Juneberry Cultivar Evaluation in North Dakota

Naa Korkoi Ardayfio and Harlene Hatterman-Valenti¹

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SUMMARY. A Juneberry (*Amelanchier alnifolia*) cultivar trial was conducted to evaluate fruit yield, quality, and other characteristics for Juneberry cultivars and a native biotype. One-year old micropropagated material was transplanted and established in North Dakota in 2004. The native biotype is available as a conservation plant from Towner State Nursery (Towner, ND) and was included as a readily available Juneberry for producers. Fruit diameter, soluble solids content, yield (total and marketable), and plant size measurements were taken during the 2010 and 2011 season. ‘Martin’, the native biotype, ‘Parkhill’, ‘Pembina’, ‘Regent’, and ‘Thiessen’ produced the highest total yield in 2010, whereas ‘Parkhill’ had the highest total yield in 2011, followed by ‘Thiessen’ and then ‘Martin’. Cultivars Martin, Parkhill, and Thiessen produced the highest marketable yield over the 2-year study. ‘Martin’ and ‘Thiessen’ fruit were larger and heavier than the rest of the cultivars. The largest plants were ‘Martin’, ‘Parkhill’, ‘Regent’, and ‘Thiessen’. Soluble solids concentrations were similar among all cultivars. Cultivars Martin or Thiessen should be recommended to commercial producers wanting a high yielding cultivar with uniform fruit ripening, whereas Parkhill should be recommended to producers with a you-pick operation wanting a high yielding cultivar with an extended fruit ripening period.

Juneberry is native to the Northwest Territories, the southern Yukon, the Canadian Prairie Provinces, and the northern plains of the United States (Mazza and Davidson, 1993). Juneberry is a shrub in the Rosaceae family with a sweet edible pome. Native American tribes used many parts of the Juneberry plant and the fruit was considered a staple (St-Pierre, 2005).

The pome contains several desirable nutrients and phytochemicals. Flavonols, anthocyanins, and phenolics are desirable nutrients known to be in high quantities in the pome (Bhagwat et al., 2014; Bors, 2010). The sweetness of the pomes and the high nutritional content makes Juneberry a desirable, healthy fruit choice. Compared with blueberry (*Vaccinium corymbosum*), strawberry (*Fragaria ×ananassa*), and raspberry (*Rubus* sp.), Juneberry has the highest nutritional value in cyanidin—an anthocyanidin—and quercetin—a flavonol (Bhagwat et al., 2014). Native American tribes made pemmican from the fruit. Apart from the benefits of an edible pome, various parts of the plant were also used for medicine by the Native American tribes (St-Pierre, 2005).

Juneberry has great commercial potential as a fruit crop (Pruski et al., 1990). However, large-scale commercial production of Juneberry has only occurred in Canada. In the 1970s, the first Canadian commercial Juneberry orchard was planted. Subsequent orchards were established in the 1980s and 1990s (St-Pierre, 2005). A fruit-processing sector was successfully established in Saskatchewan where jams, jellies, sauces, frozen fruit, dried fruit, and teas were processed from Juneberry fruit. The provinces of Manitoba, Alberta, and Saskatchewan in Canada are the largest Juneberry producers. The Canadian Census of Agriculture indicated that the fruit acreage in Saskatchewan increased 21% from 2001 to 2006 and accounted for 28% and 34% of the orchard and commercial acreage, respectively, in the province of Saskatchewan. In 2009, ≈1300 Juneberry acres were established in Saskatchewan, which contributed about one-third of Canada’s commercial Juneberry acreage (Saskatchewan

Ministry of Agriculture, 2010). In North Dakota, large-scale Juneberry plantings have not been explored.

Many Juneberry cultivars were selected by Canadian nurseries. Several cultivars such as Parkhill, Regent, and Success are hybrids in which Juneberry is one of the parents (Zatylny and St-Pierre, 2003). Presently, there are ≈26 named Juneberry cultivars. ‘Success’ was the first named cultivar, released in 1887 in the United States (Zatylny et al., 2002). ‘Honeywood’ was discovered by A.J. Porter in 1955 at Parkside, Saskatchewan in his nursery named Honeywood. ‘Martin’ was selected and introduced by D. Martin in his nursery block of ‘Thiessen’ at Langham, Saskatchewan. Similarly, J.A. Wallace, in his nursery at Beaverlodge, Alberta, selected ‘Northline’ from the wild in 1958 and introduced it in 1965. In 1974, Parkhill nursery at Bismarck, ND, introduced ‘Parkhill’ which was a hybrid from Michigan. ‘Pembina’, as a wild plant, was selected by J.A. Wallace in Barrhead, Alberta, in 1932 and reselected in 1950 and introduced in 1956. A hybrid, which was named ‘Regent’, was selected by J. Candrain in Regent, ND. ‘Regent’ was introduced in 1977. ‘Smoky’ originated from Beaverlodge, Alberta. ‘Smoky’ was discovered by W.D. Albright, selection was done with Dr. W.T. Macoun, reselected and introduced by J.A. Wallace in 1956. ‘Success’ is a hybrid from Pennsylvania. H.E. Van Deman of Kansas acquired the selected seedling in 1873 and introduced it in 1878. Originating from Hepburn, Saskatchewan, ‘Thiessen’, as a wild plant, was discovered by Maria Loewen Thiessen in 1906. Seedlings were obtained from her farm by G. Krahn and introduced in 1976 (Zatylny and St-Pierre, 2003).

Juneberry can adapt to a wide range of soil types but must have adequate surface and subsoil drainage

Units

To convert U.S. to SI, multiply by	U.S. unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
1233.4819	acre-ft	m ³	0.0008
0.3048	ft	m	3.2808
9.3540	gal/acre	L·ha ⁻¹	0.1069
2.54	inch(es)	cm	0.3937
25.4	inch(es)	mm	0.0394
28.3495	oz	g	0.0353
(°F – 32) ÷ 1.8	°F	°C	(°C × 1.8) + 32

Department of Plant Sciences, North Dakota State University Department 7670, 166 Loftsgard Hall, North Bolley Drive, Fargo, ND 58102

¹Corresponding author. E-mail: h.hatterman.valenti@ndsu.edu.

and preferably a sandy loam soil. A pH of 7.0–7.5 is preferred but plants will survive a pH range from 5.5 to 8.0. Spacing of 1 to 1.5 m between plants is recommended to provide better orchard ventilation and reduce disease problems (Government of Saskatchewan Agriculture, 2004). Specific requirements for fertilizer application are not exact as specific recommendation rates are yet to be researched. Soil analysis is advised though to help supplement fields which are deficient in nutrients. Weed control is considered crucial in a junberry