool which meant that the fruit was not totally ripe when Dr. Bors made the selections. Selection was based on visual aspects and less on flavor. These seeds were germinated in 2010 and field planted in 2011

Seeds from Haskap gathered in Hokkaido in 2008 during Dr. Bors sabbatical were germinated and raised in the greenhouse in 2009. About 2000 seedlings were raised. About 1000 were field planted at the University in 2009 and 2010 and 500 were planted at growers sites. Approximately 5000 with poor growth rates were discarded. In 2010 half of one of the fields with much of this material became flooded so much of the material was dug up, put in pots and replanted early in 2011 and many of the smaller seedling drowned. Flooding likely delayed the development of most of this material by one year. Bulk pollen of those plants that did bloom were bulked and used in some crosses.

## Selection of Block 6 seedlings

Block 6 North contained seedlings of Japanese descent from 20 controlled crosses plus bulk seedlings from Masatomo Nishimura's collection; all donated as seeds by Dr. Thompson in 2005. At the time we had no funding for Haskap research so these seedlings were planted in double rows in plastic at very high density of 6 in within the row and 6 in between the rows but with 3 feet between alternate rows. The plants became too crowded to judge them as they were stunted and it was hard to tell them apart. In 2010, bulk seeds were collected from each family and the best 15 were relocated to another field. Then the field was removed.

Block 6 South had seedlings from 70 plants that were open pollinated in the field. An estimated 100 seeds / plant were gathered. Dr. Bors had gathered them from Dr. Thompson's program in 2005 and 2006. The seeds were gathered as a back-up strategy in case cuttings gathered did not make it past customs or did not survive the shipment. As it turned out, the 2006 shipment was delayed 3 weeks by Canadian Customs but still most survived and was eventually rooted. Not really needing 7000 seedlings since we had the clonal parents, the seedlings were subjected to severe culling while in their plug trays. Only the fastest growing, healthiest seedlings were kept from each line. Technicians kept the 4 best plants from each of the 70 lines, but if a family was unusually good compared to others 8 or 12 plants were kept. Sets of 4 plants were planted in large 12" pots. By 2009 these plants were large enough in the field to be evaluated by growers attending Haskap day and by Dr. Bors.

In 2010 and 2011 the better ones began to be used in crosses (Table 9). Noteworthy is that the mother clone '40-134' is a hybrid resulting from a Japanese selection crossed with Berry Blue by Dr. Thompson. Dr. Bors deliberately selected some better Japanese x Russian hybrids from Dr. Thompson's program in hopes of getting some recombination of worthwhile traits in the next generation.

Wide crosses in breeding often result in hybrid vigour, which could be the case with Japanese x Russian crosses. Many of the berries had an elongated shape (figure 3) which is not typical of Japanese germplasm. Perhaps by saving only the most vigourous seedling we were selecting for hybrid vigour caused by combining Russian and Japanese genetics.

Table 9. Haskap seedlings derived from open pollinated plants being used in breeding. Three selections were chosen for special traits but have serious flaws. The other selections were 'well rounded' being good in all categories including productivity, fruit size and flavor. The mother plant code is the row and plant number at Dr. Thompson's breeding field.

| U of SK Code | Mother Plant Code | Special traits & flaws |
|---|---|---|
| 6-15-10 | 22.14 | Best tasting Haskap, cylindrical fruit |
| 6-15-32 | 46.55 | |
| 6-15-39 | 22.140 | Ripens early Aug. Fruit average size and flavour |
| 6-16-04 | E3 | (typo? map said E2) |
| 6-16-15 | 66.53 | |
| 6-16-17 | 40.134 | |
| 6-16-20 | 40.134 | |
| 6-16-24 | 40.134 | |
| 6-16-26 | 77.74 | |
| 6-16-30 | Unknown | |
| 6-16-34 | Unknown | |
| 6-16-44 | 56.15 | |
| 6-18-04 | 42.45 | |
| 6-18-14 | 20.04 & 21.17 | |
| 6-18-17 | 20.04 & 21.17 | |
| 6-18-38 | 74.68 | Unusually round fruit, very productive but bland |

Figure 4. Variability in fruit appearance of seedlings derived using open pollination at Dr. Thomson's breeding program. Each berry is from a different plant in Row 16 and is of mostly Japanese descent but grown at the U of SK breeding plots. Each berry is place in the same orientation with the stem end on top. Compared to the Russian fruit in figure 3, most of these are wider but shorter.

## Evaluating Dr. Thompson's Clones in Block 14

All of the clones from Maxine's program in block 14 were selected for worthwhile traits in Oregon by Dr. Bors in 2005 and 2006. They were planted in 2007 in two rows next to each other. Previous to 2010, these plants did not exhibit any winterkill but in 2010, these plants were in a partly flooded and saturated field for most of the summer. It is highly likely that these conditions created additional stress that caused some winterkill seen in 2011. It is important to keep this in mind when examining the observation listed in Table 10.

We had been using this material in crosses based on the favourable evaluations done in Oregon. Now that the plants are approaching maturity it is possible to judge them on their adaptability to Saskatchewan conditions. In preparation for the crossing, Maxine's clones were evaluated at the start of their blooming season. Traits being evaluated were timing of bloom, plant vigour and winter hardiness.

Of particular interest was finding which clones bloom last to breed for extending the growing season. Our current varieties and much of the breeding fields have an abundance of early bloomers and very few late ones.

Table 10 lists the observations made. Five accessions were tagged as superior and these were used in crosses for the next few weeks. In late July these plants were observed when fruiting and more notes were taken. Again, five selections were tagged for use in crosses for 2012. One plant of each was dug up and potted for use in crossing in the greenhouse. 41.83 was selected in the spring but not the summer because it is being used in a student's project and we did not want to remove any of those plants from the field.

Table 10. Evaluations of clones from Dr. Thompson's program. An '*' indicates clones chosen for use in future crosses.

| | May 12, 2011 notes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Bud Break & bloom | | | | Plant Vigour | | | Winter Kill | | |
| | accession | Early | mid | late | v Late | Robust | Average | wimpy | No damage | Minor Tip Kill | Major damage |
| * | 22.14 | X | | | | | X | | | X | |
| | 22.34 | | | X | | | | X | | | X |
| | 22.61 | X | | | | | | X | | | X |
| | 22.72 | | | | X | | X | | X | | |
| | 26.72 | X | | | | | X | | | | X |
| * | 41.83 | | | X | | X | | | X | | |
| | 42.45 | X | | | | | X | | | | X |
| * | 44.34 | | | X | | X | | X | | | |
| | 44.76 | | | X | | | X | | X | | |
| | 44.96 | | | X | | | X | | | X | |
| | 56.15 | X | | | | | X | | X | | |
| | 64.72 | X | | | | | X | | X | | |
| | 66.53 | | | | X | | X | | X | | |
| * | 66.89 | | | | X | X | | | X | | |
| | 73.39 | | | | X | | X | | | X | |
| * | 77.87 | | | | X | X | | | X | | |
| | C10 | X | | | | | X | | X | | |
| | G20 | | X | | | | X | | X | | |
| | G23 | | | X | | | X | | X | | |
| | Summer notes | | | | | | | | | | |
| * | 22.14 | Smooth large narrow heart, vigourous plant, med. productive, best of 22 series | | | | | | | | | |
| | 22.34 | fruit somewhat cylindrical, low vigour bush | | | | | | | | | |
| | 22.61 | fruit somewhat cylindrical, low vigour bush | | | | | | | | | |
| | 22.72 | fruit somewhat cylindrical, low vigour bush | | | | | | | | | |
| | 26.72 | Almost dead | | | | | | | | | |
| | 41.83 | Productive, bullet shaped fruit with a point | | | | | | | | | |
| | 42.45 | Round small Fruit, water or winter damage | | | | | | | | | |
| * | 44.34 | Very late ripening, very productive healthy bush, poor flavour | | | | | | | | | |
| | 44.76 | V nice flavour, pleasant aftertaste | | | | | | | | | |
| | 44.96 | Small oval fruit, BB end | | | | (BB=looks like a belly button) | | | | | |
| * | 56.15 | boxy oval shape with small opening or BB, healthy bush, fruit come off a bit too easy | | | | | | | | | |
| | 64.72 | Long lumpy fruit | | | | | | | | | |
| | 66.53 | productive , medium size oval fruit | | | | | | | | | |
| * | 66.89 | Very very big ugly lumpy fruit, diamond shaped, very vigourous bush | | | | | | | | | |
| | 73.39 | med/small oval fruit, similar to 66.53 but less vigourous | | | | | | | | | |
| * | 77.87 | med & large fruit, heart shape, productive, detaches easy | | | | | | | | | |
| | C10 | Flat oval lumpy Frt, productive | | | | | | | | | |
| | G20 | Small plant showing chlorosis, productive, lumpy bullet shape | | | | | | | | | |
| * | G23 | Productive but small bush, kurile type, boxy, smooth fruit, sweet, nice | | | | | | | | | |

## Wild Canadian Lonicera caerulea ssp. villosa

The U of SK has the world's only large living collection of *Lonicera caerulea* from Canada. Dr. Bors continued his sabbatical plant collecting of Haskap through the spring and early summer of 2009. During that time period, wild Canadian Haskap was gathered from Northeast Ontario, Quebec, New Brunswick, Nova Scotia, and PEI. (See Table 11 and Figure 5). Other grants and plant royalties funded the above expedition, but this grant funded the care of the new germplasm once it arrived at the University of Saskatchewan. Most plants needed recovery time in a mist bed. In 2009, all wild Canadian accessions that were gathered through the entirety of the sabbatical were field planted.

Most of Canada's wild Haskap had been from the Boreal Shield Forest Ecozone but was also found in the Atlantic Maritime Forest Ecozone and one small spot in southern Ontario. In the Maritimes it was considerably more difficult to find wild Haskap although in the places where it was found, the plants were large and healthy. The species was much easier to find in Newfoundland.

It is worth mentioning that this species was almost always difficult to find at each location. It was never a dominant species and was very sporadic. Only by careful observation and recording what other species were frequently found with it were we able to find it. It is highly unlikely that this could become an invasive species in the wild.

Table 11. Wild Canadian Lonicera caerulea collected in recent years and established at the University of Saskatchewan. The number of clones is an estimate. At each site an attempt was made to find 7 clones. Sometimes more were collected, but often a site was abandoned after 45 minutes if 7 could not be found.

| Year | Location | Sites | Clones |
|---|---|---|---|
| 2007 | SK | 5 | 20 |
| | MB | 35 | 120 |
| 2008 | AB | 6 | 30 |
| | SK | 35 | 175 |
| | ON | 46 | 230 |
| | QC | 11 | 55 |
| | NL | 5 | 25 |
| 2009 | ON | 15 | 122 |
| | QC | 16 | 76 |
| | NS | 25 | 137 |
| | NB | 20 | 98 |
| | PEI | 5 | 32 |
| 2010 | AB | 9 | 36 |
| | NL | 64 | 320 |
| | Total | 297 | 1476 |

Two web articles were written in 2009 that described the plant expeditions of 2008 and 2009 (Appendix I and II). More details about the collection process and the people involved are describe in those articles, but the Table 11 and Figure 5 are more up to date.

In 2010 new wild Lonicera caerulea accessions were gathered from sixty-four sites in Newfoundland and nine sites in Alberta by Bob Bors and James Dawson. Bob presented a poster and gave a short talk at the International Society of Horticulture Science conference and James wrote a web article about this endeavor (it follows). This grant did not fund these trips but did fund the care of the plants once they arrived.

In 2011, there were no plant collecting missions for wild Canadian haskap.


Figure 5. Sites across Canada where wild Lonicera caerulea has been gathered for fruit breeding purposes. It has never been found west of Alberta.

## Finding wild *Lonicera caerulea* in Newfoundland

by James Dawson* and Bob Bors,
*Ph.D. student of the U. of Sask. Fruit Program

*Lonicera caerulea* var. *villosa* is the North American subspecies of the blue berried honeysuckle or Haskap. This species can be found from Alberta to the Island of Newfoundland. The island of Newfoundland offers a unique opportunity to understand the factors influence the distribution of this Canadian subspecies in its natural habitat. On a recent plant collecting trip Dr. Bob Bors and I traveled to this rugged island and made observations on the habitats in which *Lonicera caerulea* var. *villosa* were found. These observations serve as a case study on the natural adaption of this plant to different ecological settings.

Newfoundland is an island comprising of approximately 106,000 km$^2$. The winters are mild due to the buffering effect of the Atlantic Ocean, the summers however are short, cool and wet due to the influence of the Labrador current which flow south from the Arctic. In addition the soil profile of the island is very shallow due to the effects of the last glacial retreat with eroded a large proportion of the island soils. The islands biome is that of the boreal forest that stretches across the majority of northern North America, however several other ecosystems are represented such as coniferous forest, bogs, heath and barrens.

**Figure 6. Habitats of Lonicera caerulea in Newfoundland**

**Boreal forest** – Plants less commonly found. Generally found at the edge of tree stands usually growing from under taller trees. Sometimes found in open areas where competition from grasses has been reduced. In these areas the plant form is generally upright and heavily branching.

**Meadows** – Plants with a this a less commonly found. Plants appear to have a less upright form majority of biomass underground, form somewhat resembles a rhizome system with single unbranched uprights emerging over large area.

**Shoreline** – Plant less commonly found. Plants are compact, rarely greater then 15cm in height, prostrate and generally unbranched. Plants tend to spread into a dense mat.

**Bogs** – Plants easily found. Plants are generally upright, and are usually found in raised areas created by small trees. Plants found in bog are usually small with only a few upright branches.

**Fens** – Plants are easily found. Plants are upright and usually found in raised areas created by small trees and scrubs, plants appear to be outcompeted by grasses in more open area. Generally a few upright branches can be found growing intertwined with shrub species.

**River banks** – Plants less commonly found. Plants will grow near rivers where the banks are slightly raised.

**Heath barrens** – This setting is characterized by the dominance of small woody shrubs in the heath family. Plants generally found. Plants tend to show upright growth with branches intertwined with other low-lying shrubs

**Road side** – Plants generally found. Plants appear to flourish in areas where woodlands around roadsides have been cut back and the wood materials left. This appears to create a fairly thick organic layer which the plant grows well in. In addition plants also seem to tolerate gravel shoulders and some plants can be found, however they tend to have a very prostrate and sprawling growth habit.

In general *Lonicera caerulea* var. *villosa* appears to be well adapted to Newfoundland's climate and is adapted to several different ecological settings. Some generalities in growth habit and size appear to occur in these different settings. In general plants growing in waterlogged areas tend to be small with only a few upright branches, and generally require a slightly raised area in which to grow. Plants found in areas that are not water logged tend to be much larger with many thick upright branches and tend to be confined to areas where competition from grasses and herbaceous plants is reduced.

When we collected plants from Newfoundland we only took shoot cuttings, not whole plants. This is because the Golden Nematode (*Globodera rostochiensis)* is present in Newfoundland and there are restrictions on removing plants with soil from cultivated areas. Even though we gathered from the wild we didn't want to take and chances by bring back rooted plants. That nematode would be a serious problem to potato growers if it ever became widespread in the rest of Canada.

The map (Figure 5) shows all the places we found *L. caerulea*. We did not have time to investigate the southern and central areas. We mainly travelled major highways over a 2 week period. One might think that the species is very plentiful by looking at the map below, but it is rather uncommon. We often spent 30 to 60 minutes at any given location searching for our 'target' of 7 plants per location. The species although widespread is rather sporadic and never dominates any area. It is not an invasive species.

We will be using the plants obtained from this expedition and others across Canada in the Haskap breeding program at the University of Saskatchewan. Also we plan to study their genetics and various nutraceutical compounds that may be present.

## Observations of wild Canadian *Lonicera caerulea ssp. villosa* relocated to the U of SK

In 2010, extensive flooding occurred in much of Saskatchewan and the University's horticulture field plots were no exception. The field that had ssp. villosa became mud with sporadic puddles for most of the summer. The field was planted with alternating sections of : controlled crosses | wild | controlled crosses | wild | named varieties. It was observed that leaves of the controlled crosses and named varieties became yellow and in some cases had marginal leaf necrosis during this period, likely due to iron chlorosis. In contrast, the leaves of the wild plants remained a healthy dark green (Figure 7).

Figure 7. Iron Chlorosis caused by severely wet clay soils for most of the summer months. This was seen in almost all breeding lines derived from Japanese, Kurile and Russian stock (left) but wild germplasm from Canada appeared healthy (right). The plants depicted above were typical of the plants in Block 14.

Although plants were gathered from across Canada, some from hardiness zone 6 in Ontario and Nova Scotia, all had good winter survival in Saskatoon (hardiness zone 2).

There was sporadic fruit set in 2010 but in 2011 the plants gathered in 2008 and earlier had very good fruit set. Fruit size was very small in the range of 0.2 to 0.4gms. However, fruit size was reminiscent of the fruits gathered from the wild by Dr. Bors in 2008 (Figure 8). We are expecting that 2 or 3 generations of backcrosses to larger fruited selections may be needed to restore fruit size to an acceptable size when we use this material in breeding.


Figure 8. A comparison between Wild Saskatchewan berries and wild fruit gathered from Japan. Wild Saskatchewan Lonicera caerulea berries (above) are similar in size to wild fruit gathered at the Tomakomi conservation area, Hokkaido, Japan (below). The bushes that bore the Saskatchewan fruits were only 2 years old while the Tomakomi bushes were over a decade old. Fruit size does increase in Haskap when bushes get older but it is unlikely that any of the wild bushes will bear fruit as large as the smallest Russian cultivar. But it is encouraging that Japan with the largest fruit size may have started with similarly small fruit from the wild.

A very exciting quality of the wild Canadian fruit was that almost all of them tasted good! This is in startling contrast to Russian reports that good tasting fruit was very rare (but did occur) especially in Northern Europe and North-Eastern Asia. Also it seemed that the good flavour was somewhat different than the good flavour of other breeding material. It may be that this material will be valuable for enhancing the taste of future cultivars.

It was noted that much of the Canadian material has a compact, sturdy look to the bushes similar to the Kurile types. There are also types that were gathered close to the ocean in eastern Quebec and Labrador that creep along the ground (Figure 9). Approximately 60% of Canadian *Lonicera caerulea* has reddish leaves when they begin to leaf out in spring (Figure 9). Both red and green leaves and even slightly red leaves can be found at the same site in the wild. It would be interesting to see if the plants with red leaves are ones that will have more pigmentation in their

fruit. Perhaps it will be possible to screen for anthocyanin production at the seedling stage? Leaves with a reddish tint are often seen in the greenhouse when we grow our seedlings. But in the field, the Canadian germplasm is easily seen to be the most red. Perhaps we will find that the Canadian germplasm has more anthocyanins than other types of Haskap.

Figure 9. Variation in leaf colour and bush form of wild Lonicera caerulea from Canada. The plant on the left has reddish leaves in spring and is more upright. The plant on the left has green leaves and sprawls along the ground. In the wild, sprawling plants were very rare being found in mostly in areas along the St. Lawrence Seaway and in Newfoundland. By June it is difficult to tell the red leafed ones from the green leafed ones. The reddish ones seem to turn into a slightly darker green compared to those that started green.

In 2011, pollen was gathered from the more vigourous bushes with many flowers and then bulked by province and used in crosses. Later in the season, when fruit was fully ripened, the wild material was evaluated and the best plants tagged for using as females in crosses in 2012.

Leaf samples from three plants from each site were gathered, flash frozen, freeze dried and ground for DNA studies. Graduate student Eric Gerbrandt analysis on some of the plants and other samples were given to Tyler Smith of Ag Canada who is also doing preliminary analysis of about 20 samples.

## Selecting Kurile Island seedlings for use in breeding

Discussions with Dr. Sorokin and Dr. Thompson indicate that the various 'Kurile Island' types are actually descendant of a single accession. Researchers at the Vavilov Institute gathered seeds from the mother plant that had hybridized via open pollination with other plants in the collection. Those seeds were sent to the various breeding stations in the USSR network that used them in breeding. Breeders likely chose to select for some of the unusual traits inherent in that original plant: large leaves, stocky branches, and late blooming.

In our collection are 6 Kurile varieties from Russia, 50 seedlings from open-pollinated Kurile plants at Dr. Thompson Program (likely Japanese plants were the pollen source) and 200 seedling from open-pollinated Kurile plants from our own program (likely Russians plants were the pollen source). This later group was evaluated for plant vigour and used in crosses in the spring of 2011. At fruiting time all the Kurile hybrid, regardless of source were evaluated in 2011 and the best 10 were dug up and potted for use in breeding in the greenhouse. The better selections have large fruits and good leaf disease resistance. Unfortunately, most have only mild flavour. Of the various Kurile types, it seems that the best 'Kurile x Russia' hybrids have a faster growing rate with tall sturdy plants. An example of their fruit can be seen in Figure 10.

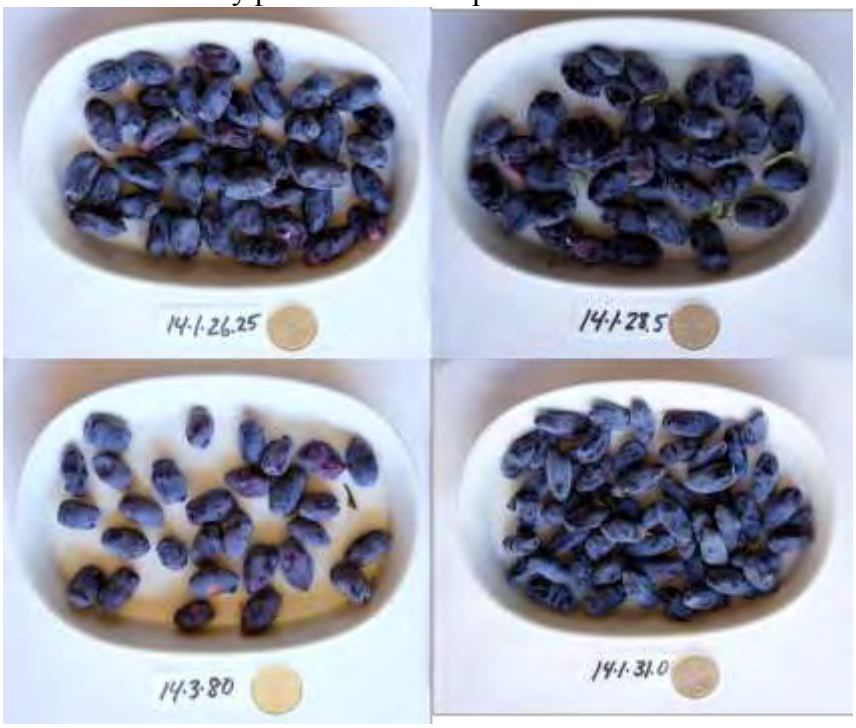


Figure 10. Berries from Kurile hybrids. These are likely to have had Russian varieties as males. The berries are more elongated like Russian varieties. The field that the Kurile mother plants were in had mostly Russian plants that were the likely male parents of plants that bore the fruit above..

# Breeding

## Strategy

The overall breeding strategy is to inter-cross various types of Haskap germplasm to bring together the best traits from each type. We have been crossing many combinations of parents and expect to find superior combinations that can be repeated in larger numbers in future years.

In 2009 most of the crosses involved intercrossing Japanese and Russian varieties but Kurile germplasm played an important role. (See figure 11) In 2010, proportionately more crosses involved U of SK hybrids and Canadian germplasm began to be used. Specific crosses were made to incorporate highly vigourous Russian germplasm into breeding. In 2011, Russian germplasm and U of SK hybrids were not used at all. Instead, Japanese and Canadian germplasm collected a few years earlier was emphasized. The Kurile accessions used in 2011 were selections from open pollinated seeds from our own fields.

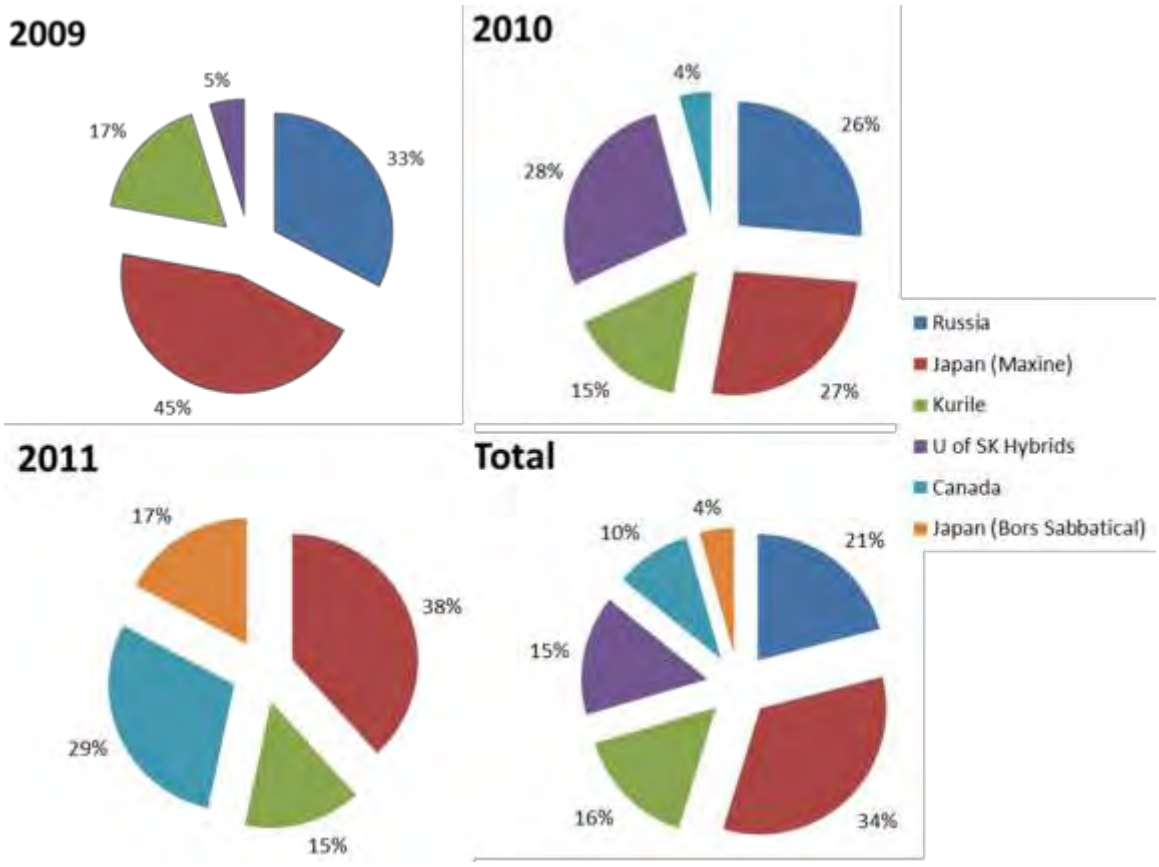


**Figure 11. Percentages of types of Lonicera caerulea germplasm used in crosses for three years.**

## Seedlings from 2008 crosses

All seeds derived from 2008 crosses were germinated and reared in our greenhouse. In previous years many seedlings became overgrown in their plug trays in the greenhouse and often needed frequent watering. Those plants were a good size for planting in March, which was three months too early. We observed that the seedlings usually started to go dormant by the time of planting and that powdery mildew often occurred in spring in the greenhouse.

In an effort to economize, germination was started in January (instead of November) which resulted in the plants being much smaller than anticipated. We started germination 2 months later in the hopes that the plants would be a more optimum size but this coincided with much greater powdery mildew infestation in the greenhouse when the plants were actively growing. Dr. Bors was away gathering Haskap at the time of the infestation and the technician in charge of watching them did not think to treat them with any fungicides quickly enough. While they were eventually treated most plants had gone dormant and were too small for field planting.

However the twenty-five percent or so seedlings that did grow to adequate size were field planted in the spring of 2009, and the remainder of the seedlings were held over to be planted in 2010. We have noted that greenhouse plants are much more susceptible to powdery mildew. Accessions that don't get powdery mildew in the field can easily get it in the greenhouse, so we have not viewed greenhouse screening of the disease as being very feasible.

## 2009 Crosses

The 2009 Crosses are listed in table 1. The crossing plan combined Japanese with Russian or Kurile germplasm with a goal of widening the genetic base on the Japanese side and improving plant vigor. Most of the Kurile germplasm blooms later than either the Russian of Japanese germplasm. A secondary goal of Kurile X Japan crosses is to have late ripening varieties to extend the growing season.

Over the last few years we have been cooperating with Dr. Thompson, a retired Professor of Oregon State University but active breeder of Haskap, and she has let us collect cuttings and seedlings from her collection to use in our breeding program. Her germplasm is mainly of Japanese descent. In previous years we have used her clones in breeding but this year was the first time we used pollen from open pollinated seedlings. These seedlings were previously selected for fast growth, overall health, and upright habits and the pollen was bulked from the best eight plants for each family. In most cases eighty to 120 seedlings had been grown in order to select the best eight. However, these seedlings were not directly evaluated for fruit quality (but the mother plants were). The pollen parents were grown in pots for a few years and bloom was forced in the greenhouse. Later in the 2009 season these pollen parents were planted in the field.

On the female side of the crossing equation, we used the six best Russian varieties in our collection based on two years of rather intense screening (ADF 2006-0140) and a few years of general observations.

Table 12. Haskap crosses of 2009. **This was the 1st year Japanese germplasm was extensively used as males in crosses with Kurile and Russian germplasm.**

**2009 Haskap Crosses**

***Kurile x Japan Crosses***

| Person | # | Female Parent | Male Parent |
|---|---|---|---|
| ERS | 41 | 3-02 | 52.41 |
| ERS | 42 | 3-02 | 52-48 |
| ERS | 43 | 3-03 | 68-88 |
| ERS | 44 | 3-03 | 41-83 |
| ERS | 45 | 3-03 | 52-35 |
| ERS | 46 | 3-03 | 43-67 |
| ERS | 47a | 3-03 | 51-53 |
| ERS | 47b | 3-05 | 43-67 |
| ERS | 48 | 3-03 | 72-63 |
| ERS | 49 | 3-03 | 52-35 |
| ERS | 51 | 3-03 | 51-45 |
| PJR | 41 | 3-02 | 44-64 |
| PJR | 42 | 3-03 | 73-61 |
| PJR | 43 | 3-03 | 52-35 |
| PJR | 44 | 3-03 | 52-48 |
| PJR | 45 | 3-03 | 41-83 |
| PJR | 46 | 3-03 | 78-57 |
| PJR | 46 | 3-05 | 72-63 |
| PJR | 47a | 3-03 | 41-75 |
| PJR | 47b | 3-05 | 41-35 |
| TDS | 41 | 3-02 | 45-24 |
| TDS | 42 | 3-02 | 41-75 |
| TDS | 43 | 3-03 | 51-53 |
| TDS | 43 | 3-05 | 78-57 |
| TDS | 44 | 3-03 | 51-45 |
| TDS | 45 | 3-03 | 52-35 |
| TDS | 46 | 3-03 | 79-95 |
| TDS | 46 | 3-05 | 22-71 |
| TLK | 41 | 3-02 | 22-71 |
| TLK | 42 | 3-02 | 52-41 |
| TLK | 43 | 3-03 | 52-41 |
| TLK | 44 | 3-03 | 41-75 |
| TLK | 45 | 3-03 | 78-13 |
| TLK | 46 | 3-03 | 44-69 |
| TLK | 47 | 3-03 | 22-71 |
| TLK | 48 | 3-03 | 43-67 |

***Russia x Japan Crosses***

| Person | # | Female Parent | Male Parent |
|---|---|---|---|
| ERS | 2 | SX2-05 | 29-37 |
| ERS | 3 | SX2-05 | 41-75 |
| ERS | 5 | SX2-08 | 22-71 |
| ERS | 6 | SX2-08 | 49-69 |
| ERS | 7 | SX2-10 | 68-88 |
| ERS | 8 | SX2-10 | 78-57 |
| ERS | 9 | SX2-10 | 79-92 |
| ERS | 11 | SX2-13 | 22-26 |
| ERS | 12 | SX2-13 | 42-48 |
| ERS | 13 | SX2-13 | 51-45 |
| ERS | 15 | SX2-16 | 45-57 |
| ERS | 16 | SX2-16 | 43-67 |
| ERS | 17 | SX2-16 | 51-53 |
| ERS | 19 | SX2-17 | 45-14 |
| ERS | 20 | SX2-17 | 51-39 |
| ERS | 21 | SX2-17 | 51-49 |
| PJR | 1 | SX2-05 | 46-55 |
| PJR | 2 | SX2-05 | 52-48 |
| PJR | 3 | SX2-05 | 19-81 |
| PJR | 4 | SX2-08 | 52-15 |
| PJR | 5 | SX2-08 | 69-75 |
| PJR | 6 | SX2-08 | 70-84 |
| PJR | 7 | SX2-08 | 73-21 |
| PJR | 9 | SX2-10 | 41-83 |
| PJR | 10 | SX2-10 | 52-35 |
| PJR | 11 | SX2-10 | 45-24 |
| PJR | 12 | SX2-13 | 69-43 |
| PJR | 13 | SX2-13 | 77-74 |
| PJR | 14 | SX2-13 | 79-85 |
| PJR | 15 | SX2-16 | 52-41 |
| PJR | 16 | SX2-16 | 72-63 |
| PJR | 17 | SX2-16 | 73-61 |
| PJR | 18 | SX2-17 | 52-35 |
| PJR | 19 | SX2-17 | 78-13 |
| PJR | 20 | SX2-17 | 79-95 |
| TDS | 1 | SX2-08 | 52-48 |

***Russia x Japan Crosses***

| Person | # | Female Parent | Male Parent |
|---|---|---|---|
| TDS | 2 | SX2-08 | 69-81 |
| TDS | 3 | SX2-08 | 77-74 |
| TDS | 4 | SX2-16 | 51-53 |
| TDS | 5 | SX2-16 | 52-35 |
| TDS | 6 | SX2-16 | 69-75 |
| TDS | 7 | SX2-16 | 78-13 |
| TDS | 8 | SX2-17 | 52-15 |
| TDS | 9 | SX2-17 | 69-43 |
| TDS | 10 | SX2-17 | 79-85 |
| TDS | 11 | SX2-10 | 70-84 |
| TDS | 12 | SX2-10 | 73-21 |
| TDS | 13 | SX2-10 | 79-92 |
| TLK | 2 | SX2-08 | 29-37 |
| TLK | 3 | SX2-08 | 45-14 |
| TLK | 4 | SX2-08 | 51-49 |
| TLK | 6 | SX2-16 | 22-26 |
| TLK | 7 | SX2-16 | 41-83 |
| TLK | 9 | SX2-17 | 42-48 |
| TLK | 10 | SX2-17 | 43-67 |
| TLK | 12 | SX2-10 | 22-71 |
| TLK | 13 | SX2-10 | 46-55 |
| TLK | 14 | SX2-10 | 51-39 |

***Russia x (Kurile x Russia) Crosses***

| Person | # | Female Parent | Male Parent |
|---|---|---|---|
| ERS | 1 | SX2-05 | TUNDRA |
| ERS | 4 | SX2-08 | TUNDRA |
| ERS | 10 | SX2-13 | TUNDRA |
| ERS | 14 | SX2-16 | TUNDRA |
| ERS | 18 | SX2-17 | TUNDRA |
| PJR | 8 | SX2-10 | TUNDRA |
| TLK | 1 | SX2-08 | TUNDRA |
| TLK | 5 | SX2-16 | TUNDRA |
| TLK | 8 | SX2-17 | TUNDRA |
| TLK | 11 | SX2-10 | TUNDRA |

## 2010 Crosses

This year all pollen collection and crosses were done in the field. Frequent rains and fairly cool temperatures disrupted crossing plans. We chose to do a higher number of combinations but do fewer flowers for each combination. Seed set was down considerably as it often rained after we had finished pollinating. We kept open pollinated seed of the best selections and in some cases used bulk pollen to compensate for the lower seed numbers.

About 5000 seeds were planted in late fall from the crosses made earlier in 2010. Perhaps 1000 of these were 'vigour crosses', 500 were hybrids with wild Canadian plants, and 3500 'mainstream' seedlings. Another 2000 or so seeds were planted in January of 2011.

### Crosses for increased plant vigour

After several years of observation, four accessions were identified as having extreme vigour (Table 12). These plants typically grow 50 to 100% faster than most plants in our collection. Not only are they fast growers but they are the tallest plants in our collection. Unlike Saskatoons and dwarf sour cherries, even the tallest Haskap are only about 2.3m and are of an acceptable size for over-the-row harvesters. Faster growing plants could result in bushes coming into production a year or two earlier.

All of these 'super vigour' breeding lines are flawed with smaller than average fruit size and poor to okay flavour. To rectify this problem, they were crossed with a wide assortment of various breeding lines having high quality fruit (Table 13). If large fruit size can be combined with large fast-growing plants it may be possible to boost yield by 30% or more. Berry blue and the Yukon series were available in large enough plant numbers but 'Magadon' and 'Row 11' had only single plants and had recently been renovated so were not used in many crosses.

These vigourous Russian types were largely ignored in previous years crossing plans. It was originally thought that plants with smaller fruit likely had more energy to put into vegetative growth and that perhaps vigour was being accomplished at the expense of yield. However, when the 'Yukon' seeds were germinated the plants outgrew all other breeding lines in the greenhouse. Theoretically at the 1$^{st}$ season of growth after germination all of the seedlings were not yet being burdened with fruit production and they all should have been just as fast growing. But Yukon seedlings were clearly faster growing. In the field it was easy to spot the 'Yukon' family as it had the tallest plants in that field at an early age.

**Table 13. Germplasm identified as highly vigorous that was used in extensive crosses in 2010.**

| Identifier | Source | Comments |
|---|---|---|
| Czech#17 (Berry Blue) | From Czech Republic via Jim Gilbert | OK flavour, small berries, 25% of fruit tends to drop off. Tallest of our Russian germplasm received before 2004. |
| Row 11 vigour | USDA genebank | Mixed lot of seedlings, might be 2x, rather bitter. Distinctively red stems. |
| Yukon Family | From Whitehorse, YK via DNA Gardens, AB | Medium sized, mostly rounded fruit, variable flavour, some unusually bright blue colour. From a gardener who grew several generations from seed. Believed to have been based on Russian germplasm, may have been OP seedling of Bugnet varieties? |
| Magadon (C10) | Russian variety via Maxine Thompson | Large tall bush both in Saskatchewan and in Oregon |

We 'fast tracked' the fastest growing seedlings by transplanting to larger containers at an early age in an attempt to use their pollen in crosses for the 2011 season. Slower growing plants were discarded. Although fast tracking did make for larger plants, not enough flowers were produced to use in 2011 crosses. From this series of crosses we have retained the fastest growing 150 or so plants.

Some of the crosses presented in table 13 are crosses between vigourous types including 'Magadon' and 'Row 11 Vigour'. These hybrids may give us insight into how far we can push vigour. When 'Magadon' and 'Row 11 Vigour' plants recover from their renovation they may be used in more crosses.

It is anticipated that the hybrids resulting from these crosses may need another generation or two to restore fruit quality and size. Studies on using wild strawberries at U. of Guelph showed that 3 generations were required. We will try backcrosses to parents with high fruit quality as one strategy. We will also be doing convergent crosses between lines with different sources of vigour as this is more likely to retain high vigour but might take more generations to achieve faster growing cultivars. Magadon and Czech#17 are far from being wild so the number of generations needed may not be so many.

Table 14. Crosses made in 2010 that involved the highly vigourous ‘Berry Blue’ or the ‘Yukon Series’. Types are: K=Kurile, J=Japan, R=Russia, H=Hybrid.

| TYPE | Cross | ID | | TYPE | CROSS | ID |
|---|---|---|---|---|---|---|
| KR | 3-05 x Yuk2 | 11-01 | | RR | 2-06 x Yuk Bulk | 11-48 |
| KR | 3-06 x Yuk6 | 11-02 | | RR | 2-17 x Yuk Bulk | 11-49 |
| KR | 3-08 x Yukon8 | 11-03 | | RR | 2-08 x Yuk Bulk | 11-50 |
| RJ | Yuk6 x K51-39 | 11-04 | | HR | (G14 x 2-11) x Yuk6 | 11-51 |
| RJ | Yuk6 x 26-17 | 11-05 | | HR | (G14 x 2-11) x Yuk2 | 11-52 |
| RJ | Yuk4 x 51-49 | 11-06 | | JR | MT51xYuk8 | 11-60 |
| RJ | Yuk2 x 64-72 | 11-07 | | RJ | Yuk2xMT51-45 | 11-61 |
| RJ | Yuk4 x R27-35 | 11-08 | | JR | MT51-53 x Yuk8 | 11-62 |
| RJ | Yuk2 x 66-53 | 11-09 | | RR | C10 x Yukon1 | 11-70 |
| RJ | Yuk6 x 26-17 | 11-10 | | RK | Yuk6 x A19 | 11-71 |
| JR | 66-53 x Yuk2 | 11-11 | | RR | Yuk5 x C10 | 11-72 |
| JR | 444-39 x Yuk2 | 11-12 | | JR | G14 x Yuk1 | 11-73 |
| JR | 44-96 x Yuk6 | 11-13 | | RJ | Yuk3 x G10 | 11-74 |
| JR | 64-72 x Yuk8 | 11-14 | | RK | Yuk6 x G20 | 11-75 |
| JR | 41-83 x Yuk4 | 11-15 | | KR | Blue Velvet x Yuk8 | 11-80 |
| RJ | Yuk6 x 44-39 | 11-16 | | RR | Bery Blue x Yuk Bulk | 11-81 |
| JR | 22-14 x Yuk6 | 11-17 | | RR | Berry Blue x Yuk2 | 11-82 |
| JR | 66-89 x Yuk2 | 11-18 | | RR | C10 X Berry Blue | 11-120 |
| JR | 41-83 x Yuk4 | 11-19 | | RR | 2-08 x Berry Blue | 11-121 |
| JR | 6-16-20 x Yuk4 | 11-20 | | RR | Berry Blue x 2-10 | 11-122 |
| JR | 6-23-18 x Yuk Bulk | 11-21 | | RR | Berry Blue x 2-08 | 11-123 |
| RJ | Yuk2 x 6-15-10 | 11-22 | | HR | 6-23-10 x Berry Blue | 11-124 |
| RJ | Yuk5 x 6-21-31 | 11-23 | | HR | 6-16-20 x Berry Blue | 11-125 |
| RJ | Yuk4 x 6-23-52 | 11-24 | | RR | Berry Blue x 2-16 | 11-126 |
| HR | 6-23-18 x Yuk8 | 11-25 | | RR | 2-06 x Berry Blue | 11-127 |
| JR | 15-19-10 x Yuk4 | 11-26 | | RR | 2-17 x Berry Blue | 11-128 |
| JR | 6-16-30 x Yuk8 | 11-27 | | RR | Berry Blue x 2-06 | 11-129 |
| JR | 6-16-30 x Yuk | 11-28 | | RR | 2-13 x Berry Blue | 11-130 |
| RJ | Yuk3 x 6-16-20 | 11-29 | | JR | 15-19-10 x Berry Blue | 11-131 |
| JR | 6-16-30 x Yuk6 | 11-30 | | HR | 6-23-52 x Berry Blue | 11-132 |
| HR | 6-23-52 x Yuk2 | 11-31 | | HR | G14 x 2-11 x Berry Blue | 11-133 |
| JR | 6-16-20 x Yuk4 | 11-32 | | JR | 64-72 x Berry Blue | 11-134 |
| HR | 6-23-52 x Yuk6 | 11-33 | | RR | Berry Blue x C10 | 11-135 |
| HR | 6-16-20 x Yuk1 | 11-34 | | JR | 64-72 x Berry Blue | 11-136 |
| HR | 6-23-18 x Yuk6 | 11-35 | | KR | Blue Velvet x 2-08 | 11-140 |
| RR | Yuk2 x 2-10 | 11-40 | | KR | Blue Velvet x R11 | 11-141 |
| RR | Yuk2 x 2-06 | 11-41 | | KR | Blue Velvet x 57-49 | 11-142 |
| RR | 2-06 x Yuk1 | 11-42 | | JK | 41-83 x Blue Velvet | 11-143 |
| RR | 2-08 x Yuk2 | 11-43 | | KH | Blue Velvet x 97-12 | 11-144 |
| RR | Yuk7 x 2-10 | 11-44 | | KJ | Blue Velvet x 42-45 | 11-145 |
| RR | 2-13 x Yuk Bulk | 11-45 | | KJ | Blue Velvet x 44-76 | 11-146 |
| RR | Yuk7 x 2-10 | 11-46 | | JK | 444-39 x Blue Velvet | 11-147 |
| RR | 2-05 x Yuk6 | 11-47 | | KH | Blue Velvet x 6-16-30 | 11-148 |
| | | | | KH | Blue Velvet x 6-15-10 | 11-149 |

## Crosses with wild Canadian germplasm 2010

Many of the wild Canadian plants bloomed for the 1st time in 2010 but often occurred during heavy rainfall. The Canadian germplasm has not yet been evaluated because the plants are too small. Therefore they were only used in a small number of crosses.

It has been noted that wild Canadian seeds had germination lower than 20%. Possible explanations for this phenomena may be that wild Canadian seeds could have a dormancy requirement, or that there are ploidy differences or that Canadian plants have some type of genetic incompatibility with other *Lonicera caerulea*.

Table 15. Crosses done in 2010 that involved wild Canadian Lonicera caerulea. Types are: C=Canada, K=Kurile, J=Japan, R=Russia, H=Hybrid.

| TYPE | Cross | ID |
|---|---|---|
| CJ | ON52 x 51-53 | 11-100 |
| CJ | ON26 X 23-18 | 11-101 |
| CH | ON43 X KR14-3 | 11-102 |
| CK | ON24 X A19 | 11-103 |
| JC | 46-55 X ON | 11-104 |
| CH | L6 X KR14-1 | 11-105 |
| CH | L2 X KR7-1 | 11-106 |
| CH | AB4 X KR5-3 | 11-107 |
| CH | SK10 X KR14-2 | 11-108 |
| KC | 3-03 X SK | 11-109 |
| CH | SK43 X KR11-1 | 11-110 |
| JC | 45-4 X SK | 11-111 |
| CH | SK35 X KR5-2 | 11-112 |
| RC | 2-08 X Q | 11-113 |
| KC | 3-05 X QC | 11-114 |
| CH | M20 X(G14 X 2-11) | 11-115 |
| HC | JR15-R13-PH10 X MB1 | 11-116 |
| KC | 3-06 X MB | 11-117 |
| JC | 43-87 X MB | 11-118 |
| CH | L6 x KR14-3 | 11-119 |

## Crosses with Borealis and Tundra

Many crosses were done between our existing best cultivars, 'Borealis' and 'Tundra' and superior selections in our breeding program. Many of these crosses were done to verify possible pollinators, but others were done to incorporate worthwhile traits. Haskap requires crosspollination between 2 compatible varieties in order to get fruit set.

Table 16. Crosses between various hybrids and Japanese germplasm and our varieties 'Tundra', 'Borealis', and 'Indigo Gem' in 2010. Types are: K=Kurile, J=Japan, R=Russia, H=Hybrid.

| TYPE | CROSS | ID | TYPE | CROSS | ID |
|---|---|---|---|---|---|
| JH | 6-16-30 x likely Tundra | 11-200 | HJ | Borealis x 6-16-20 | 11-253 |
| JH | 6-16-20 x Tundra | 11-201 | HH | 6-23-18 x Borealis | 11-254 |
| JH | 6-23-18 x Tundra | 11-202 | HH | Borealis x 6-23-18 | 11-255 |
| HJ | Tundra x 6-23-52 | 11-203 | JH | MT46-134 x Borealis x Bull | 11-256 |
| JH | 15-19-10 x Tundra | 11-204 | HH | Borealis x KR7-2 | 11-260 |
| JH | 6-16-30 x Tundra | 11-205 | HH | Borealis x KR11-2 | 11-261 |
| HJ | Tundra x 6-23-18 | 11-206 | HH | KR5-1 x Borealis | 11-262 |
| JH | 42-45 x Tundra | 11-210 | HH | Borealis x KR5-2 | 11-263 |
| JH | 22-14 x Tundra | 11-211 | HH | Borealis x KRB-1 | 11-264 |
| JH | 44-96 x Tundra | 11-212 | HH | Borealis x KR14-1 | 11-265 |
| JH | 77-87 x Tundra | 11-213 | HH | Borealis x KR14-3 | 11-266 |
| HH | Tundra x KR5-1 | 11-220 | HH | KR10-R5 x Borealis | 11-267 |
| HH | Tundra x KR11-2 | 11-221 | HH | KR2-1 x Borealis | 11-268 |
| HH | Tundra x KRB-3 | 11-222 | HH | Borealis x KR7-1 | 11-269 |
| HH | KR14-1 x Tundra | 11-223 | HH | KR7-1 x Borealis | 11-270 |
| HH | Tundra x KR7-1 | 11-224 | HH | Borealis x KR5-3 | 11-271 |
| HH | Tundra x KR13-2 | 11-225 | HH | Borealis x KR11-1 | 11-272 |
| HH | Tundra x KR13-1 | 11-226 | HH | Borealis x KR8-2 | 11-273 |
| HH | Tundra x KR5-3 | 11-227 | HH | Borealis x KR14-2 | 11-274 |
| HH | Tundra x KR8-1 | 11-228 | HH | Borealis x KR14-4 | 11-275 |
| HH | KR8 x Tundra | 11-229 | HH | Borealis x KR13-1 | 11-276 |
| HH | Tundra x KR5-2 | 11-230 | HH | Borealis x Tundra | 11-280 |
| HH | KR10-R1-P1 x Tundra | 11-231 | HR | Borealis x Hamish | 11-281 |
| HH | Tundra x KRB-1 or KR14-1 | 11-232 | HH | Borealis x Indigo Gem | 11-282 |
| HH | (G14 x 2-11) x Tundra | 11-240 | JH | 6-16-30 x Indigo Gem | 11-290 |
| HJ | Tundra x Hamish | 11-241 | JH | 66-53 x Indigo Gem | 11-291 |
| HH | Tundra x Borealis | 11-242 | JH | 56-15 x Indigo Gem | 11-292 |
| HH | 6-23-52 x Borealis | 11-250 | JH | 444-39 x Indigo Gem | 11-293 |
| HH | 15-19-10 x Borealis | 11-251 | HR | Indigo Gem x Elwood | 11-294 |
| HH | 6-16-20 x Borealis | 11-252 | HR | Indigo Gem x Elwood | 11-250 |

## Mainstream crosses

Approximately 75% of the crosses done this year were between superior selections identified the previous year and with newer germplasm acquired from Maxine Thompson's program in Oregon. Most of these are second generation crosses which intermixes Japanese, Russian and Kurile germplasm (See table 3) and only a few 1st generation crosses were done.

Table 17. Mainstream crosses done in 2010. **Types are: K=Kurile, J=Japan, R=Russia, H=Hybrid.**

| Type | Cross | Code |
|---|---|---|
| KJ | 3-03 x 22-14 | 11-300 |
| JK | 66-53 x 3-03 | 11-301 |
| KJ | 3-03 x 56-13 | 11-302 |
| KJ | 3-03 x 66-89 | 11-303 |
| KJ | 3-03 x 43-87 | 11-304 |
| KJ | 3-03 x 45-14 | 11-305 |
| JK | 444-39 x 3-03 | 11-306 |
| KJ | 3-03 x 44-64 | 11-307 |
| JK | 56-15 x 3-03 | 11-308 |
| KJ | 3-03 x 41-83 | 11-309 |
| KJ | 3-03 x 23-18 | 11-310 |
| KJ | 3-03 x 6-15-10 | 11-311 |
| JK | 22-14 x 3-05 | 11-320 |
| KJ | 3-05 x 66-53 | 11-321 |
| KJ | 3-05 x 44-64 | 11-322 |
| KJ | 3-05 x 79-92 | 11-323 |
| KJ | 3-05 x 45-14 | 11-324 |
| KJ | 3-05 x 79-92 | 11-325 |
| JK | 44-96 x 3-05 | 11-326 |
| JK | 22-14 x 3-05 | 11-327 |
| KJ | G23 x 3-05 | 11-328 |
| KJ | 77-87 x 3-05 | 11-329 |
| KJ | 3-05 x 6-15-10 | 11-330 |
| KJ | 3-05 x 6-16-20 | 11-331 |
| KJ | 3-06 x 27-35 | 11-340 |
| JK | 41-83 x 3-06 | 11-341 |
| KJ | 3-06 x 42-45 | 11-342 |
| KJ | 3-06 x 57-49 | 11-343 |
| KJ | 3-06 x 56-89 | 11-344 |
| KJ | 3-06 x 22-14 | 11-345 |
| KJ | 3-06 x 56-15 | 11-346 |
| JK | 444-39 x 3-06 | 11-347 |
| KJ | 3-06 x 66-89 | 11-348 |
| KJ | 3-06 x 41-83 | 11-349 |
| KK | G20 x 3-07 | 11-350 |
| JK | 44-96 x 3-07 | 11-351 |
| JK | 22-14 x 3-07 | 11-352 |
| JK | 77-87 x 3-07 | 11-353 |
| KJ | 3-07 x 66-53 | 11-354 |
| KJ | 3-08 x 23-18 | 11-360 |
| KJ | 3-08 x 44-76 | 11-361 |
| KJ | 3-08 x 44-96 | 11-362 |
| KJ | M28 x 23-18 | 11-370 |
| HJ | 97-12 x 44-96 | 11-371 |
| JJ | 6-16-20 x 6-16-30 | 11-400 |
| JJ | 6-16-30 x 6-15-10 | 11-401 |
| JJ | 15-19-10 x 6-16-30 | 11-402 |
| JH | 6-16-20 x 6-23-52 | 11-403 |
| JH | 15-19-10 x 6-23-52 | 11-404 |
| JH | 6-16-30 x 6-21-31 | 11-405 |
| JH | 6-16-30 x 6-23-52 | 11-406 |
| JH | 6-16-20 x 6-15-10 | 11-407 |
| JJ | 6-16-30 x 6-15-10 | 11-408 |
| JJ | 15-19-10 x 6-16-20 | 11-409 |
| JH | 15-19-10 x 6-23-18 | 11-410 |
| J? | 15-19-10 x ? | 11-411 |
| JH | 15-19-10 x 6-21-31 | 11-412 |
| JH | 6-16-20 x 6-21-31 | 11-413 |
| KR | 3-03 x2-16 | 11-500 |
| KR | 3-03 x 2-08 | 11-501 |
| KR | 3-05 x 2-06 | 11-510 |
| HK | (G14 x 2-11) x 3-05 | 11-511 |
| KR | 3-05 x 2-05 | 11-512 |
| KR | 3-06 x 2-08 | 11-520 |
| KR | 3-06 x 2-16 | 11-521 |
| KR | 3-08 x 2-06 | 11-530 |
| KR | 3-08 x R11 good | 11-531 |
| RJ | 2-08 x 6-23-18 | 11-540 |
| RJ | 2-05 x 6-16-30 | 11-541 |
| RJ | 2-13 x 6-23 | 11-542 |
| RR | 2-08 x tall gross | 11-543 |
| RJ | 2-10 x 6-16-20 | 11-544 |
| RR | 2-06 x R11 | 11-550 |
| JR | 6-16-30 x R11 | 11-551 |

## Open Pollinated Seeds

Seeds were gathered from advanced selections that had been open pollinated. Plants arising from these seeds may be used in various experiments by students or distributed to growers or used to fill in new plantings. It is planned to plant the entire 'MT' series as those parents were planted too close to properly evaluate.

**Table 18. Open pollinated seeds gathered in 2010.**

| Type | Female parent | Type | Female Parent |
|---|---|---|---|
| JR op | JR19-2 | J op | MT01 |
| JR op | JR19-3 | J op | MT03 |
| JR op | JR19-7 | J op | MT04 |
| JR op | JR19-6 | J op | MT05 |
| JR op | JR19-4 | J op | MT06 |
| JR op | JR9-3 | J op | MT07 |
| JR op | JR27-1 | J op | MT08 |
| J op | 6-25-5 | J op | MT09 |
| J op | 6-18-17 | J op | MT10 |
| J op | 6-18-14 | J op | MT11 |
| J op | 6-16-34 | J op | MT13 |
| J op | 6-18-38 | J op | MT14 |
| J op | 6-25-5 | J op | MT14-1 |
| J op | 6-16-44 | J op | MT14-2 |
| J op | 6-16-4 | J op | MT14-3 |
| J op | 6-16-17 | J op | MT15 |
| J op | 6-15-10 | J op | MT16A |
| J op | 6-16-15 | J op | MT16B |
| J op | 6-16-24 | J op | MT17 |
| J op | 6-15-32 | J op | MT18 |
| J op | 6-18-4 | J op | MT19 |
| K opop | BLK 14 R1 K3 | J op | MT20 |
| K opop | BLK 14 R2 K3&4 | J op | MT20 |
| K opop | BLK 14 R3 K4 | J op | MT20 |
| K opop | BLK 14 R4 K4 | J op | MT21 |
| K opop | BLK 14 R5 K4 | | |
| K opop | Bulk Kuril | | |

## 2011 Crosses

This year three different types of crosses were done, but all involved Japanese germplasm. Crosses done were 'Japan x Canada' (Table 14), '(Kurile x Russia) x Japan' Table 15) and 'Japan x Japan' (Table 16) . All of the 2011 crosses and most of the pollen collection were done outside as in 2010.

### 'Japan x Canada' crosses

The Canadian germplasm was crossed with Japanese selections (Table 14). This combination seems logical because the major shortcoming of Japanese germplasm is uneven ripening. It seemed reasonable that Canadian germplasm from mostly hardiness zone 1 would tend to be uniform ripening because of the short season. Also, since Canadian fruit is rather small, it seemed best to cross it with larger-fruited germplasm from Japan. Plants from the Prairie Provinces, Ontario and Quebec obtained in 2007 and 2008 were all blooming and so the bulk pollen used is somewhat representative of our collections of these. But pollen bulked from the Maritime Provinces and Newfoundland were from plants collected in 2009 and 2010 and only an estimated 20% of those young plants were in bloom.

### '(Kurile x Russia) x Japan' crosses

This type of cross might be considered 'mainstream' as seedling resulting from this combination might result in new cultivars. These crosses used the most vigourous Kurile open pollinated hybrids identified at the start of blooming in mid-May as female parents. Most of the Japanese parents used as males were derived from seeds collected by Dr. Bors on his sabbatical. The sabbatical descendants were bulked by collection site and used in crosses. The 'J3' series was used most frequently used because that was considered best site for germplasm that Dr. Bors visited. They were from a discontinued provincial Hokkaido breeding program that had impressive 30 year old bushes that appeared very healthy and productive.

### 'Japan x Japan' crosses

Conversations with Dr. Thompson indicated that Dr. Bors and Dr. Thompson likely did not visit the same farms in Hokkaido when they went on their respective plant collecting trips. These were intercrossed mainly out of curiosity to see if hybrid vigour might result from crossing within Japanese germplasm. The resulting germplasm may be useful in genetic studies particularly if compared with other types of hybrids. Far fewer crosses of this type were made compared to other two groups listed above.

Table 19. Crosses made in 2011 that combine Japanese and Canadian germplasm. The female parents are clones or seedlings of mostly Japanese descent from Dr. Thompson's breeding program. The male parents were bulked pollen from various provinces. Where a number follows a provincial abbreviation that indicates a specific location. Labrador germplasm (LB) is denoted separately from Newfoundland (NL) germplasm.

| Code | Female | Male |
|---|---|---|
| JAB1 | 100.34 | AB |
| JAB2 | 100.4 | AB |
| JAB3 | 100.05 | AB |
| JAB4 | 89.46 | AB |
| JAB5 | 22.14 | AB |
| JSK1 | 100.05 | SK |
| JSK2 | 89.46 | SK |
| JSK3 | 43.87 | SK |
| JSK4 | 66.89 | SK |
| JSK5 | 77.87 | SK |
| JSK6 | 89.46 | SK |
| JSK7 | 46.55 | SK |
| JSK8 | 66.53 | SK |
| JSK9 | 79.95 | SK |
| JSK10 | 444.39 | SK42 |
| JSK11 | 41.83 | SK |
| JMB1 | 100.34 | MB |
| JMB2 | 100.4 | MB |
| JMB3 | 89.46 | MB |
| JMB4 | 41.83 | MB |
| JON1 | 100.34 | ON |
| JON2 | 100.4 | ON |
| JON3 | 100.05 | ON22 |
| JON4 | 100.05 | ON |
| JON5 | 89.46 | ON |
| JON6 | 43.87 | ON |
| JON7 | 66.53 | ON |
| JON8 | 66.89 | ON40 |
| JON9 | 77.87 | ON |
| JON10 | 79.95 | ON |
| JQ1 | 100.34 | QC12 |
| JQ2 | 100.4 | QC |
| JQ3 | 100.05 | QC |
| JQ4 | 43.87 | QC |
| JQ5 | 46.55 | QC |
| JQ6 | 66.89 | QC |
| JQ7 | 89.46 | Q12 |
| JQ8 | 89.46 | QC |
| JQ9 | 66.53 | QC |
| JQ10 | 6.1.35.5 | QC |
| JQ11 | 22.14 | QC |
| JNB1 | 100.34 | NB |
| JNB2 | 100.34 | NB2 |
| JNB3 | 100.05 | NB |
| JNB4 | 89.46 | NB |
| JNB5 | 43.87 | NB |
| JNB6 | 77.87 | NB2 |
| JNS1 | 100.34 | NS |
| JNS2 | 100.4 | NS |
| JNS3 | 89.46 | NS |
| JNS4 | 52.33 | NS |
| JNS5 | 66.89 | NS |
| JNS6 | 77.87 | NS |
| JNS7 | 46.55 | NS |
| JNS8 | 6.1.23.25 | NS |
| JNS9 | 444.39 | NS |
| JPEI1 | 100.34 | PEI |
| JPEI2 | 89.46 | PEI |
| JLB1 | 100.4 | LB |
| JLB2 | 100.05 | LB |
| JLB3 | 89.46 | LB |
| JLB4 | 43.87 | LB |
| JLB5 | 66.89 | LB |
| JLB6 | 77.87 | LB |
| JNL1 | 100.4 | NL15 |
| JNL2 | 89.46 | NL29 |
| JNL3 | 89.46 | NL4 |
| JNL4 | 89.46 | NL48 |
| JNL5 | 89.46 | NL4 |

Table 20. Crosses made in 2011 between Kurile open pollinated plants and Japanese germplasm. Very likely the Kurile parents were actually 'Kurile x Russia' hybrids. Male parents that start with the letter 'J' were descended from seeds gathered from plants in Hokkaido in 2008 by Dr. Bors. All other Japanese parents are from Dr. Thompson's program.

| Code | Female | Male | Code | Female | Male |
|---|---|---|---|---|---|
| KOPJ1 | 14.1.56 | J3 | KOPJ19 | 14.3.60 | FELL OFF |
| KOPJ2 | 14.1.34 | J3 | KOPJ20 | 14.3.60 | 444.39 |
| KOPJ3 | 14.2.42 | J3 | KOPJ21 | 14.3.60 | 6.18.17 |
| KOPJ4 | 14.2.58 | J3 | KOPJ22 | 14.3.60 | 77.87 |
| KOPJ5 | 14.2.70 | J3 | KOPJ23 | 14.3.60 | 41.83 |
| KOPJ6 | 14.3.80 | J3 | KOPJ24 | 14.3.60 | 66.89 |
| KOPJ7 | 14.3.66 | J3 | KOPJ25 | 14.3.60 | J3 |
| KOPJ8 | 14.3.62 | J misc | KOPJ26 | 14.3.60 | J4D |
| KOPJ9 | 14.3.62 | 41.83 | KOPJ27 | 14.3.60 | J6 |
| KOPJ10 | 14.3.62 | 22.14 | KOPJ28 | 14.3.32 | J9B |
| KOPJ11 | 14.3.62 | 77.87 | KOPJ29 | 14.3.32 | J3 |
| KOPJ12 | 14.3.62 | J3 | KOPJ30 | 14.4.62 | J3 |
| KOPJ13 | 14.3.62 | J4A | KOPJ31 | 14.3.80 | J3 |
| KOPJ14 | 14.3.62 | J4D | KOPJ32 | 14.2.70 | J7 |
| KOPJ15 | 14.3.62 | J6 | KOPJ33 | 14.2.42 | J6 |
| KOPJ16 | 14.3.62 | J7 | KOPJ34 | 14.3.40 | J3 |
| KOPJ17 | 14.3.62 | J8 | KOPJ35 | 14.1.52 | J3 |
| KOPJ18 | 14.3.62 | J9B | KOPJ36 | 14.1.52 | J4D |

Table 21. Crosses made in 2011 between Japanese germplasm from Dr. Thompson and Dr. Bors. Germplasm from Dr. Thompson had been established for 3 or 4 years and was used as female parents. The germplasm from Dr. Bors had been field planted for only one or two years and was bulked pollen from each collection site.

| Code | Female | Male | Code | Female | Male |
|---|---|---|---|---|---|
| JJ11-1 | 22.14 | J6 | JJ11-8 | 77.87 | J6 |
| JJ11-2 | 22.14 | J4A | JJ11-9 | 77.87 | J7 |
| JJ11-3 | 22.14 | J3 | JJ11-10 | 66.89 | J4A |
| JJ11-4 | 22.14 | J4D | JJ11-11 | 66.89 | J6 |
| JJ11-5 | 444.39 | J3 | JJ11-12 | 66.89 | J4D |
| JJ11-6 | 77.87 | J3 | JJ11-13 | 66.89 | J3 |
| JJ11-7 | 77.87 | J4D | JJ11-14 | 66.89 | J3 |

# *Haskap Seedlings*

Although many crosses are attempted only about 90% produce a reasonable amount of seeds, assuming good weather. We had generally good conditions in 2009 and 2011 but frequent rain in 2010 during pollination greatly reduced the amount of seeds, likely by washing off some of the pollen. We prefer to have 100 to 150 seeds of any cross to fill 2 or 3 plug trays. Haskap plants have self-incompatibility genes that prevent them from selfing. Plants with the same incompatibility genes won't pollinate each other. Those genes are likely involved in the 10% of crosses that fail. As this crop is new, there have not been studies on the incompatibility genes nor any indication of how many there might be in the species. Our strategy of intercrossing different types of Haskap may have circumvented much of this problem since accessions from remote regions might not have the same incompatibility genes. Incompatibility is likely to be more of a problem in the future when hybrids are intercrossed.

In field crosses, meshed bags prevent pollination from bees but also protect the berries from predation. Almost all of the plants being selected for breeding are those that don't easily drop their fruit when ripe so fruit from crosses can be harvest up to a moth after they are ripe. Once harvested, berries are squashed and a high pressure washer in our greenhouse is used to clean them off. Then seeds are then dried and stored in envelopes or plastic containers. We now keep Haskap at room temperature for at least 6 weeks for an after-ripening period to allow the embryos to develop. Previously (before 2009) some seeds had been stored in a cooler immediately after being extracted from the berries. This was likely the major cause of delayed germination for some seed lines.

Seeds from crosses are planted in the greenhouse from November thru January, depending on the year. In 2010 (using 2009 seeds) we began 'fast tracking' about 20% of our seedlings. Once the seedling roots have filled the plugs, the fastest growing and healthiest ones are transplanted into larger plugs with a soil volume/plant 3 to 4 times larger. Seedling in larger plugs will grow larger and perhaps we may be speeding up the fruiting of those seedlings by a year. When our seedlings go to the field, the larger plants get planted first. Of the remaining plants we plant the best 50% or so and often discard the plugs less than average. In cases where there are many good plants from a cross, we may hold back some for growers who are raising additional seedlings for our program. During this project it is likely that we raised around 20,000 seedlings, field planted 12,000, gave to cooperative growers about 3000, and discarded 5,000.

In the breeding plots we plant our seedlings at 2 to 3x higher density than is recommended for commercial growers. The larger 'fast tracked seedling are often planted 0.5m apart while other seedlings are planted 0.3m apart. In anticipation of getting a mechanical harvester, all our plantings since 2009 have been placed in longer rows and about 3m between rows to allow for mechanical harvesting. Haskap plantings take up more field area than any other species at the Horticulture field plots (Figure 11), perhaps 6 acres. Maintenance of these plot requires considerable effort especially for weeding. Most are drip irrigated.


Figure 12. Overview of fruit plots at the University of Saskatchewan. The entire area depicted is about 40 acres. As of fall 2011 there are about 7 acres of Haskap seedlings and 1 acre of wild and cultivars of Haskap. There had been an additional two acres but that material was removed in 2010.

# Germplasm Evaluation

## 2009 & 2010: The search for a quality pollinator

The selection goal in 2009 was to find a higher quality pollinator for our previously released varieties. The 1400 plants fruiting in 2009 were from 2005 and 2006 seeds from open pollinated Maxine Thompson selections and from our own controlled crosses. Smaller numbers of seedling came into production in 2009 because previously Haskap breeding was funded as a major project. There is a chance for a new superior variety to emerge from the 2006 and 2007 plantings, but new seedling fields coming on stream in 2010 and beyond have 5 to 10 times more seedlings per year and thus a greater probability of a breakthrough.

Our currently released varieties, 'Borealis' and 'Tundra', and the 'Indigo' series are too closely related (full sibs) and therefore do not pollinate each other very well. Fruit growers and homeowners have been using various other Haskap varieties as pollinators which do not have very good quality fruit. 'Berry Blue' (not from our program) which has often been sold as a pollinator, has the advantage of growing fast and producing many flowers. Sadly, the fruit size of Berry Blue is just as discouraging as its flavour (figure 13). Therefore, it was our goal to find a pollinator that flowered at the same time as our released varieties that had both good flavour and large fruit size. Also it would be an asset if the selection was not susceptible to mildew on its leaves.


Figure 13. Contrast between 'Berry Blue' and 'Indigo Yum'. 'Berry Blue' has often been used as a pollinator because the plant will grow fast and produce many flowers. But its fruit size, flavour and susceptibility to leaf diseases leave much to be desired.

About 900 hundred seedlings planted in 2006 and 500 seedlings from 2007 were evaluated in the field for productivity and flavour. The 2006 plantings had been growing in pots (4 to a pot) for a few years before field planting. Most of these were from open pollinated seeds from the Oregon Program. The 2007 plants were from controlled crosses from our own breeding program and were just beginning to produce. Two year old plants in the field are too young to fully evaluate but it might be possible to identify selections that come into bearing fast. Field evaluations were done by Dr. Bors who tagged the bushes with high productivity and acceptable flavour and other traits. These were observed periodically throughout the summer. Also, growers, technicians, and visitors also participated in tagging what they considered the best. Tags were colour coded according to the participant. By the harvest time, Dr. Bors narrowed down the selections to the 20 best (Figure 14).

Harvesting was done in early July 2009 but some fruit was left on a few branches of each promising selection to allow further evaluations later in summer. Eventually from the twenty selections, six were chosen as 'Advanced Selections'. These six were considered to be the best in block 6.

Criteria for field selection was based on large healthy bushes, large fruit that tasted good and high productivity. Of the six selections, four were successfully put into tissue culture in the fall of 2009 in order to evaluate ease of propagation. The other two were not successfully forced in the fall but were eventually forced again in winter and put into culture.

Figure 14. Promising selections of Haskap berries just beginning to bear fruit in 2009. Each berry is from a different plant that was judged to have superior productivity and flavour. The purpose of the selection was to find a better pollinator than 'Berry Blue'. All of the selections had larger berries than Berry Blue.

In the spring of 2010 all of the six selections were observed to see if bloom would occur at the same time as 'Borealis' and 'Tundra'. If they bloomed at the correct time than it was planned to do test crosses in both directions to see if pollen was compatible. Out of the six selections only 6-21-31 and 6-24-18 bloomed at the right time and only 6-24-18 was compatible. But several other advanced selections were used in breeding.

Table 23 summarizes propagation, blooming and compatibility test observations. As a secondary evaluation for ease of propagation, some cultures of the 'winner' 6-24-18 were shared with two tissue culture propagation companies for evaluation. As of this report one of the companies stated that it propagated faster than 'Tundra' and 'Borealis' and it propagated as fast as the best Blue Honeysuckles on the market.

In the winter of 2010/2011 contracts were drawn up and 6-24-18 was renamed to 'Honey Bee' and was released to propagators and available for sale to the public by the spring of 2011.

Table 22 Observations & tests to determine a pollinator variety for 'Tundra' and 'Borealis'. These 6 were judged to be the best in a field of 3500 seedlings when that field just started to come into production.

| Selection | Ease of Multiplication in tissue culture | Blooming time compared to Tundra & Borealis | Compatibility with Tundra and Borealis |
|---|---|---|---|
| 6-15-11 | Good | Late | n/a |
| 6-16-20 | Good | Late | n/a |
| 6-16-30 | OK | Very Late | n/a |
| 6-18-17 | Poor | Late | n/a |
| 6-21-31 | Poor | Good | No |
| 6-24-18 | Excellent | Good | Yes |

'Honey Bee' is quite acceptable as a pollinator for 'Tundra' and 'Borealis' but its fruits are too cylindrical and it holds onto its stems too strongly to be desirable for mechanical harvesting. Yet it has some other desirable traits which were observed in 2010 and 2011 which were summarized in a web article which follows, reformatted to fit this document:

## 'Honey Bee' Description

'Honey Bee' was selected to be a pollinator for 'Borealis', 'Tundra' and the 'Indigo' series. (I'll call them 'BTI') It blooms at the same time and has given good fruit set when used in controlled crosses with them. It is very fast growing, productive and starts fruiting at an early age.

Its fruits are cylindrical and look more like its Russian parent (see figure 15); perhaps like the shape of a bee's body. Unlike most Russian varieties used for pollination, 'Honey Bee' holds onto its fruit firmly and stays on the bush longer than most other varieties. Most Russian blue honeysuckles varieties drop their fruit as soon as ripe in late June or early July, but not 'Honey Bee'. In 2011, it was still holding onto its fruit firmly the 3rd week of August. The stems stay on the fruit about 40% of the time when picked (reminds me of a stinger). That cylindrical shape doesn't roll around very well in equipment and neither do the stems (Stingers) come off very easily, so this variety is definitely not recommended for mechanical harvesting, unless juice is the goal.

The fruit is tarter than 'BTI' but less tart than most Russian pollinators. It has a general flavour like other Haskap but it has a hint of something different. A few growers that tasted it said it tasted good and a few also thought there was something different about it but couldn't put their finger on it. I think that undertone may be a very very slight bitterness or astringency that in the jargon of wine making might be a characteristic that gives better 'mouth-feel' to wines. Or in keeping with the bee theme, it could give a bit of a buzz. I hope some wine makers will one day try this variety and tell me if it makes a better wine. A bit more tartness could be an asset in processing or cooking. However, unless you are prepared to remove all those stems on the berries, it would be better to just crush the berries and use the juice for drinking, wine making, or making jelly.

**Figure 15.'Honey Bee' bush showing productive branches**

Its leaves are very similar in appearance to ‘BTI’ and like ‘BTI’ it has a high degree of resistance to leaf mildew on our test plots (see figure 16). The reason they look similar is because ‘Honeybee’ is also a hybrid between a variety from Russia (Suvenir) and a variety descendant from the Kuril Islands (F-1-9-58 alias ‘Blue Pacific’). But it pollinates them well because its parents are not closely related to ‘BTI’s parents. But both of ‘Honey Bee’s’ parents are taller than ‘BTI’s and it is suspected that it will grow to be 2 feet or so taller than ‘BTI’. The original plant of ‘Honey Bee’ is at least 50% taller than the ‘Borealis’ plants in the same row. The fruit is more cylindrical than ‘BTI’ (Fig17)


**Figure 16.** 'Honey Bee's leaves are similar size but slightly wider than our other varieties. Also it has less pubescence (hairs) on its leaves and good resistance to mildew and sunburn.

Figure 17. 'Honey Bee's fruit is cylindrical. The original bush is rather young so fruit size will likely increase when the bush gets older. Notice that some of the stems are still holding onto the berries.

**The need for a mildew-resistant pollinator** 'BTI' are siblings and do not pollinate each other well. Previously, we recommended trying other Russian varieties that were on the market. We had many complaints, especially from home gardeners, that their pollinators were getting severe mildew in July and looked poorly the rest of the summer (see figure 18). Mildew makes plants look poorly for the latter half of summer but does not seem to greatly reduce productivity or longevity. Fruit farmers don't need to pull out existing pollinators if they get mildew. But bush appearance is likely to be more important for gardeners. If replacing existing pollinators, it would be best to let 'Honey Bee' get a few years old before removing the old pollinator, to assure adequate pollen supply.

**History:** In 2009, we started a search for a better pollinator by identifying the best 6 seedlings out of about 1400 from the 2006 and 2007 plantings. All 6 were rated as productive, good tasting, vigourous, and bearing fruit at a young age. 'Honey Bee' was one of the few good producers at only 2 years old. All 6 selections were put into tissue culture to evaluate relative ease of propagation and Honey Bee was the fastest multiplier. The next season we observed the timing of flower opening and did controlled crosses with all 6. 'Honey Bee' was the best choice because it alone bloomed at the right time and gave good fruit set when crossed to 'Borealis' and 'Tundra'. We did not test the 'Indigo' series are siblings of 'Borealis' and 'Tundra' and should work well with 'Honeybee'.


Figure 18. These 2 commonly used pollinators have much smaller leaves than our varieties. All leaf photos were taken on July 22, 2011 and are the same scale. The 'Berry Blue' in this photo has a moderate level of mildew, while 'Cinderella' has a severe level. 'Honey Bee' is rated as highly resistant to mildew. Mildew varies from year to year but tends to strike in mid to late July especially if it is hot and humid.

**Pollination Myths:** Haskap or Honeyberries or Blue Honeysuckles do not have male or female plants; every Haskap (or Honeyberry) variety has both male and female parts but can't pollinate itself…just like apples, pears, plum, and apricots. It's nature's way of making healthy hybrid offspring. A Haskap pollinator will bear fruit that is quite useful. Calling something a "pollinator variety" implies that it is not as desirable as the "main variety". In the case of commercial growers using mechanical harvesters 'Tundra' and possibly 'Indigo Gem' are more durable in machinery and would be considered the "main varieties" and 'Honey Bee' would be the "pollinator variety". In the case of a homeowner growing 'Borealis,' perhaps 'Honey Bee' might be considered just as desirable and both would could be called "companion varieties". But both need each other to set fruit.

**Planting** Because of larger plant size, one 'Honey Bee' could provide pollen for 4 to 8 'Borealis' and 'Tundra' plants, if planted in close proximity. There is an article about planting strategies for cross pollination in our website: www.fruit.usask.ca . In a gardening situation, it would be better to put 'Honey Bee' either on the north side of 'Borealis' or far enough away that it won't crowd it out or reduce the sunshine. 'Honey Bee's bush is taller but seems to be similar width to 'BTI' and so can be planted at a similar spacing

**Primarily useful for juice production:** The fruit will likely need to be handpicked. If a machine is used for harvesting, the berries may become too mashed so it should be frozen soon after picking. It may be best to place it in separate rows. Somewhat mashed berries would still be good for most products. The stems holding onto the berries fruit is a disadvantage for many products, but would not matter if the fruit was used for juice, wine or jelly. The added tartness and different flavour may make it desirable for some products like wine or liquers.

**Guard Row Potential** Perhaps "Honey Bee" could be used as a guard row to protect inner rows from cedar waxwings. In 2011, we had too many fields of Haskap to protect with netting so we didn't try. We observed that waxwings were nesting in nearby trees and swooped into rows closest to their trees. The outer rows of the field were picked clean 1st! I always observed them in bushes eating fruit, never dining on fallen berries on the ground. In many bushes it appeared that waxwings were knocking off more fruit than they were eating (see figure 19). Since 'Honey Bee' fruit stays on the bushes, waxwings won't be so wasteful and it should take them longer to get to your preferred varieties.

**Blue Raisins?** If the birds don't get them, 'Honey Bee' may be suitable for drying on the bushes to make blue raisins since it holds onto its berries. Its cylindrical berries should dry much faster than the plump 'BTI' berries. The advantage of drying the berries on the bush is that they remain blue, but if dried in a drying machine they turn black. We have an article on our website called "Dried Haskap" with more details on this. Drying haskap on bushes should be considered highly experimental and we really don't know if it is feasible.

Figure 19. Two conditions are needed for fruit drop: a variety that lets go of its fruit easily and something to jostle the bushes; something like wind, hail or waxwings.

**Future & Availability:** 'Honey Bee' will be made available to all of our propagators of 'BTI' and will be able to be sold into the USA. Depending on whether a nursery does tissue culture or traditional cuttings, it may take a year or two after the release of a new variety before propagators have enough to sell. Our website lists all authorised propagators www.fruit.usask.ca .
We have identified new seedlings in our breeding fields that have berries that look like 'BTI' berries and have very similar bushes. Some of those could be worthwhile pollinators too. But we need to observe their time of bloom and test them for pollen compatibility. It would likely take a couple years before such improved pollinators could be propagated made available to the public.

**Acknowledgements:** Breeding of Haskap is continuing at the University of Saskatchewan. It is made possible through grants from the Agriculture Development Fund of Saskatchewan Agriculture and from royalties from the sale of our varieties. Almost all the royalties received come back to our program to fund more fruit research and breeding.

## 2010 Selections

The wet season greatly hampered access into most of our fields which are primarily clay (Figure 20). Also where the ground was saturated for more than 3 months (almost everywhere) plants did not put on good growth. In northeast block 14 there was standing surface water for 10 weeks which killed many plants but still some survived. There was some natural selection for flooding conditions but likely 95% of our seedlings survived.
However, amongst the survivors some likely tolerated the water better and may have an advantage by being less damaged. When field dried up mid to late August we were able to cultivate and save the plants from weeds.

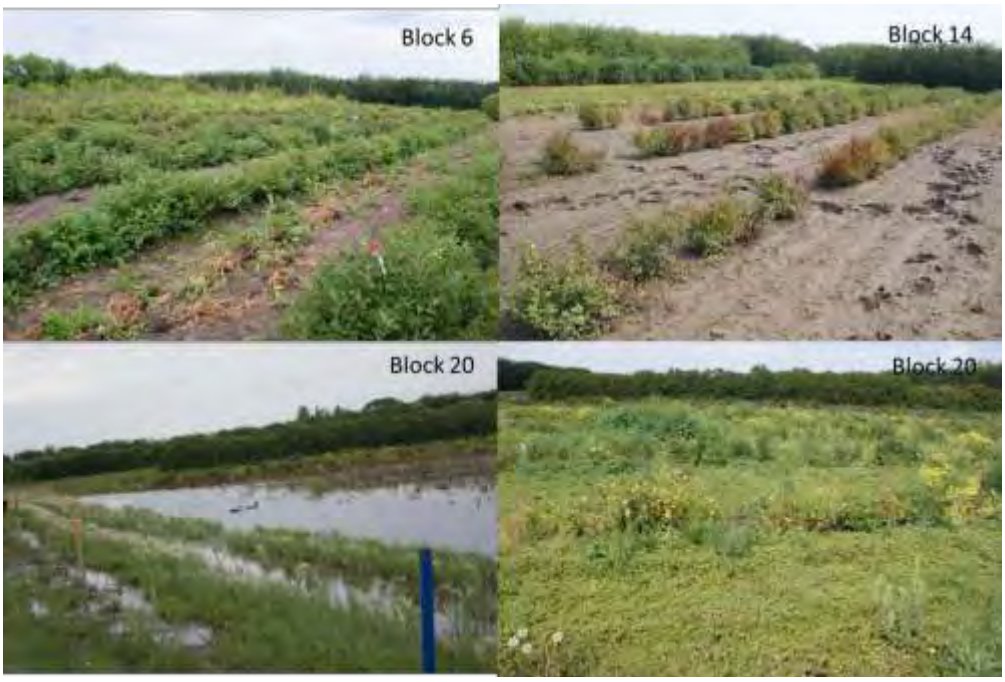


Figure 20. Flooded Haskap plots on July 21, 2010. Block 6 was evaluated despite the mud. Some bushes died in Block 14 that were 3 years old. In block 20 about 300 seedlings were pulled from the fields and put into plug trays since they were valuable germplasm recently acquired from Japan.. Weeds went rampant in some areas of Block 20 since cultivation was not possible until late August.

Under such wet field conditions we did not evaluate the 2 year old plants in various fields. But we dragged ourselves through the mud in block 6 to evaluate those seedlings.

As previously mentioned, twenty selections were flagged in block 6 in 2009 as being superior. These were reconsidered but the entire field was re-evaluated in 2010. Typically 2 or 3 years are needed for the selection process for any given field. The 'Borealis' plants in Block 6 began to fruit for the first time and so could be used as a control in that field to aid in comparison. Representative berries from each plant can be seen in figure 9. Previously we noted that younger Haskap bushes produce smaller fruit but when bushes got older their fruit was larger. 'Borealis' had smaller fruit but the plants were also smaller and less vigourous than most seedlings. Borealis fruit will get larger as the bushes get bigger, but until the plants are larger we won't know for certain if the new selections will always be larger than Borealis.


Figure 21. A berry from each selection flagged as superior in Block 6. 'Borealis' is the fourth berry in the 2nd row. But the 'Borealis' bushes are growing at a much slower rate than the newer seedlings. We have seen much larger 'Borealis' berries on the older original plant and we expect that they will be larger when the bushes in this field are closer to full grown size.

Tables 23, 24 and 25 give details on analysis done in the lab on frozen fruit of the advanced selections. 'JR19-6' is highlighted in the tables as a very promising selection. In the 'Block 6' field that selection had one of the largest bushes and was among the most productive. In the tables below it is noted that it had the heaviest berry weight and one of the best sensory evaluations. For the sensory evaluations the same form that as used to evaluate the Russian Haskap was used (table 5). This table has become the standard to evaluating many of our seedlings and advanced selections. It was only average for sugar content but was higher than 'Borealis'.

In the spring of 2011 when pollen was being collected for controlled crosses it was found that JR19-6 winter killed very badly. Likely this had been partly due to the wet conditions of 2012. But because very few plants in that field showed winter damage in 2011 we did not consider it worthwhile to release as a new variety, but it was used further in breeding.

Several of the selections mentioned in the three tables below were used in crosses in 2011 and a few were dug up and potted for use in 2012. Noticeably superior for flavour was 6-15-10 which had the highest fruit quality score in frozen test but was even more impressive when tasted fresh in the field.

**Table 23. Dimensions and mass of haskap berries from 2010 advanced selections. 'Borealis' fruit had been the largest of a previous generation.**

| | Dimensions (mm) | | | Weight |
|---|---|---|---|---|
| selection | Length | Width | Depth | grams |
| BOREALIS | 16.8 | 12.1 | 10.7 | 1.4 |
| JR9-3 | 21.7 | 12.8 | 11.7 | 2.0 |
| JR19-2 | 25.3 | 12.7 | 15.5 | 1.9 |
| JR19-3 | 22.9 | 13.0 | 11.8 | 2.1 |
| JR19-4 | 25.6 | 13.9 | 11.3 | 2.3 |
| JR19-6 | 24.8 | 15.4 | 12.2 | 2.5 |
| JR19-7 | 22.6 | 14.1 | 11.8 | 2.3 |
| JR27-1 | 27.5 | 13.3 | 11.8 | 2.3 |
| 6.15.10 | 22.1 | 11.1 | 16.2 | 1.6 |
| 6.15.32 | 20.4 | 12.5 | 10.9 | 1.6 |
| 6.16.4 | 21.1 | 12.2 | 11.8 | 1.8 |
| 6.16.15 | 21.9 | 12.3 | 10.9 | 1.7 |
| 6.16.17 | 24.3 | 12.8 | 9.8 | 1.8 |
| 6.16.24 | 26.6 | 11.0 | 9.8 | 1.8 |
| 6.16.44 | 23.1 | 13.0 | 12.3 | 2.1 |
| 6.17.50 | 17.9 | 12.2 | 10.1 | 1.5 |
| 6.18.4 | 19.4 | 13.6 | 11.8 | 1.8 |
| 6.18.17 | 23.5 | 15.5 | 10.4 | 2.1 |
| 6.18.38 | 24.2 | 14.5 | 11.8 | 2.4 |
| 6.18.41 | 18.0 | 13.6 | 12.0 | 1.7 |
| 6.25.5 | 22.9 | 15.1 | 11.9 | 2.3 |
| Mean | 22.5 | 13.2 | 11.7 | 1.9 |

Table 24. Fruit quality attributes of 2010 advanced selections. 'Borealis' had been our standard for excellent flavour. The rating scale goes from 1 to 5 with five being the best. A bitterness score of '5' indicates no bitterness, while a score of '5' for sweetness means very sweet. Discussion of how the ratings wark were explained earlier in the discussion of table 5.

| | Texture | Bloom | Sweetness | Sour | Bitterness | Aroma | Average |
|---|---|---|---|---|---|---|---|
| BOREALIS | 5 | 3 | 3 | 4 | 5 | 1 | 3.5 |
| JR9-3 | 5 | 3 | 2.5 | 5 | 5 | 2.5 | 3.8 |
| JR19-2 | 4 | 3 | 4 | 3 | 5 | 4 | 3.8 |
| JR19-3 | 2 | 2.5 | 4 | 3 | 4.5 | 3.5 | 3.3 |
| JR19-4 | 4 | 3 | 3 | 3.5 | 4 | 2 | 3.3 |
| JR19-6 | 3 | 3.5 | 4.5 | 3 | 5 | 4 | 3.8 |
| JR19-7 | 4 | 3 | 3 | 5 | 4.5 | 3 | 3.8 |
| JR27-1 | 3 | 5 | 3 | 5 | 5 | 3.5 | 4.1 |
| 6.15.10 | 5 | 3 | 4 | 4 | 4.5 | 4 | 4.1 |
| 6.15.32 | 3 | 3 | 3.5 | 4 | 4.5 | 4.5 | 3.8 |
| 6.16.4 | 3 | 3 | 4 | 3 | 5 | 4.5 | 3.8 |
| 6.16.15 | 5 | 3.5 | 4 | 3 | 5 | 4 | 4.1 |
| 6.16.17 | 1 | 3 | 3 | 4 | 4 | 2.5 | 2.9 |
| 6.16.24 | 5 | 3 | 4 | 5 | 5 | 2.5 | 4.1 |
| 6.16.34 | 3 | 4.5 | 4.5 | 3 | 5 | 4 | 4.0 |
| 6.16.44 | 3.5 | 3 | 4 | 3 | 4.5 | 3.5 | 3.6 |
| 6.17.50 | 5 | 3 | 3 | 4 | 4.5 | 3 | 3.8 |
| 6.18.4 | 4 | 3 | 3 | 4 | 4.5 | 2.5 | 3.5 |
| 6.18.17 | 1 | 3 | 4 | 4 | 4.5 | 4 | 3.4 |
| 6.18.38 | 3 | 2.5 | 2.5 | 4 | 4.5 | 2 | 3.1 |
| 6.18.41 | 1 | 3.5 | 4 | 3 | 4.5 | 4 | 3.3 |
| 6.25.17 | 4 | 3.5 | 3.5 | 4 | 5 | 3 | 3.8 |
| 6.25.5 | 3 | 3.5 | 3.5 | 3 | 4 | 3.5 | 3.4 |
| mean | 3.5 | 3.2 | 3.5 | 3.8 | 4.7 | 3.3 | 3.7 |

Table 25. Chemical analysis of 2010 advance selections

| | Soluble Solids (brix) | pH | Total Acidity (%Citric acid) |
|---|---|---|---|
| BOREALIS | 11.4 | 3.39 | 2.42 |
| JR9-3 | 13.2 | 3.36 | 1.99 |
| JR19-2 | 16.8 | 3.44 | 1.8 |
| JR19-3 | 17.5 | 3.4 | 1.91 |
| JR19-4 | 15.9 | 3.36 | 1.96 |
| JR19-6 | 14.7 | 3.38 | 1.58 |
| JR19-7 | 15 | 3.23 | 2.32 |
| JR27-1 | 14 | 3.28 | 2.32 |
| 6.15.10 | 18.6 | 3.44 | 1.55 |
| 6.15.32 | Insufficient Sample | | |
| 6.16.15 | 16.8 | 3.49 | 1.55 |
| 6.16.17 | 15.7 | 3.17 | 2.36 |
| 6.16.24 | 16.3 | 3.36 | 1.35 |
| 6.16.34 | 15.5 | 3.57 | 1.35 |
| 6.16.4 | 16.3 | 3.1 | 2.81 |
| 6.16.44 | 14.6 | 3.43 | 1.94 |
| 6.17.50 | 14 | 3.34 | 2.24 |
| 6.18.12 | 13.9 | 2.97 | 2.24 |
| 6.18.17 | 16.9 | 3.25 | 1.63 |
| 6.18.38 | 12.2 | 3.29 | 2.26 |
| 6.18.4 | 14.7 | 3.25 | 1.93 |
| 6.18.41 | 14.8 | 3.35 | 1.54 |
| 6.18.42 | 14.2 | 3.11 | 3.68 |
| 6.25.17 | 16.3 | 3.26 | 1.84 |
| 6.25.5 | 15.3 | 3.24 | 2.83 |
| Mean | 15.2 | 3.3 | 2.1 |

**2011 Selections**

In 2011 there were 4000 seedlings from controlled crosses from new fields to be evaluated in addition to the 1500 in block 6. Blocks 14, 20 north and 22 were now fruiting and the fields were accessible. Some may have fruited 2010 but were not accessible then. These newer fields were planted with the newer policy of only planting the most vigourous 50% of the seedlings. Consequently, these new fields had a much higher percentage of plants that had acceptable plant vigor and far more worthwhile plants. Selection proceeded in a step-wise fashion. As they fruit changed colour and became visible (often a week or two before ripe) they were tagged if superior in productivity, plant vigor, fruit size and fruit shape. Perhaps 150 were initially tagged. The tagged plants were evaluated for the rest of the season for flavour, ability to hold onto fruit, fruit texture and general plant health. Fruit samples were gathered, and frozen for analysis in the lab. A new challenge for us was that these hybrids were ripening at different times so some promising plants needed to be visited a few times before they could be evaluated for flavor.

Appearance is a difficult attribute to access. For the commercial farmer wanting to mechanically harvest for processing needs, shape does not matter unless it clogs up machinery. A more oval shape is desirable for rolling around in our sorting line but that doesn't mean a sorting line couldn't be developed that causes less damage. For U-picks, Fresh fruit sales at markets or homeowners, unusually shaped fruit may be more desirable. Fruit shape could be important for choosing which markets may prefer our varieties when released. In our hybrid populations we have been finding many shapes (Figure 22). Consequently, most of our selections were photographed (figure 23) and/or put in jars with alcohol so that their appearance could be observed at a later date.

By August the list of promising selections had been narrowed down to about 40 selections. Most of these selections were considered well rounded potential new cultivars, but a few were chosen as possessing special attributes for breeding. Block 14 was especially surprizing since that field had been flooded the previous year, plus the plants were only two years, yet the field had many promising plants with good productions and high quality fruit (Figure 24). Both of the younger plants in block 22 and 14 seem to be growing at faster rate than earlier generations.

Figure 22. Diversity of Haskap Berry shapes. Each berry is from a different plant from our breeding program. Berries are placed with stem ends up.

Many selections were rejected by Dr. Bors in late July because of mildew and consequently were not further evaluated in mid-August when Ellen Sawchuk rated advanced selections for Mildew resistance (Table 26). This was done by judging how many of the leaves were infected with powdery mildew. By August, a mildew value of 10% or less is considered very good and acceptable. By looking at this disease so late in the season, we are actually screening at a more intense level. Because of ADF funding we have many more seedlings in our fields to select from and can afford to reject more on the basis of disease susceptibility.

Samples from about 40 selections were frozen and then thawed in fall and analysed for fruit quality attributes in the lab (Table 27). The better selections from these tables will be scrutinized in the coming growing season. About 20 selections are slated to be tested for each of propagation in the 2012 growing season. Likely a few will be released after another season of observation and when the propagation tests are complete.


Figure 23. Berries from some promising selections from 2011. Selection 14-16-0.5 had the largest berries of all haskap we had ever grown. One berry weighted 4.2 grams and many were above 3gms, but that selection has poor bush characteristics. It would be unacceptable as a variety but could be useful in breeding. The four other numbered selections have good attributes but 14-20-5.0's round fruit shape makes it particularly desirable for mechanized harvesting. In Blocks 14 and 22 Tundra plants are inter-planted for comparison. Most of the above selections have larger fruit than Tundra.

**Figure 24. Examples of some of the better two year old Haskap in block 14.**

Table 26. Mildew assessment of promising selections in four Haskap populations in mid-August 2011. Based on visual estimation of amounts closest to 0, 10, 25, 50, 75 or 100%. Susceptible plants often contract mildew when high temperatures occur in mid-July. A level of 10% or less is considered very acceptable.

| Selection | % of leaves infected | Selection | % of leaves infected | Selection | % of leaves infected | average per group |
|---|---|---|---|---|---|---|
| Selections from Maxine's Program | | | | | | |
| 22.14 | 50 | 66.89 | 25 | 100.4 | 0 | 16 |
| 41.83 | 25 | 71.64 | 10 | 101.05 | 0 | |
| 44.76 | 10 | 73.39 | 25 | 444.39 | 10 | |
| 46.55 | 25 | 77.87 | 25 | 6-1-23.25 | 25 | |
| 56.15 | 10 | 89.46 | 10 | 6-1-35.5 | 10 | |
| 66.53 | 10 | 100.34 | 10 | G23 | 10 | |
| Kurile x op Russian, 2006 planting | | | | | | |
| 14-1-12.75 | 25 | 14-1-34.25 | 10 | 14-2-70 | 10 | 24 |
| 14-1-26.25 | 10 | 14-1-35.5 | 75 | 14-3-40 | 10 | |
| 14-1-28.5 | 25 | 14-1-45.0 | 25 | 14-3-80 | 10 | |
| 14-1-31.0 | 25 | 14-2-42 | 50 | 14-6-1.5 | 10 | |
| Hybrids, 2007 planting | | | | | | |
| 22-6-25.5 | 25 | 22-9-22.5 | 10 | 22-10-12.5 | 25 | 18 |
| 22-6-26.5 | 10 | 22-10-1.5 | 25 | 22-12-23.75 | 10 | |
| 22-8-17.66 | 25 | 22-10-2.0 | 10 | | | |
| Hybrids 2008 planting | | | | | | |
| 14-15-34.0 | 10 | 14-16-42.0 | 10 | 14-18-13.5 | 25 | 11 |
| 14-15-34.6 | 10 | 14-16-9.8 | 10 | 14-18-2.5 | 10 | |
| 14-16-0.5 | 25 | 14-17-2.0 | 0 | 14-18-3.25 | 10 | |
| 14-16-17.25 | 10 | 14-17-2.6 | 0 | 14-19-43.0 | 10 | |
| 14-16-18.25 | 50 | 14-17-5.5 | 0 | 14-20-19.25 | 10 | |
| 14-16-19.75 | 25 | 14-18-0 | 10 | 14-20-5.0 | 0 | |
| 14-16-21.75 | 25 | 14-18-0.6 | 0 | | | |
| 14-16-3.0 | 0 | 14-18-1.75 | 0 | | | |

Table 27. Lab assessments of frozen fruit from 2011 Selections. For the taste assessments a 1 to five scale was used: 1 = bad, 2 = poor, 3 = okay, 4 = good, 5=excellent. Highlighted selections were above average in berry weight, Brix, and overall taste. There are many promising selections on this list especially if compared to our current three varieties that appear on the bottom of the list. Some selections were sampled twice so their information was averaged.

| | grams / | | Total | TasteTest | | | | Overall |
|---|---|---|---|---|---|---|---|---|
| ID Code | berry | Brix | Acid | Sweet | Sour | Bitter | Aroma | Taste |
| 14-01-21.75 | 1.540 | 15.9 | 1.87 | 4 | 5 | 5 | 4 | 4.5 |
| 14-01-26.25 | 1.935 | 13.9 | 1.60 | 4 | 3 | 5 | 2 | 3.5 |
| 14-01-28.5 | 2.054 | 14 | 3.42 | 2 | 3 | 5 | 2 | 3 |
| 14-01-31.0 | 1.476 | 15.8 | 2.58 | 3 | 5 | 5 | 3 | 4 |
| 14-01-34.25 | 1.760 | 14.8 | 2.18 | 3 | 1 | 5 | 3 | 3 |
| 14-01-35.5 | 1.471 | 16.5 | 1.64 | 4.5 | 4 | 5 | 4 | 4.375 |
| 14-01-45.0 | 2.154 | 11.5 | 1.96 | 4 | 3 | 5 | 4 | 4 |
| 14-02-70 | 1.486 | 14.8 | 3.03 | 3 | 3 | 4 | 2 | 3 |
| 14-03-40 | 1.678 | 13.5 | 3.24 | 3 | 5 | 5 | 2 | 3.75 |
| 14-03-5.8 | 1.578 | 17.8 | 1.63 | 5 | 3 | 4 | 3 | 3.75 |
| 14-03-70 | 1.825 | 14.3 | 2.02 | 4 | 3 | 4 | 3 | 3.5 |
| 14-03-80 | 1.598 | 15.1 | 2.66 | 3 | 3 | 4 | 3 | 3.25 |
| 14-15-34.0 | 1.495 | 25.6 | 1.52 | 5 | 1 | 4 | 4 | 3.5 |
| 14-15-34.6 | 1.290 | 18.8 | 2.00 | 3 | 1 | 5 | 1 | 2.5 |
| 14-16-0.5 | 2.553 | 18.4 | 2.41 | 3 | 5 | 4 | 2 | 3.5 |
| 14-16-17.25 | 1.489 | 18 | 1.76 | 3 | 3 | 5 | 3 | 3.5 |
| 14-16-17.75 | 1.646 | 12.9 | 1.51 | 5 | 1 | 5 | 5 | 4 |
| 14-16-18.25 | 1.610 | 14.4 | 2.05 | 5 | 3 | 5 | 4 | 4.25 |
| 14-16-19.75 | 1.306 | 20.5 | 1.77 | 5 | 3 | 5 | 5 | 4.5 |
| 14-16-21.75 | 1.065 | 23.3 | 2.19 | 4 | 3 | 4 | 3 | 3.5 |
| 14-16-9.8 | 2.073 | 16.2 | 1.73 | 2 | 5 | 2 | 1 | 2.5 |
| 14-17-2.0 | 1.703 | 19.3 | 1.67 | 5 | 3 | 5 | 5 | 4.5 |
| 14-17-2.6 | 1.644 | 21.1 | 1.76 | 5 | 1 | 5 | 4 | 3.75 |
| 14-17-5.5 | 2.206 | 20.7 | 1.93 | 5 | 1 | 4 | 4 | 3.5 |
| 14-18-0.0 | 1.493 | 19 | 1.24 | 5 | 1 | 5 | 5 | 4 |
| 14-18-1.75 | 1.543 | 19.1 | 2.02 | 4 | 1 | 5 | 5 | 3.75 |
| 14-18-13.5 | 1.054 | 24.8 | 3.44 | 3 | 1 | 4 | 3 | 2.75 |
| 14-18-3.25 | 1.526 | 16.7 | 3.07 | 3 | 5 | 4 | 3 | 3.75 |
| 14-19-43.0 | 1.733 | 22.7 | 2.52 | 5 | 3 | 5 | 4 | 4.25 |
| 14-20-19.25 | 1.273 | 22.9 | 0.99 | 5 | 1 | 5 | 3 | 3.5 |
| 14-20-5.0 | 2.012 | 18.7 | 2.18 | 5 | 1 | 5 | 4 | 3.75 |
| 22-03-101.5 C5 | 1.167 | 16.7 | 1.35 | 5 | 1 | 4 | 4 | 3.5 |
| 22-03-17.8 C9 | 1.473 | 14.1 | 1.74 | 3 | 3 | 5 | 3 | 3.5 |
| 22-04-20.75 | 1.260 | 15.4 | 1.55 | 4 | 3 | 4 | 3 | 3.5 |
| 22-05-101.5 C11 | 1.667 | 13.2 | 1.83 | 5 | 1 | 4 | 3 | 3.25 |
| 22-06-25.5 | 1.890 | 15.9 | 1.51 | 5 | 1 | 5 | 5 | 4 |
| 22-06-26.5 | 1.904 | 16.5 | 1.70 | 4 | 3 | 5 | 4 | 4 |
| 22-06-8.5 C13 | 1.110 | 16.5 | 2.05 | 3 | 1 | 4 | 1 | 2.25 |
| JC2 | 1.203 | 18.1 | 2.17 | 3 | 1 | 5 | 2 | 2.75 |
| JC3 | 1.181 | 17.8 | 2.69 | 5 | 3 | 5 | 4 | 4.25 |
| JC3A | 1.157 | 18.4 | 2.60 | 3 | 5 | 5 | 3 | 4 |
| average | 1.592 | 17.4 | 2.07 | 4.0 | 2.6 | 4.6 | 3.3 | 3.6 |
| Cultivars | | | | | | | | |
| Borealis | 1.607 | 12.0 | 1.93 | 4 | 3 | 5 | 3 | 3.75 |
| Honey Bee | 1.271 | 12.0 | 2.21 | 4 | 1 | 4 | 4 | 3.25 |
| Tundra | 1.085 | 17.4 | 1.42 | 3.5 | 3 | 5 | 3 | 3.63 |

## Naming of the 'Indigo' Series

The Indigo series varieties are full sibs of 'Borealis' and 'Tundra'. They were originally released as test varieties with the identity numbers of 9-15, 9-91 and 9-92. These five varieties above were often collectively referred to as 'Row 9' as that is the breeding row in which originated. The Indigo plants are considered to be runner-ups to Borealis and Tundra. They were released as experimental varieties in case 'Borealis' and 'Tundra' were hard to propagate or had difficulties in the field. All of the above varieties are hard to tell apart if looking only at the fruit (Figure 25).

In the winter of 2011 many propagators and growers put in a request to name the Row 9 test plants. It was decided to name them the 'Indigo' series. Indigo was chosen as that is one of the colours that Haskap can be identified with. We did not want to use 'Blue' in the name since Northwoods Nursery in Oregon uses 'Blue' in most of their names when they bring varieties over from Russia. Once the varieties were named an article was posted on our website that gave a description and included more recent observations. That article is in Appendix III.

Figure 25. Berries from Indigo Gem, Indigo Treat and Indigo Yum (left to right). Formerly they were called 9-15, 9-91 and 9-92.

## Additional breeding information

In 2009, Dr. Bors participated in the 1st Virtual International Scientific Conference on *Lonicera caerulea* L. sponsored by Russian Academy of Agricultural Sciences, Ministry of Agriculture, and the All-Russian Horticulturae Michurin Institute. The article presented at that conference is in Appendix IV. Dr. Bors was on the organizing committee for that conference. The article gives an overview of the Haskap breeding program at the U of SK.

We are often asked about new varieties we are developing. The article "The shape of things to come" was posted to our website in early 2011 and is in Appendix V. For several years Dr. Bors has been advising growers to try the existing varieties to learn how to grow them, but that further advances will be coming. Also that article discusses breeding goals for varieties for growers and how varieties for homeowners may be different.

# Genetic Investigations in Haskap

## Canadian DNA Analysis

In the spring of 2011 samples of the Canadian germplasm were collected for future DNA analysis. The goal was to use DNA from young leaf material to see if there were genetic relationships between plants collected in different provinces and locations.

Young leaf tissue was collected in early spring as the leaves were just starting to leaf out. Approximately three or four leaves were collected from each plant. The number of leaves depended on the size of the leaves. Leaves were collected from three plants from each location in each province. That gave us approximately 550 different leaf samples. The plants collected in 2010 from Alberta and Newfoundland were not included in this group as those plants were not at the right stage of growth. They had been going in the greenhouse and had older tougher leaves from which it would be hard to extract DNA.

As soon as the leaves were picked they were transported to the building and each leaf sample was divided into two vials and quickly frozen with liquid nitrogen. These samples were then placed in a minus eighty freezer. They were later freeze dried and placed in a normal freezer and await there until we have the time and resources to do the DNA analysis.

Graduate student Eric Gerbrandt used some of the samples in a genetic student which will be discussed shortly. About 20 samples were shared with Tyler Smith of Ag Canada in Ottawa who will do DNA fingerprinting on them. Tyler is doing a project on the diversity of wild relatives of agricultural crops and fruits. It the techniques he uses can show differences between the samples of Haskap he may submit a proposal to study them further. Dr. Bors met with Dr. Smith in Ottawa whereby possible cooperative study was discussed.

## Eric Gerbrandt's Genetic Research

Eric has been a M.Sc. student in the Fruit Program who is in the process of being upgraded to be a Ph.D. student. Eric has done DNA analysis of 32 accessions of Russian, Japanese, Kurile, and Canadian germplasm resulting in a poster presentation called "A genetic distance estimate for various blue honeysuckle (Lonicera caerulea L.) subspecies using ISSRs" which was presented at the Plan and Animal Genomics Conference in Jan 2012. This information has not yet been published as a paper. Eric's thesis is largely supported by a scholarship and royalties, but this project helped provide funding for the plants he used and will be using in his research. Eris is

also studying the genetics of hybrids between subspecies. Although studying many characteristics, he is particularly interested it what happens when early and late blooming haskap are interbred and hao adaptable Also he is study total antioxidants.

# Haskap Production Research and Observations

## Mildew Prevention in the Greenhouse

*Note; The following section is a summary of Ellen Sawchuk's undergraduate thesis. She was a summer student in 2009 when this research was done. She is now a technician in our program.*

Thousands of Haskap seedlings are grown per year in greenhouse for backyard gardeners or commercial farmers. Problems begin to occur when the seedlings are being grown in these greenhouses as they can become severely infected with powdery mildew. Cultivars that are thought or seem to be resistant in the field become susceptible in the greenhouse. It is necessary to find an economical and effective way of preventing powdery mildew epidemics for this valuable crop.

Using UV-C (Ultra Violet type C) light seemed to be an attractive alternative and was evaluated against other control methods. In nature UV light often elicits plant protective responses such as more anthocyanins and thicker wax levels on leaves. Our graduate student, Tyler Kaban, was using UV-C light to induce resveratrol production in grapes. Resveritrol has anti-fungal properties. There is no literature to suggest that resveratrol in in Haskap plants, but the idea of using UV light to turn on some defence mechanism seemed like a good idea. In nature UV-C is screened out by the upper atmosphere and is much more damaging than UV-A or UV-B. As it is more intense it requires a much shorter treatment time.

In various papers and magazines it was found that using milk and garlic solutions were effective as well economical. The UV-C, garlic and milk were tested against common greenhouse preventions F-mix and Sulfur. A wide variety of controls were tested as they specific type of mildew we unable to be identified.

The experiment was carried out as follows. Firstly, two year old Borealis plants were placed in a cooler for two months and were brought out of the cooler at three different times so that testing could be done on new leaves as well as mature leaves. All of the plants were transplanted into one litre pots. The amount of UV-C radiation that these plants could take before damage occurred was evaluated. It was found that 80 seconds was the optimum time as the leaves remained green and healthy looking after their exposure. When they were exposed to 90 seconds and higher bleach spots and leaf death ensued. It was also found that the most efficient way to inoculate was to find a naturally infected plant and rub the infected leaves on the healthy leaves in a high humidity environment.

Plants were taken out at different times some plants classified as 'old' were taken out of coolers on Oct 26 but it was decided a few days later (Nov 2) to take out more. Almost a month later (Nov 30) a second batch, labeled 'Young' were taken out.

For the mildew control experiment six plants (3 young, 3 old) were treated with 80 seconds of UV-C radiation and another six plants were treated with powdered sulphur, diluted milk (3 cups water and ¾ cups whole milk), garlic extract (one bulb of blended garlic with 500ml of water), or F-mix (5 grams baking soda, 5ml Safer Soap and 15ml of Canola oil with 500ml of water). Plants were treated once a week starting Dec. 6th and then evaluated on Dec 13$^{th}$, Dec 20$^{th}$ and January 10$^{th}$. for number of infected leaves. The experiment had 6 treatment x 2 ages x 3 observation dates x 3 reps.
ANOVA analysis using SAS statistical program is presented in table 28. Treatments, age of the plants and the interaction of Treatment*Age were highly significant while observation date was significant.

Older plants had more than 3 times the infection rate of younger plants averaging 6.5% compared to 1.9% over the 3 observation dates. Older plants had leafed out about 30 days earlier than younger plants. This results was unexpected as younger leaves are usually thought to be more susceptible particularly if wax cuticle layers have not built up on the leaves. However, in the field we often don't see infection until the plants have leafed out about 2 months.

All the treatments were significantly better than the control. Sulfur gave the lowest mean but this was statistically similar to Milk, F-mix, and garlic treatments. Sulfur was the preferred treatment for other reasons beside having slightly lower infection rates. Milk could potentially give a rancid smell to the greenhouse while garlic gave an immediately strong odor that hurt eyes during preparation. F-mix required mixing several ingredients an so was not as convenient. The sulfur and garlic treatments were deemed the best due to their superior effectiveness and economics.

**Table 28. ANOVA for various treatments against mildew in the greenhouse for 'Borealis' haskap plants.**

| Source | DF | Type III SS | Mean Square | F Value | Pr > F |
|---|---|---|---|---|---|
| treatment | 5 | 852.407407 | 170.481481 | 7.34 | <.0001 |
| age | 1 | 560.333333 | 560.333333 | 24.12 | <.0001 |
| date | 2 | 185.12963 | 92.564815 | 3.98 | 0.023 |
| rep | 2 | 79.796296 | 39.898148 | 1.72 | 0.187 |
| treatment*age | 5 | 1346.777778 | 269.355556 | 11.59 | <.0001 |
| treatment*date | 10 | 153.648148 | 15.364815 | 0.66 | 0.7559 |
| treatment*age*date | 12 | 259.222222 | 21.601852 | 0.93 | 0.5227 |

**Table 29. Means of treatments used to control mildew infections on 'Borealis' haskap under greenhouse conditions.**

| Treatment | Means | | |
|---|---|---|---|
| Control | 9.9 | A | |
| UV-C | 4.9 | B | |
| Milk | 3.7 | B | C |
| F-Mix | 3.5 | B | C |
| Garlic | 2.1 | B | C |
| Sulfur | 1.2 | | C |

Initially it was difficult to get mildew growing in the greenhouse, which was why leaves from outdoor plants were gathered and used. Often mildew occurs spontaneously in our greenhouse. But once it started, it almost doubled within that 1st week (table 30). But the next 20 days had only an incremental change of about 20%. In the worst treatment combination (Control + Old) The infection rate was 10% on Dec 13$^{th}$, then 24% on Dec 20$^{th}$ and then only 25% on Jan 10$^{th}$. These resulting indicate that mildew infects can progress rapidly and that growers should be prepared to immediately treat symptoms when they appear.

**Table 30. Progression of mildew infection for all treatments under greenhouse conditions for 'Borealis' Haskap.**

| Date | Infection % | | |
|---|---|---|---|
| Dec-13 | 2.4 | a | |
| Dec-20 | 4.5 | a | b |
| Jan-10 | 5.6 | | b |

The interactions between treatments and age are presented in table 31. As was the case with the treatments by themselves, there is much overlapping of LSmeans groups. Larger sample sizes might be useful in giving more distinction between thee treatment/age combinations. It is surprizing that young control plants did not have infection yet. Perhaps the results would be different if a longer period of time was allowed for observations.

**Table 31. Interaction of treatments and age of plants on % mildew infection in greenhouse grown 'Borealis' haskap plants.**

| Treatment & age combination | | | Means | | | |
|---|---|---|---|---|---|---|
| Control | + | old | 19.8 | | A | |
| Milk | + | old | 5.7 | | B | |
| UV-C | + | old | 5.1 | C | B | |
| UV-C | + | young | 4.7 | C | B | |
| Garlic | + | old | 4.1 | C | B | D |
| F-Mix | + | young | 3.8 | C | B | D |
| F-Mix | + | old | 3.2 | C | B | D |
| Milk | + | young | 1.8 | C | B | D |
| Sulfur | + | young | 1.3 | C | B | D |
| Sulfur | + | old | 1.0 | C | | D |
| Garlic | + | young | 0.0 | | | D |
| Control | + | young | 0.0 | | | D |

Table 17- Average percent infection* per treatment and age group
Treatment Date treated Average Percent Infection Old** Plants Average Percent Infection Young** plants

## Production Articles

The need for grower information on this crop was perceived as urgently needed so several articles were written during the timeline of this project and have already been published on our website.

Each year our online article “Growing Haskap in Canada” has been updated to include new observations and answer questions. The most recent version appears in Appendix VI.

Since very little is written in English about Haskap growing, some growers might try to grow haskap in a way similar to crops they are familiar with. Appendix VII “Comparing Haskap to other berries” delineates some of the major differences between haskap and saskatoons, raspberries, blue berries and cranberries.

## Mechanized Harvesting

In 2009 we tested a growers ' Joanna 2 harvester' on haskap and other fruit crops and an article was written about this in 2010 (Appendix VIII). Our department bought us a Joanna-3 Harvester in 2010. This is a more modern version of the harvester that we tested in 2009. However the machine arrived in August which was too late for optimum harvesting. But we did run it through some seedlings and noted that little damage was done to the bushes.

In the summer of 2011 we were able to harvest the most Haskap that has ever come out of the plots. We brought in close to five hundred pounds of fruit with the machine and it only took us two days on the machine. It did however take about a week or so to sort and clean all of the fruit after harvest. With a surplus of Haskap we were able to ship extensive quantities to other companies for fruit analysis and testing.

The harvester seems to work surprisingly well on the bushes. It is very beneficial that the machine comes with a small bush attachment at enables it to get quite low. We did notice however that if the bushes were not tall enough to reach the shaking tongs none of the fruit fell off. There were some rows in the younger blocks that were too small for this harvester. However, it seems that our previous methods of shaking plants into containers and using a sorting line are much rougher on Haskap berries than our harvesting machine.

# Value added research and cooperation

Haskap can be used in a wide range of products and is more versatile that most other berries. Like most berries it can be eaten fresh, used in jams, pies (although mushy). General information on the uses of this crop are mentioned in appendix VII and VIII.
But Haskap is emerging as a superior fruit for dairy products, wine, and may be useful for nutraceutical products.

We actively encourage growers and food manuafacturers to try haskap. Many times we have given haskap berries to those who request it and other times we give it to people who may be interested. Often in talks, Dr. Bors brings samples of the fruit for people to try. IN some cases we have done some trials of fruit products to help growers and processors thinking in new directions.

## Dried haskap berries

During the flooding year of 2010, fields were too wet to harvest berries in some fields so many fruits were dried on their bushes when we were able to get to those fields in mid-August. Noticing that some tasted good, some investigation was done of deliberately drying them. Details on that study are in appendix IX.

## Haskap Wine and Liqueur

We first made Haskap wine in 2006 as part of the undergraduate class PLSC 441: Fruit Science and have encouraged growers to experiment. In 2009, Dr. Bors, Peter Reimer and Tyler Kaban attended the Vitinord (International northern wine group) conference in Quebec. Although that visit was primarily for learning about northern grapes we also promoted the use of Haskap by bringing Jam samples that was tasted by about 50 participants. We sent haskap fruit to Larry Peterson, of Ontario, and Tom Plocher, of Minnesota for wine experimentation. These individuals were VIP's for this group: Larry has an active website that caters to amateur wine makers and Tom is the author of the leading book on northern grape growing and wine making. Both relayed to us that they were very excited about the quality of the resulting wine.

Fruit for wine experiments was also given to Doug Eryou, of Manitoba who also passed the fruit onto a professional winemaker in Ontario and Will Stafford, of Prince Albert, SK who is setting up a winery in northern SK.

John Cody from Souleio Foods in Saskatoon was samples of various Haskap types in the winter of 2010/2011 and he made them into Haskap Liqueur. In the summer of 2011 he spent days out at the field lab tasting from our newly fruited bushes and selecting ones that might be best for wine/liqueurs. These made it onto our advanced selections list as JC numbers.

Peter Reimer of our program, did some experiments using different yeasts and he followed the changes during the fermentation process. A summary is in Appendix IX: "Haskap Wines at the U of S Fruit Program"

## Nutraceutical Research on Haskap

Ph.D. graduate student James Dawson has begun his thesis in which he is investigating six healthy compounds produced in haskap berries. He is tracking their production out the growing season both in the leaves and the fruit of 4 important breeding parents and out 'Borealis' and 'Tundra' varieties. This information is incomplete and needs to be confidential until he publishes his research in a scientific venue. James will be involved in the follow-up project to this one which will be more involved in nutraceutical.

Dr. Bors and James Dawson, advised Haskap Canada what types of healthy compounds should be investigated for marketing purposes. We also send fruit samples for analysis for them, all of which helped Haskap Canada get required information for their new pamphlet 'Indulge in Healthiness, Haskap' (Appendix XI).

Fruit samples were also sent to a few organizations working onnutraceutical research (Table 32)

**Table 32. Cooperators for haskap nutraceutical research. All of these groups were sent fruit from our program to assist them in research**

| Company/Individual | Uses/research/details |
|---|---|

| | |
|---|---|
| Dr. Vasantha Rupasinghe ( Nova Scotia Agriculture College) | Bioflavonoid research |
| Phytocultures LTD, PEI | Antioxidant testing |
| A Japanese Pharmaceutical company | Product development (confidential) |
| NRC, PEI | animal/diet study (confidential) |

## Value Added Food Products

For our program we usually brought fresh fruit, frozen fruit or Jam to various meetings and talks. Perhaps 600 jars of jam or topping (figure 26) have been given away to visitors to the U of Sk during the time of this project. Dr. Bors also gave about 150 away during the last half of his sabbatical in 2009. An addition 1500 or so have been sold to companies or individuals at our event.


**Figure 26. Haskap topping made by the fruit program for promotional purposes.**

Fruit has also been distributed to various companies who were either developing fruit products or wanted haskap for promotional purposes. Some of these companies have generate favourable press (Appendix XII).

Table 33. Some recipients of U of SK haskap for R&D and Promotional uses

| Company/Individual | Uses/research/details |
|---|---|
| Anita Stewart, chef and food writer http://www.anitastewart.ca/ | Savour Canada" Olympic breakfast where it was included in a special breakfast/press conference highlighting healthy foods |
| Manitoba Food Centre | Processing research, cooperating with 5 food centres |
| U of SK Ag Econ Students | Class project, needed sample to take to Booster Juice and restaurants |
| Jerry's Food emporium | Gelato product development |
| Dean of Agriculture & Bioresources | Pancake Breakfast for returning students & Ice cream for use on tours |
| Gerber Foods | Product development |
| Ryo Minoue, Food Broker based in Saskatoon | Propmotion to his clients |
| Homestyle Ice Cream | Product research |
| Haskap Canada | 3 Annual meetings, cooking contest |
| 8+ propagators of haskap | Various promotional activities |

Product Development (120 pounds)

Nutraceutical Testing (1.5 kilograms)

# Extension activities

## Haskap Days

Each year we have a one or two day event on haskap at the U of SK which usually includes talks and a tour.

Haskap Day 2009

Haskap day occurred on July 17th, two or three weeks later than previous years. We wanted to highlight the Japanese Haskap germplasm, which is noticeably later ripening that the Russian germplasm seen in previous years. However, the rather cool spring resulted in Russian germplasm being optimum and Japanese germplasm just starting to ripen.

The event was attended by about 80 people at the Horticulture Field Plots of the University of Saskatchewan. The format this year was that of an Open House, which was different from

previous years. Tours of the field plots were given every hour or when enough people had accumulated. A self running slide show entitled "Fruit Breeding at the University of Saskatchewan" was set up. Although we planned for people to 'come and go', three quarters of the people showed up at the starting time. After this large group had their tour they talked Bob into giving other presentations that he had on his computer. Most of the people stayed the whole day.

Haskap Day 2010

Haskap Day occurred on July 9th. The format was to have a tour of all of the Haskap plots in the morning and then talks from students, propagators and Bob in the afternoon. Since 2010 was a very wet year we were unable to do our usual hay ride tour of the plots so we instead had a walking tour of the plots. All of the visitors were equipped with white tags so when they came to block 6, where our advanced selections for that year had come from, they were able to put a tag on any plant that they liked the taste of. Once Haskap day was over we were able to go through that block and make further selections based on the plants that had massive amounts of white tags on them.

Haskap Days 2011

Haskap Day occurred on both July 8th and 9th this year. The format for the first day was much the same as in 2010. There was a tour in the morning, this time on a tractor, and people were allowed to go through and taste plants in blocks fourteen and twenty-two which was where this year's advanced selections came out of. They were again armed with tags and encouraged to tag the plants with the best taste. We also provided a demonstration of how our mechanical harvester works. Then in the afternoon there were talks and question and answer periods from propagators and students as well as by Bob. We also demonstrated how we use our sorting machine to sort the harvested Haskap. The second day involved a tour of a local growers commercial Haskap orchard in Outlook.

## Websites

We maintain a sizable collection of Haskap articles on our website at www.fruit.usask.ca. a listing of haskap articles is in table 34. Also there is a link to photos from our program. Searches for 'Haskap' or 'Lonicera caerulea' in Wikipedia will result in an article mostly written by Dr. Bors including many of his photos.

**Table 34. articles on Haskap at the www.fruit.usask.ca website in January 2012. More than half of these article were written during this project.**

- 'Honey Bee' a new pollinator variety by Bob Bors
- Indigo Haskap by Bob Bors
- Dried Haskap by Bob Bors
- Haskap Wines at the U of S Fruit Program
- Haskap: the Shape of things to come in 2010 by Bob Bors
- Mechanical Harvesting trials of 2009 by Bob Bors
- Haskap Pollinator Research in 2009 by Bob Bors
- Wild Honeysuckle Pictures (Lonicera Villosa)
- Edible Blue Honeysuckle: A Fruit for Cold Climates by Clayton Wiebe (Jan. 2010)
- Sabbatical Report by Bob Bors (Sept. 09)
- A Visitor from Russia by Bob Bors (Sept. 09)
- Haskap Sister Crops by Bob Bors (Sept. 09)
- Haskap Breeding at the University of Saskatchewan by Bob Bors
- Growing Haskap in Canada by Bob Bors
- A Pollination Strategy by Bob Bors
- New Haskap Varieties from the University of Saskatchewan by Bob Bors
- Observation of Japanese Haskap in Oregon by Bob Bors
- Haskap Research & Opportunities by Bob Bors
- Haskap & Japan by Bob Bors
- Shocking News about Haskap for Growers by Bob Bors
- Haskap Growers Unite by Bob Bors
- Blue Honeysuckle by Bob Bors
- Blue Honeysuckle Update 2004 by Bob Bors

## Talks

The following 38 presentations have been substantial content about haskap and have been given within the last 3 years. Additional talks on Haskap are given in some of the courses that Dr. Bors teaches.

B. Bors. Fruit Research Update Saskatchewan Fruit Growers Association Annual Conference.

B. Bors, 2011. New, Old and future fruit varieties. Bruno Cherry Festival, Bruno, SK.
B. Bors, 2011. Starting an orchard. Orchard Management and Grafting Workshop sponsored by Manitoba Agriculture.
B. Bors, 2011. Fruit growing for Alaska. Alaska Master Gardening Conferences, sponsored by Master Gardener's of the Tanana Valley, Inc.
B. Bors, 2011. Gathering and propagating wild and orchard fruits. Alaska Master Gardening Conferences, sponsored by Master Gardener's of the Tanana Valley, Inc.
B. Bors, 2011. Haskap Research Update. Haskap Canada Conference.
B. Bors, 2011. Fruit Research Update. Saskatchewan Fruit Growers Association Annual Conference.
B. Bors, 2011. New fruit varieties at the University of Saskatchewan.. Bruno Cherry Sunday, Bruno, SK.
B. Bors, 2010. Tree and Bush fruit production for landscaping. Green Industry Conference, Edmonton. Sponsored by Landscape Alberta Nursery Trades Association.
B. Bors, 2010. Apples, berries & cherries… fruit from the farmyard all summer long. (Given 2x) FarmTech Conference, Edmonton.
B. Bors, 2010. Fruit Trees and Shrubs for the Prairie Provinces. Annual Conference, Saskatoon, sponsored by Canadian Institute of Forestry & International Society of Arboriculture
B. Bors, 2011. Distribution, Habitat, and Characteristics of Wild Lonicera Caerulea (Blue Honeysuckle) in Canada. Poster and talk. International Hort Conference, Lisboa, Portugal. Sponsored by the International Society of Horticulture Sciences.

B. Bors, E. Sawchuk, P. Reimer, & R. Sawatzky 2011. Haskap Tour and workshop. (5 hours long) U of SK Haskap Day.
B. Bors, 2010. Fruit Research Update. Saskatchewan Fruit Growers Conference.

B. Bors, 2010. Summary of Vitinord Conference. Saskatchewan Fruit Growers Conference.

B. Bors, 2010. Haskap Research Update. Haskap Canada Conference.

B. Bors, 2010. Experimenting with Fruit; Ideas Worth Trying. Manitoba Direct Farm Marketing Conference.

B. Bors, 2010. Mechanical Harvesting of Bush Fruits: Haskap, Saskatoons, and Cherries. 'Northwest Orchard and Vineyard Show' sponsored by Michigan State University.
B. Bors, 2010. Haskap. Gardenscape show, Saskatoon.

B. Bors, 2010. Introduction to Haskap. Northern Haskap Day, sponsored by Haskap Central Sales, near Prince Albert.

B. Bors, 2010. Gathering Haskap in Japan and the Boreal Forest of Canada. Bruno Cherry Festival, sponsored by Carleton Trail Agricultural Society.

B. Bors, 2010. New Fruit Varieties. Bruno Cherry Festival, sponsored by Carleton Trail Agricultural Society.

B. Bors, 2009. Old Wisdom and Cleaver Tricks: How the Saskatchewan Fruit Program Builds on the Past. 'Training for Rural Development' Conference in Mongolia sponsored by the U of SK and Mongolian State University of Agriculture (MSAU).

B. Bors, 2009. Cold Hardy Fruit. 'Training for Rural Development' Conference in Mongolia sponsored by the U of SK and Mongolian State University of Agriculture (MSAU).

B. Bors, 2009. Prairie Fruit Genebank. Lecture to staff at USDA Fruit Genebank at Corvallis Oregon.

B. Bors, 2009. Saskatchewan Fruit Breeding Program. Lecture to faculty, staff and students at Nova Scotia Agricultural College.

B. Bors, 2009. Growing Haskap. Lecture to growers and researchers in PEI, sponsored by Phytocultures, Inc.

B. Bors, 2009. Gathering Haskap in Japan and the Boreal Forest of Canada. Saskatchewan Fruit Growers Conference.

B. Bors, 2009. Gathering fruit plants in the Boreal Forest of Canada. Saskatchewan Native Plant Society, Annual Conference.

B. Bors, 2009. Fruit Growing Tips for Southwest Saskatchewan. Women's Club, Leader, SK.

B. Bors, 2009. Hokkaido trip and the Haskap collected. Haskap Canada Annual general meeting.

B. Bors, 2009. Collecting Haskap in Canada. Haskap Canada Annual general meeting.

B. Bors, 2009. Grower-assisted Fruit Program for Haskap Breeding. Haskap Canada Annual general meeting.

B. Bors, 2010. Haskap Day 2010 and Tour. U of SK Haskap Day.

B. Bors, 2010. Haskap Research Update. U of SK Haskap Day.

B. Bors, 2010. Distribution, Habitat, and Characteristics of Wild *Lonicera caerulea* L. (Blue Honeysuckle) in Canada. U of SK Haskap Day.

B. Bors, 2009. Growing Haskap. U of SK Haskap Day.

B. Bors, 2009. Haskap Tour. U of SK Haskap Day.

## Posters

In addition to Eric Gerbrandt's poster presentation mentioned earlier, 3 posters were made. A few of our propagators have reproduced the 1st twoafor use in promotional materials

B. Bors, 2011. Haskap breeding. First Saskatchewan Food Summit in Saskatoon.

B. Bors, 2011. Haskap. Haskap Day at U of SK.. (A product poster from pictures taken in Japan)

B. Bors, 2010. Distribution, Habitat, and Characteristics of Wild Lonicera Caerulea (Blue Honeysuckle) in Canada. Poster and talk. International Hort Conference, Lisboa, Portugal. Sponsored by the International Society of Horticulture Sciences.

## Photos

Photos taken during this project have been made available to our growers, processors and plant nurseries and occasionally to the press. Hundreds of photos have been taken of haskap to document aspects of the research but some are taken that could be used in marketing. Photos of products also require that we make the products. Note that almost all the photos used in the Healthy Haskap Pamphlet (Appendix IX) where from our program.

Figure 27. Photos of Haskap fruit and products. Dozens of photos have been made available to the industry. The above is a representative set of the types of photos often requested.

## Conclusion

Funding from Saskatchewan's Agriculture Development fund has allowed us to greatly expand research into Haskap breeding and production through this project. Haskap is a new crop that is being widely tested across Canada, but especially in Saskatchewan, and we are regarded internationally as having the most progressive program. We are on the cusp of releasing the next generation of improved varieties and the groundwork has been laid for future varieties with widely different ripening dates.

Recently we have been given word that Haskap breeding will be continued in a new ADF project with greater emphasis on nutritional analysis being used in the selection process. Such a project is only possible because this project has generated larger numbers of desirable seedlings from which more intensive selection is possible. Our program is attracting worthwhile bright graduate students who will be playing important roles in the next stages of improvements of this crop.

## Appendix

The following pages are reports and articles, mostly posted to our fruit website (www.fruit.usask.ca) that were written from 2009 through 2011 concerning Haskap.

The articles may look differently on the web as they may have received additional formatting prior to fir in this report.

## Appendix I: Overview of Bob Bors Sabbatical

July 1, 2008 to June 30, 2009

### New Germplasm

Almost 1000 wild Haskap plants and 100 seedling lines were obtained during my sabbatical. Most of this germplasm was gathered from across Canada with important seedling lines obtained during my visits to Hokkaido and Oregon (Table 1). Seeds were also sent to me from Russia, China, and Mongolia during my sabbatical. Haskap was collected from 200 sites but perhaps 600 locations were investigated which did not have any. Particularly frustrating was that no *Lonicera caerulea* was found in either BC or the Northwest Territories despite spending about a week in each location. In these later two areas plants and seeds of other fruit species were obtained. Also, there was not enough time to visit Newfoundland and only a small portion of Labrador was investigated. However, far more germplasm was obtained than I thought possible. Perhaps if I had been less observant I would not have found so much material and had more time available to go farther east.

**Table 1. Summary of new Haskap germplasm obtained in 2007 and 2008. Each location was at least 30km apart. *Germplasm from China, Russia and Mongolia was sent to us, but all other germplasm was directly gathered by myself.**

| Year | Location | Sites | Seeds | Clones |
|---|---|---|---|---|
| 2008 | AB | 6 | ---- | 30 |
| | SK | 35 | ---- | 175 |
| | ON | 46 | 15 | 230 |
| | QC | 11 | 4 | 55 |
| | NL | 5 | 3 | 25 |
| | Japan | 12 | 16 | ---- |
| | China* | 1 | 1 | ---- |
| | Russia* | 1 | 16 | 6 |
| | Mongolia* | 1 | 1 | ---- |
| 2009 | ON | 15 | ---- | 122 |
| | QC | 16 | ---- | 76 |
| | NS | 25 | 13 | 137 |
| | NB | 20 | 3 | 98 |
| | PEI | 5 | ---- | 32 |
| | Oregon | 1 | 30 | ---- |
| | Wild | 200 | 43 | 980 |
| | Cultivars | | 59 | 6 |
| | Total | 200 | 102 | 986 |

In Japan, gathering Haskap was done by Dr. Bors in cooperation with Dr. Ukai and Dr. Suzuki of the University of Hokkaido and at least a dozen others assisted in the tours that were given. Seeds obtained during the Japan trip were shared with Dr. Suzuki for their breeding program.

Dr. Kristine Naess played a key role in finding Haskap in Eastern Quebec and Labrador as she had already known several locations where the plants could be found, and she accompanied Dr. Bors on all searches in those areas in 2008.

During my Sabbatical I successfully obtained a 'PTP II Grant' and was able to bring Dr. Artem Sorokin of the Vavilov Institute (the world's largest genebank in Russia) to Canada for a month. He accompanied me on a plant gathering expedition through western Ontario and visited various fruit breeders and the Canadian Clonal Genebank in Southern Ontario. When he returned to Russia he sent us additional germplasm from the Vavilov Institute.

In Oregon I visited Dr. Maxine Thompson where I assisted in setting up bird netting and took notes on early ripening Haskap in her breeding program. Also, Dr. Thompson allowed me to gathered seeds from plants that I deemed superior for use in the U of SK breeding program.

Other grants and plant royalties funded the above mentioned expeditions, but this grant funded the care of the new germplasm once it arrived at the University of Saskatchewan.
The accessions from 2007 have been planted in the field but 2008 accessions are currently in pots and plug trays and will be field planted in 2009.

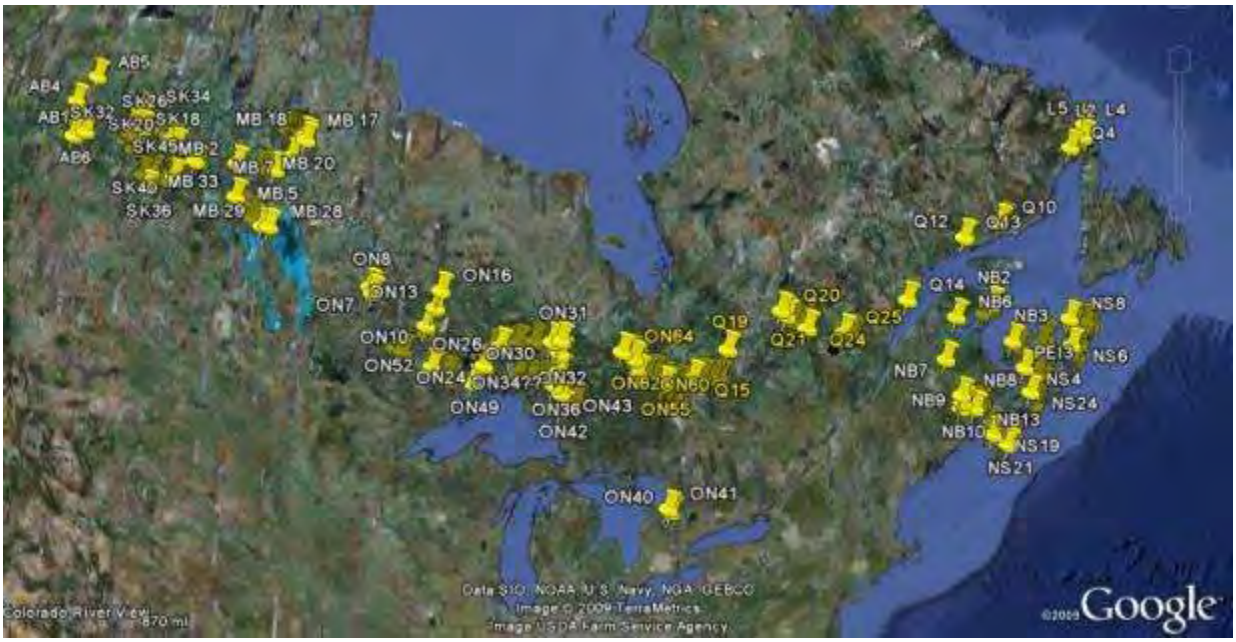


**Figure 1. Places in Canada where I collected *Lonicera caerulea*. All plants except Manitoba were collected during my sabbatical. (Manitoba was done previous to the sabbatical). The small scale of the map does not allow one to see all 184 Canadian sites; sites were at least 30kms apart. L.c. was not found in either BC nor NWT despite a week spent in both locations. Newfoundland was not visited.**


**Figure 2. Some of the people involved in gathering haskap.**

Wild *Lonicera caerulea* was found in: seasonal streams, openings in deciduous boreal forest where fallen trees were decomposing, high calcium soils, and disturbance areas near road construction. It was never observed to be a dominant species and was not as common as other *Lonicera.* It seems highly unlikely that this species will ever be invasive. Mainly it grows in areas where trees are doing poorly, in wet areas and partly shaded. It may be an understory plant adapted to low light levels. Figure 1 shows areas in Canada where plants were gathered.

High diversity was noted among wild accessions gathered in Canada. Variation in leaf size, disease resistance, plant height was noted. Some plants were found close to salt water and most berries tasted were good flavoured. Compared to cultivars, wild plants had very small fruit. It is hoped that these plants will be valuable in providing hybrid vigour, disease resistance, and adaptation to Canadian growing conditions. Japanese accessions will undoubtedly contribute large fruit and good fruit shape in future breeding efforts (figure 3). However, Japanese Haskap lacks characteristics needed for mechanized harvesting which can be found in Russian and probably Canadian germplasm. In the years to come this germplasm will be studied and shared with genebanks around the world.

**Figure 3. Japanese Haskap with exciting large fruit, most of which have the desired round or oval shapes. Some fruit was twice the size of the largest fruit grown at the University of Saskatchewan! Too bad the largest fruit was rather fragile. Seeds were saved from all the fruit shown.**

## Outreach & Engagement

I estimate I met with over fifty fruit researchers and extension agents and talked to over three hundred growers & fruit processors in Canada and Japan during my Sabbatical. At least eighty percent of these people and institutes I had never visited before. The Sabbatical also allowed colleagues to become aware of the University of Saskatchewan's fruit program and many possibilities for future collaborations were planned. See Table 1.

**Table 1. Summary of Outreach and Engagement activities on Bob Bors Sabbatical.**

| Institute / group | Province | Activity |
|---|---|---|
| Saskatoon growers | MB | Gave talk to growers, tour of research plots |
| Sask Fruit Growers | SK | Spoke at annual meeting |
| Sask Ag | SK | Meeting with Provincial fruit specialist |
| U of Calgary Herbarium | AB | Meetings with Herbarium staff, viewed botanical records |
| Fruit Growers | ON | Visited 6 growers |
| University of Guelph | ON | Meeting with several fruit breeders |
| U of G Herbarium | ON | Wet with researchers about 'DNA barcoding' and looked at botanical records |
| U of G Arboretum | ON | Collected seeds of about 30 *Lonicera* species |
| Royal Botanical Gardens | ON | Tour, Part of PTP 2 grant |
| Wineries | ON | Toured several wineries |

| | | |
|---|---|---|
| Niagara Fall Arboretum | ON | Tour, Part of PTP 2 grant |
| Ag Canada, Clonal Genebank | ON | Tour |
| Thunder Bay Herbarium | ON | Review records, meeting |
| University of Guelph Research Station at New Liskeard | ON | Tour and meetings regarding their tissue culture lab and virus free techniques |
| Phytocultures Ltd. | PEI | Gave talk to growers about Haskap, Toured lab and greenhouses, Gave advice, met researchers and extension agents who were also speaking at the grower meeting |
| Vegetolab Inc. | QC | Toured lab and greenhouses, Gave advice, many meetings, They helped gather wild Haskap |
| Les Buissons research center | QC | Tour facility, meetings, plant gathering |
| Provincial Research Centre | NB | Met with Fruit extension agent, searched for wild L.c. |
| Ag Canada | NS | Meetings, tour |
| Nova Scotia Agriculture college | NS | Talk to faculty and staff regarding U of SK Fruit Program, meetings, tours of research plots and labs |
| Organic Agriculture Centre of Canada | NS | Meetings on possible collaborations |
| Blue Berry Isles | NS | Meetings, found wild Haskap together |
| Vavilov Institute | Russia | Researcher visited me for a month, helped collect Haskap, many meetings for PTP2 grant |
| Haskap Breeding program | OR, USA | Assisted with early season evaluations, helped set up netting, meetings, collected seeds |
| USDA Fruit Genebank | OR, USA | Gave talk to researchers, tours, meetings |
| Various Companies | Canada | 10 new propagators of our fruit varieties were added during this period. In most cases, I was directly involved in negotiations, arranging for plant material and answering questions. |
| Various Web articles | U of SK | 8 new or revised articles were written for our website. Much information was gained during the sabbatical that can be used to write more articles. |

**Acknowledgements**

I sincerely wish to thank the University of Saskatchewan for providing me the opportunity to have this sabbatical. The U of SK provides 80% salary for sabbaticals lasting a year as well as a $5000 grant toward expenses. Much of the remaining expenses were paid from letting my annual 'Professional Expense Account' build up (this too was provided by the U of SK) and royalty income from propagators of our fruit varieties. Also the PTP II grant from USSU provided funding that allowed a Russian fruit researcher to visit me for a month touring researchers and gathering wild Lonicera caerulea in Ontario. Most important for last: my wife (Loretta) and the kids still at home (Aurora and Nick) made tremendous sacrifices and 'covered for me' at home during my frequent long absences.

## Appendix II: A Visitor from Russia

Dr. Artem Sorokin of the Vavilov Institute in Russia visited me for a month starting in Mid-August of 2008. The Vavliov institute is the world's largest genebank and Dr. Sorokin is the head of the Fruit Division of the genebank. His special interest lies in "Underutilized Fruit Crops" which includes Blue Honeysuckles, Seabuckthorn and High Bush Cranberries. I obtained a 'Partnerships for tomorrow Phase II' grant from the association of Universities and Colleges of Canada that paid for his visit.

Dr. Artem Sorokin in Ontario

The following are excerpts from the grant write up for the PTPII program, that give insights into the Russian fruit industry and wild Haskap found in Ontario:

### *Visit to various fruit farms in Saskatchewan, Manitoba and Ontario.*

*Goal:* Better understanding of the Canadian fruit industry, production methods and needs for improved varieties.

*Activity*: Perhaps 6 fruit farms were visited in Saskatchewan, Manitoba, and Ontario and dozens seen from the road, especially in Ontario. Also, a few produce stands were visited. Only in a few instances were growers available for discussing their farm. We also visited a few nurseries and greenhouses.

*Results:* Fruit farms of various sizes and degrees of sophistication were observed from small u-pick operations to large scale orchards with processing capability. Some operations merged their farms with other businesses such as gift shops and greenhouses for houseplants. This led to

discussions of fruit growing in Russia. According to Dr. Sorokin, there are practically no fruit farms in Russia and virtually all of the produce in grocery stores is imported. (Dr. Sorokin is very familiar with St. Petersburg & Moscow) Instead, many Russians raise their own their own produce, often involving many family members at dachas.

The fruit farming situation in Russia may be very similar to the early days of agriculture on the Canadian Prairie. Grain and livestock farming was the only mainstream agriculture and the only fruit grown was at home orchards. Early fruit research on the Canadian prairie was geared toward the homeowner. Improved new varieties were made available to nurseries and information was written in gardening magazines. Early fruit farms were often the result of entrepreneurs who were already familiar with raising fruit on the home orchard or were from experienced fruit farmers moving in from the east.

Dr. Sorokin was not aware of any national or local gardening magazines in Russia, but then it is not a mandate of his institute to deal with gardeners nor engage in extension activities. He did not believe that there was any government institute in Russia that has any such mandate. When gardeners contact VI in hopes of obtaining plant material they are referred to various individuals who may be propagating that crop. I was given the impression that there are not any large nurseries in Russia and that the average Russian gardener must spend much effort trying to track down a source for any specific fruit variety.

## *How have the Canadian participants of your project increased their knowledge of the Balkan and Eastern European reform process?*

During his visit, Dr. Sorokin met with or lectured to at least forty agricultural researchers and over sixty farmers. Most of the farmers and many of the researchers were previously unaware of the Vavilov Institute or its large network of researchers and plant collections and that it maintains thousands of fruit varieties. All of these participants became aware to some degree of reforms and changes occurring in Russia.

As the main Canadian participant, I was present for 95% of the meetings with Dr. Sorokin. We had extensive discussions of the reform processes occurring in Russia in regards to their fruit industry and the Vavilov Institute. The following is my impression based on conversation with Dr. Sorokin and others we met during this project. I have never been to Russia so I lack first-hand knowledge.

While various industries in Russia have become ‘capitalized’ there has not been a coordinated effort to create a fruit industry capable of marketing products either in Western Russia or for export markets*. While it is positive that the Vavilov Institute continues to exist and carry out its mission to preserve plant germplasm, it is not well funded. Few recent university graduates are being employed despite the fact that a large percentage of researchers and curators at the Vavilov Institute are over 65. Some researchers continue well past retirement age because they love what they are doing or because they are unlikely to get a job in another industry. Operating funds come almost exclusively from a planned yearly budget from the federal government.

*note: there may be some fruit farms organized in the Siberian part of Russia per other sources.

Unlike Canada, there are no grower groups, provincial governments or other institutions to apply for additional funding. Dr. Sorokin mentioned that some funding from outside Russia was obtained a few years ago by the director of the VI, but researchers at Vavilov are not aware of places to apply for funding. New varieties are occasionally created by Vavilov researchers as a by product of genetic studies but plant breeding is not a mandate of the institute. Consequently, royalties are not funding research at VI. Rules do not exist at Vavilov for how a royalty would be distributed if it existed. At the University of Saskatchewan 65% of variety royalties go to the breeding program that produced it and 35% to the Department of Plants and College of Agriculture. At the University of Guelph, 50% goes to the breeder as a salary bonus and 50% goes to general University funds. The Canadian examples mentioned offer strong incentives for breeders to not only develop new varieties but also get them commercialized as royalties only occur when someone buys the plants. This also leads to more extension activities to make the public aware of new breakthroughs in plant breeding.

Vavilov Institute would have to change its mission statement and create new operating policies to take on the role of plant breeding and commercialization of the fruit industry in Russia. However, the plant collections at Vavilov are certain to be an important asset with much potential to form breeding populations needed for the development of new fruit varieties in colder climates around the world. Its current strategy of working with breeders of other institutes is a wise one as fruits need to be bred for different climatic regions.

One of the areas Dr. Sorokin was particularly interested was the selection process and important attributes for breeding fruit crops suitable for mechanical harvesting. Curators at VI regularly study their plant collections for suitability for many quality traits. If curators were to evaluate their collections for suitability of mechanization they could identify which varieties could be used currently and help breeders identify useful parents. This could set the stage for large scale fruit production and commercialization in the future. But it seems likely that other institutions in Russia such as universities need to be involved to help build a fruit industry.

## *Plant gathering expedition on route to visit the Ontario Clonal Genebank.*

*Goal:* New germplasm obtained. Better understanding of where blue honeysuckles (Haskap) live in the wild in Canada, which may give insight into cultural methods and areas they could be grown.

*Activity:* Perhaps 10 full working days were spent gathering plants in Northern Ontario. Mostly this was the area north of the Great Lakes going as far north as Red Lake and Pickle Lake. We started from Manitoba and went as far east as North Bay before going south to visit researchers and farmers in Southern Ontario. Most plants were gathered in the north while the southern part of the expeditions was spent visiting universities, research stations, fruit farms and other areas of interest.

Although the main goal for this collection trip was to obtain Blue honeysuckle plants, we gathered seeds of other fruit species that were of interest to either of us. At each location, GPS coordinates were taken and notes made on the habitat, nearby plant species, and unique

characteristics of the Blue Honeysuckle plants and fruit. When a site was located which had blue honeysuckles, we would travel at least 30km before exploring another site. In most cases it took 35 minutes to explore, take plants samples and write notes. Rarely did we remove whole plants. Most plants had multiple stems and we would take just one, leaving the mother plant in the location.

*Results:* Fruit seeds or plants were gathered from 54 locations with 44 sites containing blue honeysuckles. Approximately 175 wild blue honeysuckles plants were gathered in Ontario. Other fruit crops seeds gathered were from: Raspberries, cranberries, high bush cranberries, blueberries, currents and aronia. Strawberry plants were occasionally gathered too. It should be noted that the resulting collection of blue honeysuckles is likely the only collection ever gathered from Ontario. Dr. Sorokin mentioned that there are only a couple plants from Canada in the Russian collection and that these were from Alberta. Although it was past optimum time for fruit, blue honeysuckle berries were found in several locations and seeds of these and other species were shared with Dr. Sorokin. Dr. Sorokin also took many samples which he pressed and dried for his institute herbarium, he also made some pressed samples for the University of Saskatchewan.

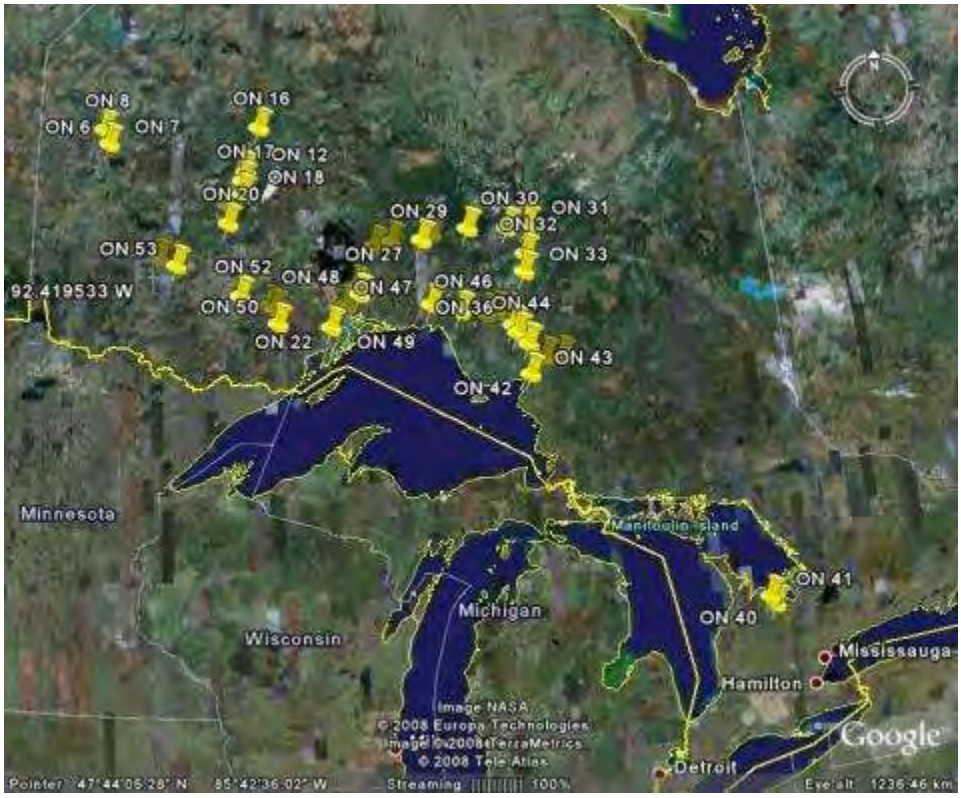


**Figure 1-Wild fruit plants or seeds were collected in 54 locations in Ontario.**

At least twice as many locations were searched that did not have plants of interest. Dr. Sorokin took at least 40 seeds samples back to the VIR genebank while all plants went to the University of Saskatchewan collection.

We may have visited 60 sites that did not contain blue honeysuckles especially during the 1st few days of the trip. After finding them in a few sites and noting the other plant species in the area, we became better at deciding where to stop and look. Key indicator species included Black Spruce, Alders, Labrador Tea, and Cattails. Blue Honeysuckles were found in low lying wet areas often on the edges of bogs in high organic soils or peat.

Dr. Sorokin noted that the wild High Bush Cranberries were much more flavourful than any accessions in his collection. Dr. Sorokin mentioned that the Ukraine might be very interested in such germplasm since that plant is practically a national symbol there.

Dr. Sorokin stated that the most valuable part of the plant collection trip for him was that we had so much time for discussion. As a result, we have a much better insight into the challenges and possible solutions facing fruit breeding, research and industry development in each other's country.

## Appendix III: 'Indigo' Series Haskap by Bob Bors

The Indigo series varieties are sisters to 'Borealis' (breeding ID '9-94') and 'Tundra' (breeding ID '9-84'). The 'Indigos' were originally released as test varieties with breeding IDs of 9-15, 9-91, and 9-92. All 5 of these varieties are closely related and have the same mother and father. The 'Indigos' were considered 'runner-ups' to 'Borealis' and 'Tundra'. All 5 are occasionally referred to as 'Row 9' which is the seedling row that they grew up in.

Previous to their release we did propagation experiments where we found some varieties easy and others difficult to multiply and root in tissue culture. I thought it was a good idea to include additional selections for release, just in case one of the 2 named varieties was hard to propagate. As it turned out, 9-92 was hardest to propagate and 'Tundra' was hard too. 'Borealis' and '9-15' propagated at almost twice the rate of 'Tundra'. Since that time, some propagators have figured out ways of propagating 'Tundra'. But propagators and many growers want ed these test varieties named. 'Indigo' was chosen because there are many 'Blue' names out there; by these all starting out with 'Indigo', perhaps people might remember that they are closely related.

| | |
|---|---|
|  | After shaking fruit off bushes by hand, Haskap berries were run through this sorting line and then rated for durability.<br><br>'Tundra' had the highest durability rating while 'Borealis' was the most fragile. The 'Indigo varieties' were intermediate.<br><br>But this was done many years ago on the original bushes. It remains to be seen how durable berries will be with harvesting equipment under commercial growing conditions. |

**Differences**

Compared to the Russian varieties available on the market in Canada in 2006, one might say all 'Row 9s' are very similar in bush size, bloom time, leaf appearance and all have superior flavour

when ripe. But there are subtle differences when compared against each other, which are described below.

| | |
|---|---|
| Indigo Gem (formerly 9-15)<br><br>The original bush was the most productive of 'Row 9', but berries were the smallest, and this was the only variety that was susceptible to mildew on leaves (others were classified as highly resistant). Also the fruit had a slight 'chewiness' that perhaps would indicate a more durable fruit. But in tests using a sorting line, 'Tundra' was always the best for being durable. Some growers have indicated that this variety grows more upright and faster too. |  |
|  | Indigo Treat (formerly 9-91)<br><br>This variety seemed most similar to 'Tundra' with berries only about 10% smaller. But this variety was much easier to propagate than 'Tundra'. |

| | |
|---|---|
| Indigo Yum (formerly 9-92)<br><br>The berries on this variety are more stretched than the others. The original bush was noticed a year earlier than the others, which might indicate that it comes into production a little quicker. Since this variety was the hardest of all to propagate only a few nurseries have it. We quit propagating it at the U of SK and only a few propagators have this variety. |  |

**Are these Haskap?**

There has been some concern about whether to call these Indigos 'Haskap'. In 2009, Haskap Canada attempted to trademark the term 'Haskap' but was turned down by the Canadian government. The term 'Haskap' was deemed a term for generic crop in use internationally and could not be trademarked. Haskap Canada had wanted to use the term exclusively for varieties that they felt were of high enough quality for marketing to Japan. During my 2008 visit to Hokkaido (home of Japanese Haskap) I took bulk samples of 'Row 9' fruit. The largest distributor of Haskap in Japan and representatives of a natural-products pharmaceutical company told me that our Haskap exceeded the quality that they expected when they bought fruit locally. I also asked if they minded the stretched look of 9-92. I was told that although that berry shape was different, they liked the shape and they thought it could be easily marketed if the fruit was large. However, most likely it would be processed and it wouldn't matter what shape it was.

Haskap Canada is still interested in having a trademark for quality that members can use on varieties and fruit products that they judge meet quality standards. Perhaps they will adopt a system like winemakers that use 'VQA' or come up with grading standards, as is common for other fruit crops. In 2011 and 2012, larger plantings of all the 'Row 9' varieties will be coming into production for the first time. We will see if these 'subtle differences' really make a difference to producers or consumers. Then we will have a better idea of durability, yield and fruit size amongst these varieties, but I'd predict that it would be very hard to tell the difference between these for flavour. We will also have a better idea of what growers would consider 'high quality'.

**Bye Bye Numbers**

As happened with cherries and apples in our program, propagators and growers that receive 'numbered selections' after a few years uniformly want everything to be given a name. The original concept was that growers would say which was best, and the winner would be named. The major problem with naming these is that some will think that these are all something new.

**Around the corner**

Starting in 2011, several thousand new hybrids from our breeding program will begin fruiting. Undoubtedly some of these new ones will be better than the old. But that is always the case with active breeding programs. The row 9 'Indigo' series were bred during a time of limited resources. We only had a few varieties to use as parents and we relied on volunteers to get things done. During this period we quietly amassed a large collection of Russian varieties, Japanese seedlings, and Wild Canadian germplasm.

We didn't have enough resources to do much with the collection until Saskatchewan Agriculture began funding us in 2007. Then we went crazy doing hundreds of crosses and planting thousands of seedlings each year. Also we studied in depth the characteristics of our Russian varieties to use as parents in breeding. In retrospect we discovered that the row 9 parents were actually among the best for fruit quality and row 9 was among the best for disease resistance. However, the 'Row 9s' are only average for bush size and plant vigour.

Varieties 'around the corner' are likely to grow faster and bushes will be larger with potentially greater yield. Berry size might also increase, but likely flavor will be similar and of excellent quality. If we are lucky, future varieties might be as resistant to leaf disease like 'Row 9'. But we have been using the 'Row 9' plants as parents in our program, so it isn't exactly left to luck! We'd also like to develop some late ripening and southern adapted Haskap. All 'Row 9' varieties are fairly early.

But around the corner could be a few years. My advice is to learn to grow what we have now, but leave room for the future varieties. (End of Article).

## Appendix IV: Breeding of Lonicera caerulea L. for Saskatchewan and Canada

Note: this article appeared as part of the Proceedings of the 1st Virtual International Scientific Conference on Lonicera caerulea L. Sponsored by Russian Academy of Agricultural Sciences, Ministry of Agriculture, All-Russian Horticulturae Michurin Institute in 2009.

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ABSTRACT
Only the University of Saskatchewan is breeding blue honeysuckles in Canada. Our goal is to develop cultivars adapted to mechanical harvesting and processing. We are interbreeding lines from Russia, Japan, and the Kuril Islands to bring together traits desirable for mechanization. Russian germplasm is most valuable for uniform ripening, early fruiting, and easy to detach fruit, but fruit is often tubular shaped and small. Japanese germplasm has heavier, more rounded fruit but usually is hard to detach and ripens unevenly. Kurile Island fruits can be large and round but these accessions have low productivity but have good disease resistance. Good flavour is very important, but can be found all 3 germplasm pools above.

Farmers are growing half the seedling from our program in a cooperative project. Perhaps 30,000 seedlings from controlled crosses have been planted in the last 5 years, but 95% of these are first generation hybrids. We recently released two cultivars we consider superior for our location, but expect more improvements in future generations.
Collecting wild *Lonicera caerulea* from the boreal forests of Canada began in 2007. So far, 650 accessions have been gathered from 131 sites in 6 provinces. Plants and leaves are quite variable in the collection. The few plants that had berries on them when collected tasted good but were small. It will be a few years before these plants are large enough to evaluate their usefulness for breeding.

**Background & History**
Our fruit program was established in 1920. It is the northern-most and coldest location where fruit is being bred in Canada. We are located in hardiness zone 2 with winter lows around -40$^{o}$C each winter. In addition to *Lonicera*, we maintain a collection of 17 fruit crops on 15 hectares. We breed most of the crops in our collection on a small scale but in recent years we have emphasized breeding of blue honeysuckles, grapes, sour cherries, apples, and interspecific strawberries.

Almost half of Canada's tillable land is located in Saskatchewan but our farmers mainly produce grain, meat and dairy products. Fruit is a very minor crop in this part of Canada, but there is much potential because of the availability of fertile cheap land. But since we have relatively sparse population we do not have the labour force like other fruit growing regions. For this reason, crops with potential for mechanical harvesting and processing are emphasized in our program.

We began growing blue honeysuckles in 1998, but began doing crosses in 2002. Grants specifically for *Lonicera* breeding from the Government of Saskatchewan began in 2007 and will continue through 2010. These grants have allowed us to greatly increase our breeding efforts with this crop.

Currently, Dr. Bob Bors heads the program, and we have two full time technicians R. Sawatzky and T. Sander, and one part time technician V. Oster. In the summer we hire 2 or 3 students. We have one part time graduate student Jon Treloar working on *Lonicera*.
We are the only fruit breeding program on the Canadian Prairie, other than hobbists, and we work closest with Saskatchewan, Alberta, and Manitoba growers. But we also work with nurseries and growers growing our varieties in northern regions of most provinces.
Growing Blue honeysuckles is new to Canada. Perhaps 150 farmers are trying them commercially and 10s of thousands of home gardeners. 29 farmers are involved in the 'Grower Assisted Fruit Breeding Program'. In this program, farmers each grow 300 to 600 seedlings from controlled crosses and are involved in selecting the best ones. We produce more seedlings than we can plant at the University, and the excess plants go to the farmers. They buy the plants at a low price which almost covers the cost of planting all seedlings for the program. We also have a one day plant sale where we sell directly to the public. In recent years perhaps 1000 people show up for this sale. Some of our growers have formed a nationwide group "Haskap Canada" to help promote the development of this crop. They maintain the website www.haskap.ca.

We have a strong volunteer base consisting of farmers and master gardeners. Volunteers typically plant more than half of our seeds in the greenhouse and have helped with cross pollinating, planting, pruning, and harvesting fruit. We have even trained some volunteers to do tissue culture.

Undergraduate students at the University often have labs or projects dealing with *Lonicera*, in plant propagation, greenhouse management, and fruit science classes. It was class projects that first propagated our new varieties in tissue culture and made wine from *Lonicera caerulea*.

We are also the only program breeding Blue Honeysuckles in Canada. We work closely with Dr. Maxine Thompson, who has the only breeding program in the U.S. Dr. Thompson has given us many accessions and seeds while we have sent personnel to assist her to evaluate fruits at harvest. We have also shared germplasm with Dr. T. Suzuki and had accessions evaluated for health properties by Dr. M. Ukai, both are from the University of Hokkaido, Japan.

About 50 years ago there was a program in Beaverlodge, Alberta, Canada that bred a few *Lonicera caerulea* varieties 'Bugnet'. These were in fact bred as ornamental plants but overly imaginative nurseries called them 'sweet berry honeysuckles' and 'blue honeysuckles' despite them tasting horrible. I believe these poor examples caused complete lack of interest on the part of fruit breeders in Canada. In our program, we have been calling this crop, the ancient Japanese name 'Haskap' to signify that what we are working is quite different from the Beaverlodge varieties, plus it is indicative that we are intensively using stock from Japan in our breeding program.

**Goals**

We want our Haskap varieties to taste very good and to be adapted to mechanical harvesting and processing. Our farmers have much land but few labourers so mechanization is very important. Another important goal is to have a wide range or ripening times to spread out harvest. For most of our other fruit crops, cold hardiness is an important goal, but this is not a problem for us with Blue Honeysuckles. Even the Japanese Haskap seem to survive well for us. While we emphasize breeding for farmers, we do consider gardeners and have released varieties suitable only for home production.

We are fairly confident that varieties developed in Saskatchewan will be ideal for the cold, fairly dry Canadian Prairie. Of concern are other areas in Canada with high humidity or fluctuating temperatures on the east and west coasts and the Great Lakes region. But we are have 5 test locations outside of the prairies where farmers are growing seedlings which may make it possible to select future varieties adapted to other areas.

**Activity Level**

From 2002 to 2006 about 3000 seedlings were raised each year with half being planted at the University and half at farmer's fields. In 2007 and 2008, 8000 and 18,000 seedlings were raised, respectively, with half going to farmers each year. However, we are now more selective in early stages by planting only the best looking 50% of seedlings so many plants are discarded.

In the last two years there have been about 120 different combinations of parents used each year. Our germplasm originates from 4 types: Russia (R), Japan (J), Kuril (K), and Canada (C). About 50% of all crosses were R x J, and 25% are R x K. We plant to do more J x K crosses in the near future, but crosses with C will be minimal until that germplasm has been more extensively evaluated.

While we have many seedlings and a fairly large germplasm base, we are in our earliest generations of Honeysuckle breeding. Only about 5% of our seedlings are second generation crosses between Honeysuckles from different regions. We will need a second generation for recombination and the possibility of selecting for desirable recessive traits. Since Blue honeysuckles are tetraploids it will likely take several more generations to bring together the best desirable traits.

**The selection process**

Selection begins in the greenhouse. Plants with unusually high vigour or particularly promising lineage may be transplanted into larger pots and grown for a season to speed up the time for fruiting. We call this "fast tracking". Fast tracking may be done for 200 plants per season.

But most seedlings are started in plug trays in a greenhouse during January and February and planted in the field in June or August. July is too hot. If there is variation within the seedlings of a particular cross, we plant only the largest healthiest plants. It is quite common for us to reject 30 to 60% of the plants of one cross before planting. In two years of very low funding we planted seedlings as double rows with plants 5 cm apart. In years with funding, plants are 10 cm apart in single rows. Later when exceptional plants are found we will thin out the inferior plants around it.

When plants are about 3 years old we do a field assessment, marking the better plants for each cross with flagging tape. Yield, fruit size, flavour and health of bushes are taken into account. Fruit flavour and health of bushes is most important at this age. It is thought that fruit size and yield can increase dramatically as the plants get older so it is important to compare seedlings to control plants of cultivars that were planted in the seedling orchards for comparison. The flagged individuals are evaluated more closely, using an evaluation sheet (table 1).

The better selections are evaluated further by mimicking mechanical harvesting and processing. We do not have a harvesting machine so we shake bushes by hand into umbrellas or children's swimming pools as in figure 1. Harvested berries are poured into a sorting line (figure 2) and the resulting berries are assessed for damage. Damage is most easily seen as wet and squashed berries that have released juice onto the sorting table.

**Details on different types of germplasm**

**Russian Accessions** From 21 Russian cultivars we did not find any perfectly suitable for mechanized harvesting and processing, but several are closer to the ideal than others. We believe that within our collection of *Lonicera* accessions it will be possible to breed desirable attributes into new cultivars suitable for mechanization. The Russian cultivars we evaluated are most desirable for even ripening, high productivity and early fruiting. But common difficulties are elongated shape of berries (which do not roll on the sorting table) and fruit weight often less than a gram (which tends to get stuck on the sorting line belt). Both these shortcomings could likely be overcome by using superior 'K' or 'J' accessions to create varieties with larger rounder fruit. I have seen photos of round-shaped Russian cultivars in books given to me by Alla Kuklina and Artem Sorokin which depict desirable shaped fruit, but these cultivars are not in our collection. Our favourite Russian cultivars to use in breeding are Lebedushka, Suvenir, and Pushkinskaya. These three always seem to be high on our list when we evaluate our accessions. However we have used about half of our Russian cultivars as parents in the breeding program.

**Japanese Accessions** Until 2008 our only source of Japanese accessions were plants and seeds given to us by Dr. Maxine Thompson. Decisions on which to use in breeding were based on evaluations done in Oregon when Dr. Bors or students visited her to assist in harvesting and plant evaluations. For several years we were afraid that such material could not survive our winters so we kept clonal material in pots and used them as males in breeding. These potted plants were moved to a storage facility during winter so they would not face the extreme cold. In the field we planted large numbers of seedlings, expecting few to survive. However, almost all Japanese seedlings have survived. Only in 2008 did we plant our Japanese clonal material in the field.

In 2008, Dr. Bors visited Hokkaido and collected 16 seedling lines. Of these 12 lines are considered to have commercial potential and 4 lines are from wild types. 6 of the commercial lines are from specific clones while the rest are bulked from many plants.

The general opinions about Japanese germplasm listed in table 2 are mainly based on visits of a week or two at Dr. Thompson's program over several years and a 10 day trip to Hokkaido in 2008. It is too early to tell if any of the characters described will be different in our location. Saskatchewan climate changes rapidly from winter to summer, and we have dramatically hot day temperatures and cool nights in summer. We are hoping that these environmental conditions will

lead to a faster, shorter bloom period and quicker accumulation of sugars in fruit and lead to even ripening in Japanese germplasm.

**Kuril Accessions** Our 6 Kuril accessions seem almost indistinguishable except for one important factor. When fruit is picked in mid July, most will bleed where the berry was attached to its pedicel. This may be an indication of being not being fully ripe. The exceptions are F-1-9-58 and Kiev # 8 which are a bit earlier ripening than other Kuril types and which taste better at that time. Those two accessions were used more often in our program a few years ago. In 2008 we are used all our Kuril accessions as parents.

**Canadian Accessions** Dr. Bors is currently on a sabbatical to gather wild Canadian *Lonicera caerulea.* Plants collected during this sabbatical and those collected the year before are summarized in table 4. More will be gathered in 2009 in spring and early summer. Dr. Artem Sorokin of the Vavilov Institute participated in the Ontario expedition and has some seeds from that trip.

Wild Canadian accessions have not been evaluated other than in notes taken when they were gathered. The collecting expeditions focused on capturing the diversity of plants at each location. Wild *Lonicera caerulea* was found in: seasonal streams, openings in deciduous boreal forest where fallen trees were decomposing, high calcium soils, and disturbance areas near road construction. It was never observed to be a dominant species and was not as common as other *Lonicera.* Mainly it grows in areas where trees are doing poorly, in wet areas and usually partly shaded areas. It may be an understory plant adapted to low light levels in central and western Canada. But in eastern Canada it grows in widely open areas with few or stunted trees. It seems highly unlikely that this species will ever be invasive, which is important to know. Many government agencies are quite worried about such matters.

High diversity was noted among wild accessions gathered in Canada. Variation in leaf size, disease resistance, plant height was noted. Some plants were found close to salt water and most berries tasted were good flavoured. Compared to cultivars, wild plants had very small fruit, which will likely be a major problem with this group of germplasm. But less than 5% of the plants had fruit at the time of collecting so more evaluations are needed under cultured conditions. It is hoped that these plants will be valuable in providing hybrid vigour, disease resistance, and adaptation to Canadian growing conditions.

**Tissue culture research**

Our program also uses tissue culture to propagate new varieties and does limited research to provide information to nurseries working with us. *Lonicera caerulea* is relatively easy to propagate in tissue culture. We do not publish this information but we do provide it to our propagators.

**Accomplishments**

Two varieties were named and released in 2007. Characteristics are listed in table 5. All of these are from the same cross: Kiev#8 x Tomichka. The variety 'Borealis' is recommended for the home gardeners. It had the largest fruit and best flavour but is too fragile for mechanization. 'Tundra' was the best of those that that have mechanization potential. Its fruit is at least 50% larger than blue honeysuckles varieties currently available in Canada. It had the highest rating

for firmness which is a fairly rare trait for large fruited blue honeysuckles. But Tundra is a bit slow to propagate, so 9-15, 9-91, and 9-92 were released for further testing. We have been recommending 'Berry Blue' (Czech#17) as a pollinator because it is unrelated to either parent and this variety is very fast growing.

During 'Haskap Day' in 2006, the growers and nurserymen were quite impressed with the row of 'Kiev#8' x 'Tomichka' seedlings and they insisted that the best from that row be selected and released as new varieties. The convincing argument given at the time was that inferior cultivars were finding their way into the marketplace which could discourage growers and consumers from this crop. Growers were aware that even better cultivars would be produced by the program in perhaps 5 years, but most felt they would rather learn to grow with these new plants than with inferior ones. In 2008, after extensive tasting of more Japanese and Russian Cultivars, these seedlings are very high on our evaluations for flavour. In a sample of berries from 43 accessions sent to Dr. Ukai of the University of Hokkaido, 'Borealis' was selected as the best tasting. Also when Dr. Bors visited Hokkaido in 2008, he brought berries of this family to Hokkaido which received very favourable comments on the flavour.

We also developed tissue culture recipes for our propagators. Recipes for Haskap and other fruit crops are often improved by students in Dr. Bors' propagation course.

**Challenges and areas for cooperation**

The goals of flavour and mechanized harvesting go well together. If a crop can be mechanically harvested quickly, then the growers can let the fruit fully ripen before harvesting. The fruit would taste better and be more acceptable to the average consumer. But if growers are only picking by hand and have limited labour, picking may start too early and continue too late in the season. If there is uneven ripening, pickers will tend to pick all berries within reach, even if some are still partly red.

Varieties bred for mechanization could be useful for farmers who do not have machinery. A simple collection device like umbrellas or children's swimming pools could reduce the time to harvest fruit by 90% or more. But only varieties bred for this type of harvesting would be still be good condition.

An important challenge for us is to select varieties that are firm when fully ripe. Otherwise, a problem could happen where growers would mechanically harvest unripe berries to increase firmness. Another question in this area is understanding optimal fruit size. Perhaps the largest berries will always be more fragile.

There seem to be many papers in Russia, Japan and elsewhere that have extensive evaluations of many traits of Blue Honeysuckles. Fruit size and shape are often studied, but other attributes important for mechanization are not usually discussed. So far we have only evaluated varieties by subjecting varieties to shake harvesting and putting them through a sorting line and visually inspecting the fruit. We are investigating texture analysis machines and pull force meters that could give us quantitative data rather than using a subjective scale.

Table 1. General characteristics of *Lonicera caerulea* germplasm as observed in Canada, Oregon and Hokkaido. Traits important for breeding a crop adapted for mechanized harvesting are included.

| Types | Advantages | Disadvantages | Other |
|---|---|---|---|
| Russian | +Uniform ripening<br>+Most can be harvested by shaking<br>+Upright plants<br>+Productive<br>+Early ripening<br>+Tart flavour common | -Tubular, smaller fruit<br>-Plants quit growing by end of June<br>-some can be bitter | *Variable for flavour and disease resistance |
| Japanese | +Larger more rounded fruit<br>+Longer period of active growth<br>+Productive<br>+Late ripening<br>+Tends to be resistant to leaf diseases<br>+Upright plants | -Uneven ripening<br>-Most plants hold onto fruit too tightly | *Variable for flavour |
| Kuril | +Uniform ripening<br>+Late ripening<br>+Sweet pleasant flavour<br>+Larger, round fruit<br>+Highly resistant to leaf diseases<br>+Leaves stay green and healthy through summer<br>+ Wide, velvet leaves may hide fruit from birds? | -Low productivity<br>-Short plants<br>- Most plants hold onto fruit too tightly | *most of the good traits seem to be dominant when used in crosses |
| Canadian | +Early ripening<br>+Some have very bright blue fruit<br>+Most are sweet pleasant flavoured<br>+Well adapted to Canada<br>+Mostly round fruit | -Small fruit size<br>-Most plants have drooping branches | *Only recently acquired, there is much we don't know about these.<br>* variable resistance to leaf diseases |

**Table 2. U. of Sask. germplasm collection originating from other programs and nurseries, listed by year and source.**

| | | |
|---|---|---|
| 1998 | ***Jim Gilbert / Northwoods Nursery, Oregon, USA*** | |
| | Tomichka (Blue Belle) | Kiev #8 (Blue Velvet) |
| | Sinyayapitsa (Blue Bird) | Czech #17 (Berry Blue) |
| 2002 | ***Dr. M. Plekhanova / Vavilov Institute*** | |
| | Altair | Omega |
| | Amfora | Pushkinskaya |
| | Kamchadalka | Roksana |
| | Lebedushka | Slavyanka |
| | Malvina | Solovey |
| | Morena | Suvenir |
| | Narymskaya or Fialka | Volkhova |
| | Nimfa | |
| 2003 | ***Jim Gilbert / Northwoods Nursery, Oregon, USA*** | |
| | Zarnitsa (Blue Lightning) | Kamchatskaya (Kamchatka) |
| | Sergey (Blue Moon) | Magadan (Blue Forest) |
| | Novinka (Blue Nova) | N-17 (Blue Magic) |
| | Valery no. 2 (Blue Sky) | Dimka (Smoky Blue) |
| | F-1-9-58 (Blue Pacific) | |
| | ***Alexandre Lebedev / Magma Exports, Quebec, Canada*** | |
| | Berel | Lazurnaya |
| | Gerde | Zolushka (Cinderella) |
| | Golunoe Vereteno | Ognennyi Opal |
| | ***Dr. Maxine Thompson / USDA Genebank*** | |
| 2004 | 20 seed lines, controlled crosses | |
| | 1 bulk op seeds from 6 selections | |
| 2005 | 25 clones | 46 lines open pollinated seeds |
| 2006 | 26 clones | 30 lines open pollinated seeds |
| 2007 | 20 clones | |
| 2008 | ***Dr. Bob Bors / Sabbatical expedition*** | |
| | 16 seed lines from Japan | |
| | ***Dr. Artem Sorokin / Vavilov Institute*** | |
| | 16 seed lines | 6 clones |

**Table 3. Characteristics of University of Saskatchewan cultivars released in 2007. Integrity was based on condition of berries after being subjected to conditions mimicking mechanized harvesting and sorting.**

| Name | Scar | Fruit Weight (g) | Fruit Shape | Flavour | Integrity |
|---|---|---|---|---|---|
| Borealis | Wet | 1.62 | short flat boxy | sweet tart | c+ |
| Tundra | Dry | 1.49 | long flat bullet oval | sweet tangy | a |
| 9.15 | Dry | 1.30 | robust short oval | sweet, chewy | b |
| 9.91 | Dry | 1.41 | Flat cylinder | Nice tangy sweet | b-c |
| 9.92 | Dry | 1.29 | long flat oval | tangy sweet | a |

**Figure 28.** ***Lonicera caerulea*** **of Eastern Canada is often found growing in close association with other low-lying shrubs. Often branches are weeping and spreading along the surface, but occasionally upright forms are found.**

**Figure 2.** ***Lonicera caerulea*** **in Eastern Canada showing a wider range of the environment. They are not only found in low areas but can also be found on hillsides and sometimes just meters away from salt water.**

## Appendix V: The Shape of things to come

Breeding plants can be so fun! This summer many Haskap/honeysuckles seedlings began fruiting that were hybrids between Japanese, Russian and Kuril parents. Usually, I walk down the rows looking only for the most productive plants with reasonably large fruit with a 'desirable shape' and taste the best ones. If I like it, it gets tagged, picked and the fruit gets evaluated further. After detailed scrutiny, the very best may get propagated for further evaluation and perhaps released as new varieties. If I don't like a plant it gets ignored.

***Fruit shape and size***

But this year was different. I was asked to evaluate a draft 'Plant Breeder's Rights' form that would be used to describe future varieties. 'Question 24' gave 3 options for berry shape: narrow elliptic, elliptic, and circular. I could think of 4 others but it occurred to me that there were more. So I picked a berry from each plant in 4 rows of hybrids in breeding program (see fig. 1).

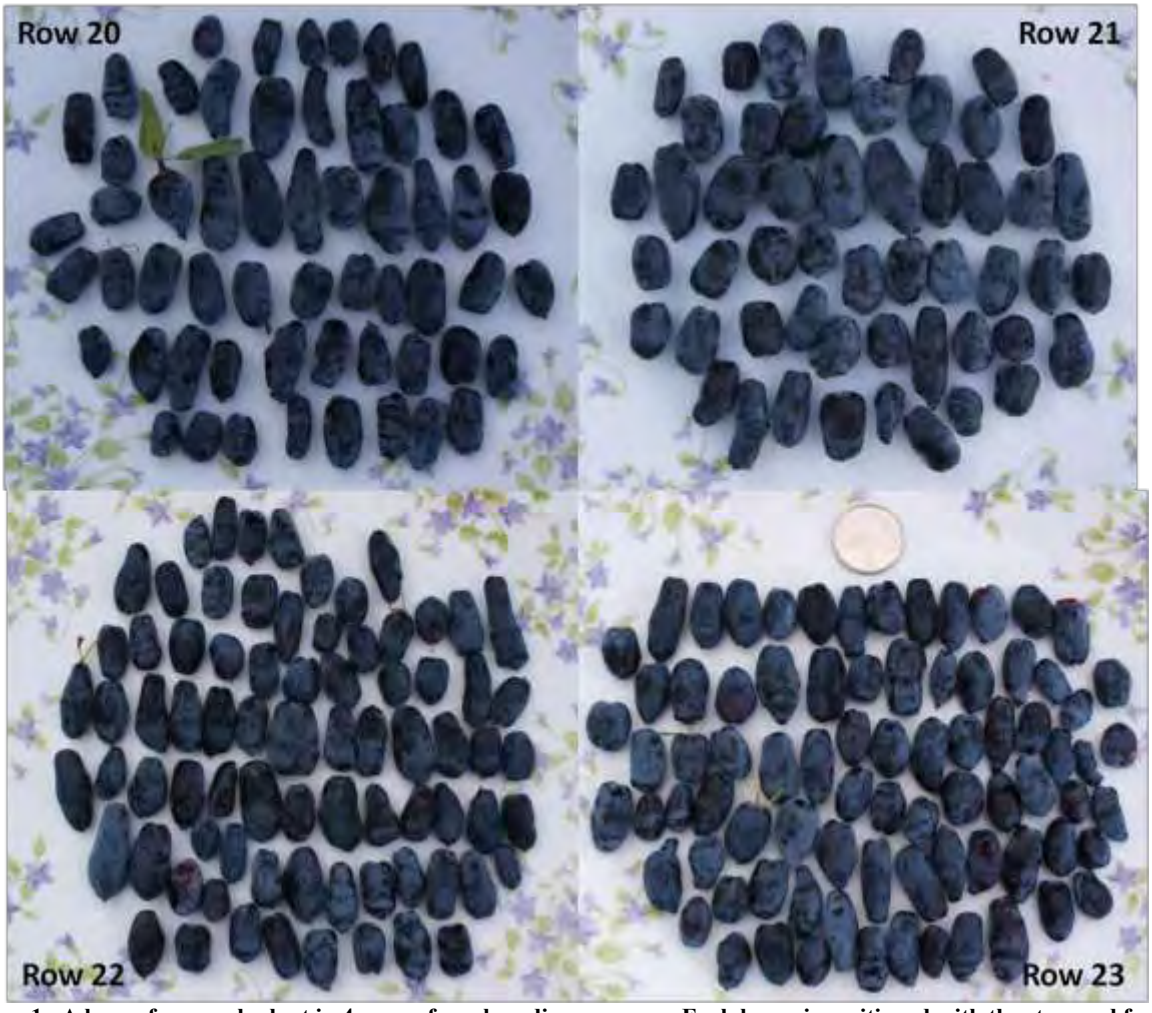



**Figure 1. A berry from each plant in 4 rows of our breeding program. Each berry is positioned with the stem end facing up.**

Then I scrutinized them to make an assortment of the different sizes and shapes (see figure 2). It occurred to me that *Lonicera caerulea* probably has the world's most diversely shaped berries…I wonder if this crop could get in the Guiness Book of World Records for that?

**Figure 2. Different sizes and shapes from 4 rows of seedlings. These berries are the result of hybridizing Japanese, Russian, and Kuril Island types. Again, each berry is positioned with the stem end facing up. Note: a Canadian quarter is the same size as an American quarter and slightly larger than a Euro 20 cent coin.**

### *Superior selections for commercial growers*

While the different shapes are fascinating, many are not practical for commercial purposes. Pointed tips are fragile and prone to damage, and damage leads to short shelf life and decay. The berry with leaves in figure 2 is especially vulnerable with points at both ends. Oddly shaped berries don't roll around on sorting tables too well either, which then takes longer to take out any off types.


**Figure 3. Berries from superior selections that began to fruit in 2010.**

Figure 3 shows a berry from each superior selection considered to be the best that bore fruit for the 1st time last year. Of course, berry shape was not our only criterion for choosing these. Flavour, yield and firmness are very important, plus there are about 20 other characteristics we evaluate. The larger wider berries in Figure 3 are considered 'close to optimum'. The tubular-shaped ones are not desirable but likely those plants had something special that made them stand out. As breeding progresses, it is likely that most commercial Haskap berries in the future will look like the wider ones depicted above.

***Fun for Gardeners***

It would be fun to have varieties with different shaped berries for home gardeners, as long as they taste good. An assortment would be especially fun to give as gifts to surprise friends and relatives. But don't make the mistake of thinking there is a variety that makes many shapes. There is just one general shape per bush. If a bush has pear shapes, all the berries on that bush are pears. If the bush has 'lumpy pillow shapes' all the fruit looks like lumpy pillows. So if you wanted 6 different shapes, then you should make room for 6 bushes. The only time there are different shapes on one bush is when some berries are poorly pollinated. With poor pollination

berries are usually smaller and thinner. Starting in 2011, we will be on the lookout for weirdly shaped berries that taste good.

***Flavour***

After taking those pictures, I had to eat all those berries; one at a time! Most of the berries tasted 'nice' a few were bitter, more than a few were sour and about 10% were exceptionally flavourful. Overall, the average plant in this generation shows much better fruit quality than our 1st generation of Haskap breeding. Flavour in the breeding field could be described as sweet, sour, bland or bitter versions of raspberry, blueberry, plum or black currents and any mixture in-between. The best ones however seem to have a predominantly raspberry flavour with sweetness and just a hint of sour or bitter or astringency to give a little zing. That little zing might be described as desirable 'mouthfeel' in the world of red wine tasting. To me it seems like a little 'Tang' or carbonation (like soda) has been added to the fruit. Fortunately, big berries were just as likely to taste good as small berries.

***Comparison to 'Borealis' and 'Tundra'***

There were only a few plants that had berries with somewhat better fresh flavour than our 'Borealis' and 'Tundra' varieties. In the years to come, I'd predict some improvements in flavour. However, there will be dramatic improvements on how fast the plants grow and larger berry size. I'd guess that the average seedling in last year's new breeding field was growing 50% or faster than the 'Borealis' planted in the same field. But that is a guess. To make a valid comparison, we'd need to vegetatively propagate 'Borealis' and our favourite new selections at the same time to ensure the plants were similar size when planting.

***Jigsaw Puzzle***

Breeding Haskap is like building a jigsaw puzzle where we are accumulating desirable traits from various parents to build better varieties. Most of the desirable selections found this year were descendants of 'Borealis', 'Tundra' and the 'Row9' family crossed with plants from Dr. Maxine Thompson's program. But some good ones were descended from other germplasm. That we found superior characteristics in our seedlings does not mean that they have been 'put together' in a complete package. We have identified a few plants that have good flavour and berry size, but we need to evaluate these for productivity, suitability for mechanical harvesting, even ripening, leaf disease resistance, and ability to stay dormant in warm winters.

***New varieties in the short term***

In the near future (possibly as early a January 2011) we may release a pollinator for 'Borealis' and 'Tundra' to our propagators. [propagators will need 6 months to a year to begin producing plants for sale] This future variety will be faster growing, but bloom at the same time as Borealis' and 'Tundra' and have compatible pollen. Because of the pressing need for a pollinator we will release it, but it will still require a few years of observations to determine if this new variety is good enough to be a mainstream variety. If it proves superior to 'Tundra', growers may want to plant it in larger numbers and grow 'Borealis" and 'Tundra' as the pollinator.

In 2009, 6 superior selections were observed in the field from the new generation. In 2010 these 6 plants were bagged and used in crosses and observed for blooming time. They were also put into tissue culture. Of the 6 only 2 bloomed at the same time as Borealis and Tundra. Of the two

remaining ones, only 1 had good crossability and seemed to do well in tissue culture. We are now looking at whether this remaining selection roots easily in tissue culture and if it can be propagated reasonably well. If it is slow to propagate it would be better to test the plants that bore the fruit in Figure 3 for pollen compatibility.

***Future varieties***

In 2010, 8 rows of seedlings came into production for the first time. But in 2011, 18 more rows will begin producing . By 2014 there should be 60 rows that will need to be evaluated. There is bound to be something good in all that material since each year we are using better quality parents in our crosses. Most of our advanced breeding material is based on hybridizing germplasm from Maxine Thompson (Oregon State University) who gathered material in Japan, Russia and Europe, Jim Gilbert (Northwood's Nursery) and Maria Plekhanova (Vavilov Institute, Russia). In the next couple years 3 major new sources of germplasm will begin fruiting: material gathered from Hokkaido and across Canada (from my sabbatical) and more material from Russia (Artem Sorokin, Vavilov Institute). Having a wide germplasm base gives our program much potential but a few generations will still be needed to bring together the attributes we want.

In particular we likely need a few generations to develop Haskap that bloom and ripen late and that are better adapted to warmer areas. Since we now have a Johanna-3 harvester we will be able to directly measure suitability for mechanization. Also as this plant begins to be more widely planted we will get feedback on what needs to be improved. Our first varieties emphasized fruit quality but now we want high quality with higher yield.

## Appendix VI : Growing Haskap in Canada

**Why grow Haskap?**
Good varieties of Haskap have a fresh raspberry/blueberry flavour with a special zing common only to Haskap. The plant has few pests and is the first fruit crop to ripen each season, being earlier than strawberries by a few weeks. The plant is well behaved: it doesn't sucker, no thorns, need little pruning in early years and likes to fruit when very young.

**Too many names for such a new crop!**
Common names for *Lonicera caerulea* include: Haskap: an ancient Japanese name of the Ainu people (also spelled phonetically as Haskappu, Hascap, Hascup),
Blue Honeysuckle: descriptive translation from Russian
Honeyberry: coined by Jim Gilbert of 'One Green Earth Nursery', Oregon
Sweet Berry Honeysuckle; an old common name from the 1940s
Swamp fly honeysuckle: a common name coined by botanists who found it growing in swampy areas. Not a recommended name for marketing purposes!
The species itself is commonly listed in old records of Canadian herbariums as:
*Lonicera edulis*
*Lonicera villosa*
*Lonicera villosa* var *edulis*
*Lonicera villosa* var *caerulea*
'Haskap' is being promoted as the name to use by the 'Haskap Canada' grower group to signify superior varieties descended from Japanese germplasm (see haskap.ca). It may become a brand for fruit that meets quality standards suitable for the Japanese market.

**History**
*Lonicera caerulea* is a circumpolar species native to northern boreal forests in Asia, Europe, and North America. It is mainly found in low lying, wet areas or high in mountains.

Hokkaido Island in Japan has a history of using this berry that goes back hundreds of years.

Siberian horticulturists became interested in this plant in the 1950's which spawned collecting of wild plants and resulted in breeding programs throughout the former Soviet Union. The Vavilov Institute has a tremendous collection in St. Petersburg.

**Figure 1- Left: 'Borealis' a cultivar for the home gardener. Right: 'Tundra' a cultivar for the commercial gardener**
Horrible tasting, ornamental versions of this plant were bred in the 1950's at a research station in Beaverlodge, AB which probably caused fruit breeders in North America to be disinterested in this plant.

In the late 1990's Dr. Maxine Thompson and Mr. Jim Gilbert (both of Oregon) began spreading the word at scientific and grower's conferences that there were flavourful versions of this plant in Japan and Russia. Dr. Thompson began her breeding program at Oregon State University, basing much of her breeding program on Japanese selections. Her selections are being tested in several states and at the University of Saskatchewan. Mr. Gilbert's nursery, 'One Green Earth' has been selling Russian cultivars with anglicized names that have the word 'Blue' in them. Notable are the varieties 'Blue Belle and Berry Blue which were our favourites in 2003.

**Figure 2. A Russian variety beginning to ripen. Wait for all berries to be blue outside, inside they will be purple (not green) when fully ripe.**

The University of Saskatchewan planted four varieties that Mr. Gilbert was selling in 1998. In 2008, we have one of the most diverse collections in the world. We have thirty five named Russian cultivars, over seventy 'Japanese-type' selections, hundreds of seedlings from Dr. Maxine Thompson breeding program in Oregon, six Kuril Island types and about six hundred accessions gathered from the Boreal Forest in Canada. We have perhaps eight thousand seedlings planted from controlled crosses as of 2008.

So far Japanese types have been hardy here. We are anxious to see what the hybrids will be like that resulted from crosses between Japanese, Russian or Canadian parents. Often hybrid vigour results when plants from distant lands are intercrossed. Hybrid vigour can mean faster growing, larger plants with bigger fruit! We are attempting to bring together the best attributes from the different regions represented in our collection. Already we have combined worthwhile attributes from Russia and Kuril Island types.

*The recommendations below are based on my experience with Russian and the hybrids in the U of S breeding program. .*

**Hardiness:** They are extremely hardy. We have never seen winter damage on them. One winter we forgot to cover some plants in 3inch pots with woodchips (our usual procedure for nursery stock). All the plants survived. Our worse winter had a low -47C; no problem.

Hardiness is not just the ability to survive extremely cold winters. It may also involve the ability to stay dormant when warm weather occurs in the middle of winter. **If you live in a more southern location or on the west coast there is a good chance Russian or Russian/Kuril hybrids may attempt to grow during a warm spell.** This is the case in Oregon and the reason Dr. Thompson is working with Japanese types; they are much slower to come out of dormancy. Our breeding plan includes developing cultivars with a deeper dormancy for warmer areas and for a later season crop.

**Spacing:** Within-row spacing is recommended at 1 meter if you want them to grow into a hedge. At 1.3 meter they would probably remain as individual bushes.

**Pollination & planting several varieties**
In Saskatchewan they bloom from late April to early May and can take -7C to an open flower without damage. Haskap needs two unrelated varieties in close
proximity for good pollination. Almost any Russian variety will pollinate any of the new University of Saskatchewan varieties. There is an in-depth article on this subject on our website.

**Figure 3. Haskap bushes are well behaved: they don't make suckers and have a nice rounded shape. When they get older they need to be thinned.**

**Planting Depth**
Plants can be planted one, two or more inches deeper than original depth to compensate for possible heaving or to establish a deeper root system. In the wild, shoots sometimes fall over, get covered with leaves, and then root. I think it would be possible to plant overly long shoots sideway under the ground and it may make for a wider bush if shoots sprout from the underground buds along the stem.

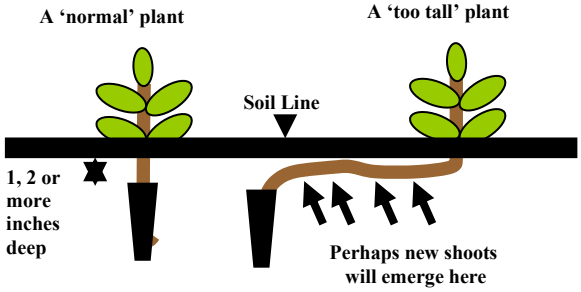



**Figure 4. Planting a normal plant and an idea to try if you get plants with shoots long shoots. The 'plug plants' depicted are what fruit farmers usually buy or what you might get from a mail order company. Retail nurseries are likely to sell older, bigger plants with multiple stems.**

**Soils and pH:** One advantage that Haskap has over blueberries is adaptation to a wide range of pH. At the University of Saskatchewan we have them growing on a clay soil with pH 7.9. But I have seen Canadian Haskap growing side by side with blueberries which indicate a pH around 5.4. Russian researchers recommend a pH between 5 and 7. In the wild, Canadian blue honeysuckles are often

found in boggy areas and near or in seasonal stream, typically with high organic matter such as peat. A plant ecology text indicates that the species can be found in mineral- rich wetlands, so don't put them on nutrient deprived soils and expect them to flourish. But just because Haskap can survive in wet areas while other plants cannot, does not mean that it prefers wet areas. I asked a few farmers to plant them near wetlands and in nearby well-drained soils: all 3 reported they grew better on the well drained soil. Plants seem to do ok in the low spots of our university field and at our Bruno trial where water sits for a few weeks each spring. But certainly don't plant them in an area that has water sitting at the end of June when you want to harvest them.

**Fertilizer:** Many Prairie and Great Plains soils have adequate soil fertility to sustain Haskap. If you get soil testing done, it is highly unlikely that any testing company will know what to recommend specifically for Haskap due to lack of experience. However, Haskap is actually more closely related to potatoes and tomatoes than it is to other fruit crops. Perhaps ask for a tomato recommendation and let me know if it works out well for you. Soil testing and fertilizer incorporation prior to planting is recommended. Subsequent fertilizing should take place only during spring as rapid succulent growth later in the growing season is prone to winter injury. In Japan growers are using composted manure as the chief fertilizer.

**Watering:** During the first three years watering is extremely important for tree establishment. Irrigation is less critical for established bushes. The established Haskap orchard at the U of SK is seldom irrigated but we have heavy clay soil that holds moisture. If we were on sand, we would probably be irrigating much more. Farmers often water once a week during the hottest part of the summer. As a general practice it is best to water a few times thoroughly to promote deep root growth. Watering frequently with small amounts of water results in a shallow root system, which can make a plant more prone to drought conditions especially when you go on vacation and stop watering it! Keep in mind that it is very hard on a plant to use wilting as a sign to water. If your plants wilt every 6 days then you should water every 5 days.
Where irrigation is provided, it should be discontinued in fall to encourage dormancy development.

**Grass Cover and weeding:** Grass between rows serves to reduce mud, and to compete with trees for moisture at the end of the growing season. In dry areas it is best to maintain grass-free alleys between rows. Similarly, establishing trees should be kept grass and weed free. In areas with adequate moisture,
grass can be permitted to fill in below established trees. Some growers keep orchards weed/grass free through July, but permit weeds and grass to grow in August to reduce the available moisture supply promoting dormancy, and also facilitates snow trap. Long grass in winter may however also provide
winter cover for rodents that gnaw bark and girdle trees. Glyphosate herbicides are not recommended. Most fruit species are highly susceptible to damage. It is possible to use herbicide but beware that a drifting mist can cause extensive damage.

**Windbreaks**: Protection to the west and north of any prairie orchard is highly recommended. Winter damage is often a function of desiccation caused by direct exposure to prevailing winds.

**Pests:** There are reports in our Herbarium that deer browse bushes in the wild, but we have not seen that at the University field. When deer get into our research plots they usually eat cherries and apples and have not been seen on Haskap. Birds, particularly Cedar Waxwings, love Haskap. For 3 years they ignored our berries but then they wiped out 2 years of crops before we bought bird netting. I recommend using half inch netting. If you buy the cheaper one inch you will have birds stuck with their heads in the net. It's pretty gross especially when they are dead. Waxwings will 'freeze' when trapped and it is fairly easy to remove them. They don't try to attack you. A grower suggested buying a type of bailing netting for round straw bales. I was told this may be a quarter the price of regular netting but is likely to have a 1inch holes so you could have a bird problem. It might only last a year.

In Japan, they don't have bird problems in commercial orchards, but I did not see many birds when I visited. Perhaps they have lost habitat in southern nesting areas of Japan or the nearby Asian mainland where the human population is so dense.

**Figure 4. Help me!!! This bird got under the net and then was trapped inside.**

In Canada many growers have reported bird problems. I have noticed birds tend to ignore Haskap when other berry crops, like Saskatoons, begin to ripen. Perhaps in the future we can grow early varieties of Haskap for the birds and later varieties for us. But bird netting may be the way to go.

**Diseases:** The only diseases we have seen is powdery mildew which starts in the heat of July which is well after harvest. Susceptibility varies tremendously between varieties. Some varieties are severely affected while others seem immune. Our new selections are very resistant except 9-15 which was susceptible. (9-15 had twice the yield and may have been particularly stressed that year from the heavy fruit load). The mildew is white for a few days but then the leaves became partly brown in some Russian varieties. On some varieties we see a mysterious bronzing on leaves that may be sunburn. Our plant pathologist, Dr. Jill Thomson, found no evidence of any pathogen causing this. Perhaps this occurs when leaves unfold under many days of cloudy weather and then subjected to long bright days? Like the mildew, we found some varieties get this more than others.

**Figure 5. Mildew on a susceptible cultivar. So far, the U of SK have been highly resistant to his disease but many varieties get this in mid July. It may not matter much to the farmer but could be rather ugly in your yard.**

**Figure 6- Sunburn? No diseases or pest were found that could explain this disorder. This too is highly dependent on what variety is grown. The new U of SK varieties are highly resistant to this. It has been suggested by an American nursery that perhaps this problem is caused by high temperatures.**

**Pruning:** I think it best to train it as a renewable shrub like saskatoons, dwarf sour cherries or high bush blueberries. Pruning should be undertaken in late winter or early spring. Mainly you should thin out older branches when the bush gets too dense. But never remove more that 25% of a bush in any year. They don't sucker so you won't have to worry about that. If some unfortunate event occurs that kills the top of the bushes, say a major ice storm, unusual winter, fire, or someone runs it over with a lawnmower; it is quite possible the plant will come back from the crown. They are on their own roots so the regrowth will be the same variety.

**Harvest:** Bushes often bear a few fruit the year after planting but it will be 3 or 4 years before the bushes are big enough to get a few kilos per bush.

In Saskatoon, we usually see our first fruit changing colour around the 1st of June in Saskatoon. (June 1st is also our average last day for frost!) However it is the 2nd or 3rd week in June when all the berries are purple and have begun to be purple inside. Don't be too anxious: bite some berries in half, if its green inside they aren't ready.

In 2006 & 2007 we left a row of plants unharvested to see how long the fruit would still be good. In 2006, which was a hot year, the berries tasted good until the second week in August. In 2007, which had the coolest August in 30 years, the fruit tasted good until early September. Selections that had big fat berries (like Borealis and Tundra) were the best, but thin tubular Russian types dehydrated by late July. Some varieties dropped their fruit easily and others (including our new varieties) held onto their fruit.

**Uniform Harvest** Russian and Russian / Kuril hybrids have uniform harvesting; all the fruit is ready all at once. This attribute may make them particularly adapted for mechanical harvesting. We have shaken fruit from young plants into umbrellas and when larger into kid's swimming pools. Japanese types are known to have uneven harvesting but these types of varieties are not currently available on the market.

**Yield:** Our oldest plants were bearing about 7 kilos / bush after 5 years. In Japan they expect their better plants to produce 3 kilos and I have read Russian papers that indicate 3 kilos are expected for yield. We haven't had our new varieties around long enough to know but I would think it would be similar level. Because Haskap produces its crop so early, I don't think it will ever be as productive per acre as later crops such as cherries or apples.

I would venture to guess that Haskap will be a very consistent crop from year to year because the plant will have most of the summer to prepare for winter. The crop will be harvested before hail starts in July and August and before insects have time to build up.

**How long can my plants live?**
We have some ornamental blue honeysuckles at the University that are over 30 years old. They are quite healthy despite being partly shaded by a large poplar tree. Many productive 30 year old plants were seen at Japanese farms.

**Figure 7. A 30 year old bush growing in Japan.**

**Figure 8. Trunk of a 30+ year old haskap growing at the U of SK.**

The trunk of old Blue Honeysuckles look similar to an old grape vine with a 'shredded bark' look. Although rather ornamental, it would be rather hard to shake the fruit off this bush because the trunk is 3 inches across. Hopefully, growers will prune out branches when they begin to get too thick. Gardeners may opt to turn the plant into a bonsai-like plant with character, and hand pick each fruit!

**Uses and Fruit Quality:**
Haskap can be used in processed products: pastries, jams, juice, wine, ice cream, yogurt, sauces, and candies.

When frozen fruit is placed in the mouth it melts away. Seeds aren't noticeable when eating but if you look for them you will see they are practically the same size and shape as kiwi fruit. The skins simply disintegrate which has caused some excitement amongst ice cream and smoothie makers. Also the fruit turns dairy products into a bright purple-red.

Haskap makes excellent wine, some say similar to grape or cherry wine. The wine will be a rich burgundy colour. Its juice has perhaps 10 to 15x more concentrated color than cranberry juice.

**Figure 9. Haskap wine and juice has a deep burgundy colour.**

## Appendix VII: Comparing Haskap to other Berries

**Sister crops:** There are economic advantages to additional crops that can be harvested at another time especially if the new crop can utilize the same harvesting or processing equipment. Better yet is if the new crop can also be used to make similar products. Not only can a factory be kept going longer but the sales staff have an additional crop to sell. It also provides steady work over a longer period for staff. It also reduces risk. If one crop has a failure, the others may be fine. Often crop failures are industry wide, so if there is a general shortage of a particular berry crop, won't buyers be looking for something to fill the gap?

Below are discussed some possible sister crops for Haskap and key similarities and differences:

**Blueberries & Haskap:** Most Haskap varieties have upright bushes similar in size and shape to commercial highbush blueberry cultivars. Likely they can be planted in a similar density per acre and pruned in a similar way. But Haskap has a much wider range of pH: from 5 to 8! But I understand that blueberries are beginning to be grown on a wider range of pH when attention is paid to getting a proper Calcium / Magnesium ratio.

Occasionally in the wild I have found Haskap and blueberry plants growing side by side. But I have never found Haskap growing in thick natural stands like I have seen with blueberries. I doubt that Haskap could be grown and managed like wild low-bush blueberries. Haskap in the wild is found in wetter areas, possibly because this reduces competition from taller plants.

I'm guessing that early fruiting Haskap can be a month or 6 weeks earlier than blueberries. Why guess? We can't grow blueberries on the prairies so I haven't grown them side by side. In Saskatchewan, early Haskap ripens 2 to 3 weeks before strawberries while late Haskap ripen towards the end of the strawberry season. Currently (2009) there are no late ripening Haskap varieties on the market. But the late types we are developing are ripe in mid July but can still be good into August or September depending on how hot the summer is.

The same harvesting equipment could be used for highbush blueberries and Haskap but maybe the sideways harvesters (like Joanna) are better than upright harvesters. This harvester causes less damage to the fruit since it pulls branches over to the side and fruit only falls a foot or less. Haskap fruit requires less pull force to detach but its fruit is more delicate than blueberries. If the harvester has an adjustment for shaking it can be slowed down. While most blueberry varieties can be handled with machinery, only a few Haskap cultivars are adapted. But within Haskap varieties there are differences for how durable the fruit is and likely there are differences on when you decide to harvest. Our new variety 'Tundra' was one of the few selections that held up to shake harvesting and running through sorting lines.

Blueberries and Haskap have the annoying trait of looking ripe perhaps 5 to 10 days before they are fully ripe. They should be tasted tested before being harvested. In the case of Haskap, the berry should be purple on the inside, not green.

Haskap is softer so the fruit can't be stacked as deep. But Haskap has a thick wax coat and could have a similar shelf life as long as it stays intact. The firmness of Blueberries is an advantage for products like pies where it is nice to have intact berries after cooking. But unlike blueberries, Haskap skin once frozen simply melts away in the mouth. This makes it smoother in dairy products. Both blue berries and Haskap make great muffins and jam.

Highly prejudiced Haskap growers claim Haskap makes better muffins than blueberries because the skin disintegrates when cooked. I'm fairly sure that the average person wouldn't be able to tell the difference in a muffin but the jam would be obviously different. Haskap when fully ripe is deep purple throughout the fruit and its juice is intensely more colourful than blueberries. Finally, Haskap flavour is different than blueberries but most people say is most similar to blueberries + raspberries.

Nutritional studies are showing Haskap to have similar or greater levels of antioxidants compared to blueberries. Blueberries already have many well documented studies showing them to among the most impressive fruit we can grow in Canada regarding antioxidants. Each fruit has its own assortment of antioxidants which have different and complex interactions in the human body. To have another high-antioxidant fruit available for Canada will undoubtedly be exciting for health researchers and consumers.

**Haskap vs. Cranberries**

I have also seen Haskap growing with Cranberries in the wild and have noticed that Haskap Berries float. With Haskap's high tolerance for water, I wonder if they could be grown and harvested in a similar way to cranberries? The harvest day would be earlier and we'd have to breed plants to be more weeping and low to the ground.

All the commercial Haskap varieties and seedlings that we have from Russia and Japan are upright but cascading weeping plants are easily found in the wilds of Canada. Cranberry growers use flooding not only for harvesting but also for weed reduction. Perhaps occasional flooding of the Haskap at harvest might serve to reduce weed pressure. But this idea is certainly high risk, since I don't think anyone has or will try such a thing in the prairies, but maybe some cranberry grower might?

But a farmer growing Cranberries might consider growing Haskap on drier land just to have another fruit to add to their production.

Cranberries are well known for being used in juice products and being blended with other fruits. Haskap juice is a deep purple colour that certainly could be used to colour juices. But little research has been done with Haskap juice at the University of Saskatchewan. We have however, made many batches of Haskap wine. Amateur wine makers have claimed it to be the fruit most like grapes for making wine, but with a difference. Our Haskap wine had a hint of spiciness with some similarities to cherry, but was preferred when compared to our cherry wine.

**Haskap vs. Raspberry**

Haskap bushes are quite different from raspberries since they don't sucker and Haskap doesn't have canes. So, cultural practices would be quite different for these two crops.

While raspberries are the easiest fruit to remove by shaking, some varieties of Haskap are almost as easy. Saskatchewan's recently retired fruit specialist, Clarence Peters was quite convinced that harvesters designed for raspberries could also be used for Haskap. Raspberry harvesters are probably the cheapest of all fruit harvesters but until now the cheapest models can't be used on any other fruit crop.

Many raspberry growers hand pick their crops, especially if they are going after the fresh market. If a raspberry farm already has available labour for picking, it may be worthwhile to grow some of the larger fruited Haskap varieties that are not suitable for mechanized harvesting. I suspect that these unusual shaped fruit could cause quite a sensation in the produce section or the farmers market. While the rounded Haskap varieties suitable for mechanized harvest might be easily overlooked/confused with blueberries on the grocery shelf, fruit such as those below shouts out to consumers "I'm different!"

**Figure 1. The top three photos show selections not available on the market, but are being used as parents in our breeding program. The bottom is our test selection '9-92' being sold by a few of our propagators. Such unusual shapes are not good for mechanized harvesting but might be worthwhile for hand picking. For cleaning and sorting lines, more rounded or oval fruit is best because it can roll.**

While early Haskap might be a month or more earlier than raspberries, a later fruiting Haskap might coincide with Raspberry production. Perhaps mixed Haskap and raspberries in the same container would make a colourful, attractive combination. As mentioned earlier, Haskap flavour has some similarities to Raspberries so blending the fruit together could be a nice flavour combination.

**Haskap vs. Saskatoons**

Haskap and Saskatoons have similar bush shape but Haskap is less vigourous and does not sucker. But they can be pruned in a similar way.

While Saskatoons usually require pesticides and fungicides Haskap seems to have few pests and diseases. Good thing too since no pesticides are registered for this new crop. Harvest time of early Russian-type varieties would be weeks earlier than Saskatoons but late Haskap would coincide with them and last weeks later. The firm Saskatoon berry retains its shape in pies but Haskap disintegrates. Many products made from Saskatoons could also be made with Haskap, such as ice cream, sauces, and candies.

**Haskap vs. native berries**

With many invasive weeds challenging farmers around the world, a major concern in any new crops is whether it could become invasive. Having searched and found about 800 wild Haskap plants across Canada in every province (except BC), I can say emphatically that it has never been a dominant plant in any location. There are other, non-edible Honeysuckle species that are rather aggressive but not Haskap. The wild Canadian Haskap/blue honeysuckles berries are very small, perhaps one $1/5^{th}$ or $1/10^{th}$ the size of commercial varieties. Although tasty they are so infrequent that it is doubtful one could find enough berries to do anything commercial

**Research for the future**

In this article I have mentioned 3 types of Haskap that are not currently on the market, but which we are fairly certain we could achieve in our breeding program:

1. Late fruiting varieties suitable for mechanized harvesting
2. Large fruited varieties with unusual shapes for hand picking
3. Weeping low plants to try in cranberry operations.

#1 we are working diligently to achieve as we consider this type of plant to be very important for the fruit production industry. **We are quite happy to have this work funded by Saskatchewan Agriculture.**

As a by-product of breeding for commercial production, it is quite possible that some plants will be generated that are #2 and #3 types. But #2 and #3 are low on our priority list. However we recognize these types could also be desirable for home gardeners, and the nurseries that sell to them. If we heard from grower groups or nurseries especially interested in these types we might be more inspired to put more effort into breeding these, especially if funding was involved.

## Appendix VIII: Mechanical Harvesting of Haskap, Saskatoons, and Dwarf Sour Cherries using The Joanna Harvester in 2009


Figure 29. The Joanna Harvester

### *Background on the Harvester*

The Joanna harvester was designed for the harvesting black currents and is manufactured in Poland. In a 2006 tour of Saskatoon Growers in AB, SK and MB, I found that this was the most popular type of harvester being used by Saskatoon growers. Three of the leading Saskatoon farms on the prairies Prairie berries (SK), The Saskatoon Farm, AB, and Ritz Farm, MB were giving glowing recommendations for this machine. There are at least 3 other farms that have purchased these in SK recently.

The machine depicted above harvests half a bush at a time. Branches are forced down to a $45^{O}$ angle and finger-like bars penetrate the canopy while shaking off the fruit. Fruit drops to a conveyor belt which moves the fruit past a fan that blows off

leaves, soil, and other debris and loads the fruit into containers. In figure 1, the harvesting arm is shown in the 'travelling' position. When harvesting the arm sits on the ground and is dragged forward; this allows harvesting of branches as low as one foot off the ground.

The sideways harvesting style of this machine is more efficient than upright harvesters and causes less damage to the fruit. In an upright harvester, fruit drops from 1 to 6 feet down depending on where it is located on the bush. In the Joanna, fruit drops a most for about a 1 ½ feet. Because the branches are moved away from the bush, few fruit bounces toward the middle of the bush and it is estimated that less than 5% will be lost during harvesting. An upright harvester can easily lose 20% or more of the fruit for if the bush has multiple trunks but could be as efficient as 10% loss if the grower is vigilant about pruning and training. In my tour of Saskatoon farms I found few farmers that had pruned their bushes in a suitable way for an upright harvester.

The big disadvantage of a sideways harvesters is that it is harder on the branches. If a branch is too thick it can become jammed in the machine. If too brittle it could break. Varieties (like Theissen) with an upright growth habit can be pulled out of the ground if the bush is young or if it has a shallow root system.

**Tests at the U of SK**

In 2009, local grower Keith Jorgenson brought his Joanna Harvester to the U of SK plots and tried them on Haskap, Cherries and Sasaktoons. The machine was able to harvest all 3 types of fruit. I was highly impressed by the lack of damage to the fruit and that the machine was able to reach very low to the ground (fig 2). Reaching low was very important for the harvesting of Haskaps. The upright harvesters I have seen in person or have seen pictures have collection plates (also called fish plates) at 12 to 18 inches off the ground which means that branches lower than that cannot be harvested. Young Carmine Jewel bushes have been observed with productive branches close to the ground (fig 3).


**Figure 30. Joanna Harvester with collector lowered to the ground. It is designed to pick fruit just a few inches of the ground**

**Figure 31. Four year old 'Carmine Jewel' bushes showing productive branches close to the ground.**

Since 2007 we have been planting new seedling rows of Haskap far enough apart for mechanized harvesting. Those plants were too young and small to be useful to demonstrate mechanical harvesting, so we removed several rows from our oldest seedling plots (fig 4).

**Figure 32. Haskap bushes also have branches close to the ground. This particular row was the one from which our new varieties 'Borealis' and 'Tundra' were selected.**


**Figure 33. Haskap bushes being fed into the Joanna harvester.**

**Figure 34. Haskap berries from different rows and different settings. The harvesting machine can have different settings which will blow off more leaves. But also some seedlings/varieties hold onto their leaves more strongly than others. This was done on seedling rows where each plant is different.**

While no damage to branches was noted on Haskap, there were some plants that dropped their fruit just before entering the machine or on the side of the bush that was not being harvested. It was apparent that such a harvester caused damage to upright and thick branched phenotypes of Saskatoons and cherries. When encountering large branches, the machine snapped branches, jammed the machine or pulled bushes out of the ground.

For a breeding program, branch strength and flexibility would be very hard to evaluate without such a machine.

The split row method of this machine offers another advantage to a breeding program that no other machine can provide: It allows the breeder to compare a harvested side of a bush with an unharvested side. Also it allows two harvest dates.

Thus it would be very worthwhile to have a Joanna harvester for our breeding program not only as an aide in the selection of plants, but as a machine representing current harvesting trends of prairie growers.

## Appendix IX: Dried Haskap Berries

# Dried Haskap berries

**By Dr. Bob Bors**
**University of Saskatchewan Fruit Program**

**Figure 1. Dried Haskap package from Hokkaido.**

In Hokkaido I purchased a package of dried Haskap, which I prompt lost for almost 2 years. When I found it in the bottom of my closet, I was hesitant to eat it. After all, food preservatives are not allowed in Japan. I scrutinized the package and saw no signs of mold. I tried one and it was fine, then another and another. I stopped munching when I realized I hadn't taken a picture of it yet. When you look at figure 1, realize that the package when purchased looked full. That package had 60g of dried fruit which cost 1229 yen or $14.55 CDN. That would be $110.09 / lb! The size, colour, texture and flavour were remarkably similar to raisins. The only obvious sign that it was Haskap was the occasional appearance of seeds.

We had a very wet summer in 2010 which made heavy mud our of our clay soils at our research plots. Consequently we did not harvest berries from our 3 year old seedlings which happen to be in a very wet spot. Going into October we noticed that many of the plants still held onto their berries. These berries were 'naturally dried' and had lost at least half their moisture. But unlike the commercially dried berries, they were a beautiful blue colour (see figure 3). When several seedlings were sampled it was noted that flavour was not always like grape raisins. Some were better and others worse. Sweetness also varied. But it was also noted that some seedlings had dropped all their berries while other bushes held onto them. This was in the breeding field where each plant is genetically different from its neighbors.

**Figure 2. Close up of dried Haskap shown close to actual size. Except for the small red seeds, they could pass as raisings from grapes.**

Because the naturally-dried berries weren't dried fully, many were harvested and put in a fruit dryer to speed the

**Figure 3. Naturally dried haskap from the field. This photo was taken on October 13th. If the summer been a normal hot one, perhaps berries like these would have been seen in September.**

process along (see figure 4). Berries placed in that dried all turned black.

Other berries were placed in a desiccator (an airtight container hooked up to a vacuum pump). Those berries when dried retained the blue colour (see figure 5).
The blue colour of Haskap berries is caused by a naturally occurring wax called 'bloom' that is on the surface of many kinds of fruit, but is more noticeable in fruits of darker colours. Examples include blueberries, plums and some apples.
The drier we used creates heats to dry fruit faster which caused the wax to melt and disappear into the berries. Unfortunately, the drier we had did not have a setting to turn off the heat. It would have been nice to just have the fan running to dry the berries faster than the desiccator methods which took a couple days.
We have noticed that frozen berries are also blue, but when thawed the berries leak juice. It might not be feasible to dry such berries at room temperatures to retain the colour. The quality of the resulting product would be lower as all the sugars in the juice would be lost. If going for a high end product it might be best to dry fresh berries or let them ripen naturally on the bushes.

**Marketing and cost concerns**

Dried blue-coloured Haskap would likely have greater marketing appeal over black dried Haskap and over raisins. But the extra time to dry them at lower temperatures would likely increase the cost. Perhaps there would be food safety concerns since the berries aren't heated.

**Figure 4. The 'American Harvest' food drier that we used on Haskap berries.**

Such berries would be best used in products where they could be consumed raw like in trail mixes, breakfast cereals and salad toppings. To be marketed for use in baking in muffins or other baked goods would defeat the purpose of retaining the blue colour. They would simple turn black when heated.
Freeze drying is another possibility that would likely retain the blue colour, but that method is even more expensive than drying at room temperature.

**Breeding possibilities**

It should be possible to breed and select Haskap for the dried fruit market. Flavour will have to be evaluated in the dried state. Likely some selection criterion will be at odds with what we look for in varieties for fresh or frozen markets.

In the fresh market, round berries that come off relatively easy at harvest time are ideal. Round berries are easier to handle with machinery and they last longer both on the bushes and later in storage.
Perhaps an ideal dried Haskap variety would be long and thin (like many Russian varieties) because they would dry quicker than rounder berries due to increased surface area. However, bushes of Japanese Haskap hold onto their berries when ripe while Russian varieties tend to drop their fruit. Perhaps some 'Russian x Japanese' hybrids would have the right combination of attributes. But that combination would only be needed if a grower intended to dry the berries naturally, outside and on the bushes. It may be possible that driers could be developed with higher wind speeds that could do an acceptable job of drying Haskap at lower temperatures. Then there would be no need to wait the berries to dry naturally. Even with good driers, only so many fruit can be handled at a time. A variety that holds onto its fruit while drying would have a long harvest window particularly if the berries are allowed to shrivel.

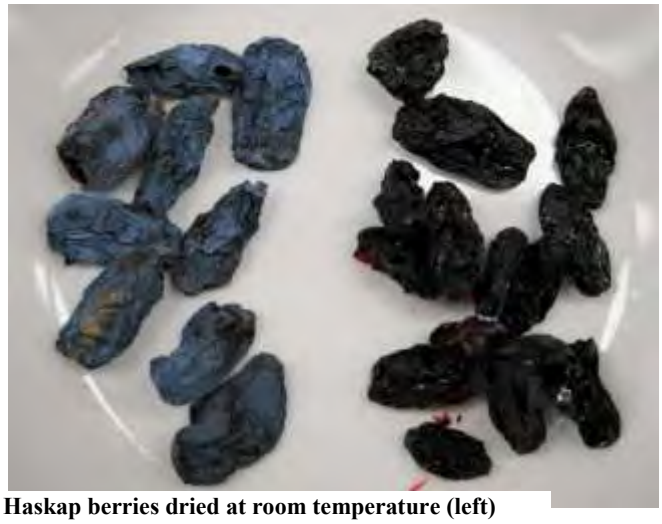


**Figure 5. Haskap berries dried at room temperature (left) retained their blue colour while berries dried using heat (right) became black.**

We plan to investigate dried Haskap berries further in our breeding program. It is ironic that it took a wet year to bring this to our attention. We could certainly use a normal or dry year to better investigate this!

## Appendix X: Haskap Wines at the U of S Fruit Program

# Haskap Wines at the U of S Fruit Program

**Peter Reimer**

A small but serious fruit wine industry is beginning to emerge in Saskatchewan. This is due, in part, to recent legislation which aims to nurture successful grape, and non-grape, cottage wineries. These wineries are driving a search for fruit which is reliably productive, and hardy, while resulting in a quality fermented product. Some of Saskatchewan's fruit wine makers have discovered Haskap, and are beginning to see the full potential of the fruit. Haskap is a fruit which has rich color, is full of flavour, and depending on the recipe, could be adapted for both fruit wine and dry table wine markets. Some tasters have even gone as far as to say the wine made from Haskap has a flavour comparable to grape wines like Cabernet Sauvignon. Haskap is an edible form of Blue Honeysuckle. The fruit is prized in Japan, where is used in a variety of candies and other products, including wine.

Haskap has been referred to by wine makers as the closest thing to grapes currently growing in zone 2. This is due to the neutral flavour of Haskap. Neutral flavour is important when considering wines intended for the table. As most people who have tasted a Merlot, or Pinot Noir grape know, a good wine grape doesn't possess any overwhelmingly dominant flavour. Their flavour is reminiscent of a number of other fruits, but no flavour is particularly dominant or overpowering. If a wine grape tastes "grapey", it would be called "foxy", an off flavour as far as wine is concerned. A neutral flavour allows wine to be enjoyed with a meal, often complimenting, not overpowering the flavour of the food. This neutral flavour gives Haskap wines a balanced flavour which is reminiscent of grape wines.

A deep burgundy color is also a trademark wine attribute which Haskap shares with Grapes. Consumers associate this color with richness, flavour, and age fighting phytochemicals like resveratrol. Haskap has this color in abundance. But while intense, this color is not inky, a trait which some hardy wine grapes are known to display. We've also noticed that after Haskap juice is fermented, the color maintains its burgundy color, even when diluted. Fresh Haskap juice fades to a bluish hue when diluted.

**Figure 35: Haskap lends an intense color to a wine.**

Haskap berries are also convenient fruit to juice. The fruit is relatively soft and the liquid is separated from the pulp quite easily, especially after it has been frozen and thawed.

**Yeasts**

The type of yeast used to ferment the wine changes the personality or character of a wine. Winemakers know that pairing the right yeast with the right fruit or grape type can mean the difference between a passable wine and a really good one. Yeast will influence which flavours are expressed and accentuated and which are muted. Yeasts even determine variables like the rate of fermentation, the final alcohol level, and even the color of the finished product.

Yeasts are generally categorized into which grapes or wine styles they complement the most.

**Red wine yeasts:** These yeasts are generally good at increasing mouthfeel (polysaccharides). They also must not inhibit malolactic fermentation.

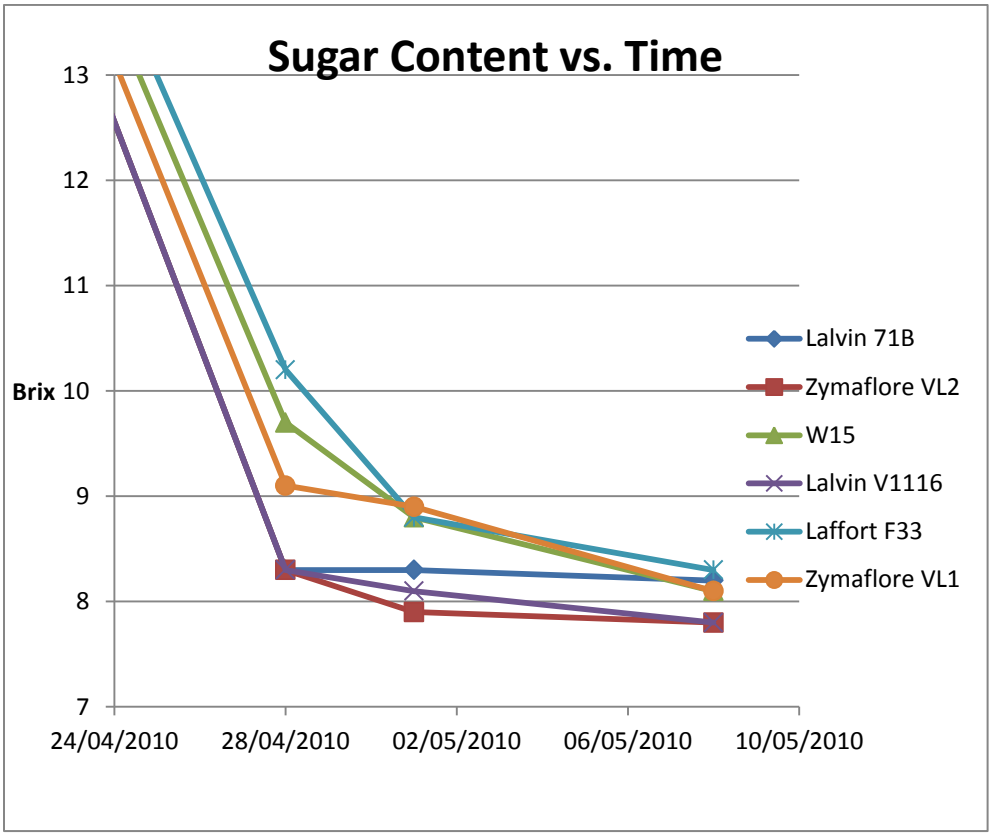
**White wine yeasts:** Generally good at elevating volatile terpenes and aromatics. (smells like pear, or citrus)

**Fruit wine yeasts:** Yeasts specifically selected for use in fruit wines are relatively rare. Usually grape wine yeasts are selected based on fermentation characteristics which are thought to compliment the flavour of the fruit in question. Popular fruit wine yeasts are often acid reducing and are selected to bring out fruity aromatics.

**Haskap yeasts?**

We created a little experiment to help us find the right yeasts for the job. We mixed a 6 gallon batch of must, and added everything except for the yeast. We split the must up into 6 individual 1 gallon batches and pitched each with different yeast. The yeasts were chosen for us by a wine supply company in Ontario as yeast which might work well for fruit wines.

The chart below plots sugar levels in the wine vs. date. The lines which drop rapidly before becoming nearly horizontal are the plots of fast fermenters. These would work well as killer yeasts, overpowering any naturally occurring yeasts, and for high alcohol fermentations. However, the faster fermenters usually generate more heat, which can influence more delicate fruity flavours. Slower fermenting yeasts are known to generally maintain the more delicate flavours.


Sugar Content vs. Time
Brix
13
12
11
10
9
8
7
24/04/2010
28/04/2010
02/05/2010
06/05/2010
10/05/2010
Lalvin 71B
Zymaflore VL2
W15
Lalvin V1116
Laffort F33
Zymaflore VL1

After taste testing, we found that the slower fermenting yeasts tested above average. Fruity aromas and cherry flavours were more prominent in the wines made with slower fermenting yeasts. We also found that the faster fermenting yeasts were considered more grape wine-like than the slower fermenters.

Haskap Wine styles

Grape wines are usually separated into their grape cultivars, or regions where they're grown. But within these designations also exist different ways of making wine from these grapes. These include social wines, table wines, apertifs, digestifs and ports. The

flavour of Haskap lends itself to a number of these wine styles. At a Vitinord Northern Winemaking conference we made a number of

connections with wine makers, reviewers, and growers from eastern wine making regions. They suggest that some suitable wine styles for Haskap might include table wines, social wines, and ports.

Table wines are typically drier wines, and are meant to compliment meals. To make this sort of wine you would want to add just enough sugar to have the wine ferment to dryness. A little bit of sugar left over works well to counter the acid. Oak and Tannin are two common additives in this style wine.

Figure 28: A dry 'table wine' style Haskap wine

Social wines have a sweeter, more balanced flavour, and are meant to be consumed on their own. For this style wine, you would want to add enough sugar to leave a slightly palatable sweetness, or stop the fermentation before it continues to dryness. Good yeasts for this style wine include slower fermenters like Laffort F33, W15, and Zymaflore VL1.

Ports are usually fortified and sweet, and often served as dessert wines. This style wine requires the continuous dosing with sugar. Good yeasts for this style include high alcohol tolerant strains like EC1118, Lallemand 43, V1116, and W15.

See for yourself. Make your own Haskap Wine!

This is a simple recipe that worked for us. These are by no means hard and fast rules. Have fun and experiment, and by all means let us know what you find.

Ingredients:

- 6kg Haskap
- 4kg sugar
- Water to 5gallons
- Yeast Nutrient
- Potassium Metabisulphate
- Wine Tannin(something like Tannin Plus works best)
- 30-40g Oak chips

Instructions:

The first step whenever you're about to make any sort of wine is sanitation. Sanitize at every step, whenever possible. Bottles and equipment should be cleaned and sulphited. Most wine kit stores sell a pink chlorinated cleanser that cleans gunk off equipment and the insides of bottles very well.

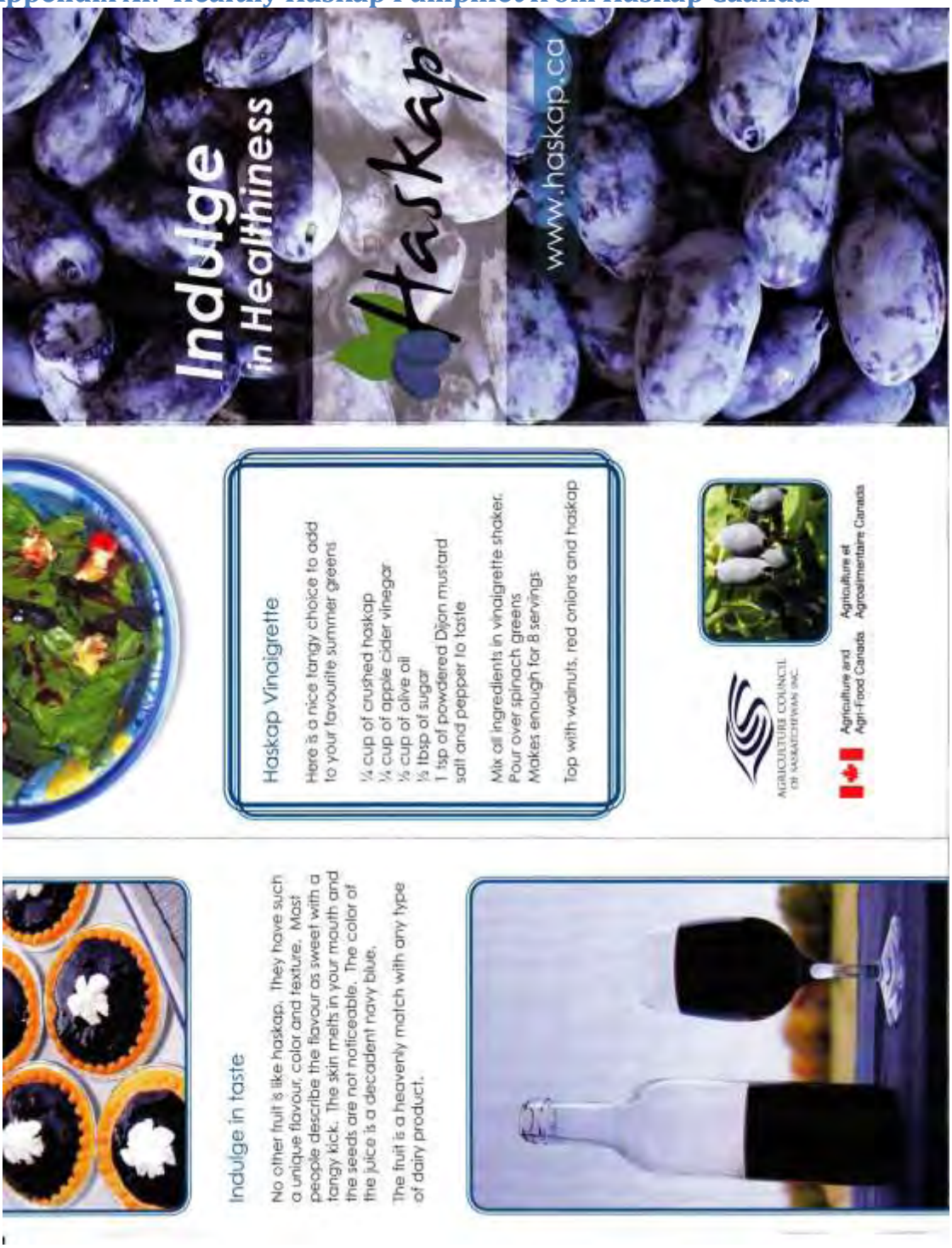
Now that the equipment is clean, crush the fruit. Some people prefer to crush the fruit in the same container they use for fermentation. Another method would be to crush the fruit in a nylon bag, leaving the bag in the must for the first fermentation step. This saves some additional filtering later on. Leaving the fruit in the must for the first steps of fermentation is referred to as maceration. Macerating gives the wine more contact time with the fruit pulp and skins which allows greater extraction of anti-oxidants, color and flavour.

To the fruit add the rest of your ingredients. Depending on the style you're trying to achieve, this is where you'd add your tannins and other additives. Leave the must uncovered for at least 6 hours after adding the sulphite before adding the yeast. Most wine yeasts are sulphite resistant, but not at high concentrations.

After about a week, the liquid can be separated from the pulp and added to a glass or food grade stainless vessel. This is when oak should be added, again, if this suits the style. Let stand for at least 1 month. Filter and bottle.

For more information about Haskap and other crops go to: www.fruit.usask.ca

## Appendix XI: Healthy Haskap Pamphlet from Haskap Caanda



## What is HASKAP?

It is the Japanese name for Lonicera caerulea. It is also known as 'Blue Honeysuckle', 'Honeyberry', 'Edible Honeysuckle' and 'Sweet berry honeysuckles'. When translated into English it can be spelled as Hascap, Haskaap and Hasukappu.

Most people mistakenly group haskap as a new type of blueberry, when in all reality, haskap's closest fruit relation is the tomato.

Ripening weeks before strawberries, they have a flavor commonly described as a combination of blueberries, blackcurrants and raspberries. They have been used in a wide range of products including juice, wine, candy, pastries, jams, dairy products and are eaten fresh.

Haskap fruit production is a new and developing industry in Canada. The original varieties of these fruits released to the Canadian fruit industry produced quite a small bitter fruit. The new varieties that are being developed from the U of S are being branded as 'Haskap' because our Japanese cooperators considered them to be of high enough quality to be used in the Japanese market. Also, these varieties are partly descendant from Lonicera from the Kuril Islands which were once part of Japan.

## Indulge in Healthiness

The old analogy of," If it doesn't kill you, it will make you stronger!" Does not apply to Haskap. Why should the food that is good for you taste bad. That is not the case with Haskap. Haskap has a sweet tangy zing flavour that most people say is a cross between blueberry, raspberry and black currant. Haskap has long been known by the ancient Japanese as, "The fruit of Life longevity and fruit of vision".

As you can see from the attached Nutritional Guarentee, the fruit is high in Vitamin C and A along with high fibre and potassium.

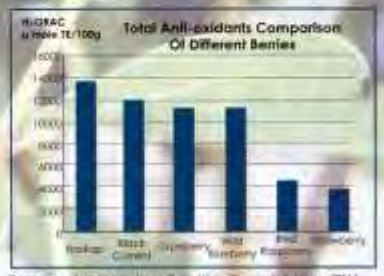
**Nutrition Facts**
**Valeur nutritive**
Per 2/3 cup (100 g)
pour 2/3 tasse (100 g)

| Amount<br>Teneur | % Daily Value<br>% valeur quotidienne |
|---|---|
| **Calories / Calories** 60 | |
| **Fat / Lipides** 0.3 g | **1 %** |
| Saturated / saturés 0.1 g<br>+ Trans / trans 0 g | **1 %** |
| **Cholesterol / Cholestérol** 0 mg | |
| **Sodium / Sodium** 0 mg | **0 %** |
| **Potassium / Potassium** 220 mg | **6 %** |
| **Carbohydrate / Glucides** 14 g | **5 %** |
| Fibre / Fibres 3 g | **12 %** |
| Sugars / Sucres 8 g | |
| **Protein / Protéines** 1 g | |
| Vitamin A / Vitamine A | 15 % |
| Vitamin C / Vitamine C | 60 % |
| Calcium / Calcium | 4 % |
| Iron / Fer | 4 % |
| Magnesium / Magnésium | 6 % |
| Zinc / Zinc | 2 % |
| Copper / Cuivre | 6 % |
| Manganese / Manganèse | 8 % |

The berries also have an extremely high ORAC value and have high levels of Anthocyanins, Poly Phenols and Bioflavanoids.

| | |
|---|---|
| ORAC | 13400nmoles TE/100gms |
| Total Phenolics | 1014mg/100gms |
| Total Anthocyanins | 949mg/100gms |
| Total Bioflavonoids | 867mg/100gms |

The following chart shows a comparison of various berries and their anti-oxidant levels.




Based on Averages from 3 studies: Brunswick Labs, 2011, Wu et al., 2004, USDA, 2007

So what are Phenols, Anthocyanins and Bioflavonoids? They are all different type of compounds known as anti-oxidants. Each one has different types of health properties. Most people tend to use the overall ORAC value in determining the oxidative capacity of the food. Here at Haskap Canada, we believe that variety is the spice of life, and any time you can consume a variety of foods with different chemical combositions, your health is better for it.

## Appendix XII: Globe and Mail Article "Agriculture Minister pushes Canadian flavour" by Jane Taber.

THE GLOBE AND MAIL

*Vancouver Notebook*

## Agriculture Minister pushes Canadian flavour

*Jane Taber*

Posted on Thursday, February 11, 2010 7:32PM EST

A large meaty burrowing clam with a crunchy texture and a new antioxidant berry developed at the University of Saskatchewan but grown in PEI were on an Olympic podium today.

The Conservative government is taking advantage of the Winter Games to sell other parts of Canada – not just our sports and scenery – to the rest of the world.

On Thursday morning it was Canada's good taste that was the featured event – its flavours and food, including that huge but odd-looking clam, which is spelled Geoduck, but is pronounced "Gooey-duck".

It is mostly exported to Hong Kong and China.

"I want people coming back to Canada after the Olympics," said federal Agriculture Minister Gerry Ritz, who threw on an apron adorned with a Maple Leaf to cook with chefs at the "Savour Canada" Olympic breakfast.

"We are not ashamed at all about the amount of time and energy we're putting into promoting Canada and Canadians," he said, telling the crowd that Canadian food is going to "rock" over the next few days while Canadian athletes are going to "kick ass."

International journalists attended the breakfast, which showed off all sorts of Canadian fare, including grains, cheese, beef and fish. There were no seal products there, however – a decision Mr. Ritz said wasn't deliberate.

In a prelude to the theme raised by Prime Minister Stephen Harper later in his speech to the B.C. Legislature, the Agriculture Minister said that Canadians are "a shy retiring people" and have been "reticent" in the past to aggressively market their food. But he wants that to change and the breakfast was meant to be a "reawakening" for both the domestic and international markets.

About that berry: It's called a Haskap berry and Mr. Ritz was singing its praises because of its high antioxidant properties, even higher, he said, than blueberries. He thinks it has lots of potential domestically.

Internationally, he says Canada's "heart smart" grains and oils are catching on. In China, for example, they are now importing Canadian canola oil.

"The days when all we exported was wheat and barley and durum are no more," he said. "They are becoming the rotational crops and not the mainstream crop."

The Agriculture Minister also says beef is also coming back since the mad-cow crisis in 2003. Canadians, he says, are "fussy eaters" and only buy the good cuts of beef. But a market is growing in Hong Kong for cow tongue and stomach.

"That's a potential to export millions of dollars worth of product that right now is not usable," he said.

There were no displays of cow tongue or stomach at the breakfast. Instead, there were chefs from across the country cooking dishes, using regional food, including chunks of the big clam that was put into a congee, a type of rice porridge.

And there was also Michael Smith. The award-winning chef from Prince Edward Island is head chef for the Olympic athletes in Whistler. He said he is leading a team of 60 cooks who are producing 12,000 meals a day.

"In Whistler we are serving the single-best food ever prepared for the athletes of the world," he said, not to put too fine a point on it.

In a tent the size of three football fields, he's set up food stations, including pasta, pizza, an Asian wok and a grill. He says the bobsledders must be eating "9000 calories a day" in pasta.

"We are jumping through the highest nutritional hurdles that I have ever faced in my career," Mr. Smith said.

About his pasta sauces? "These are very healthy, well-made, well-crafted sauces made just the way I would make it at home except that my pan now is 250 litres big."

***(Photo: Clayton Perry)***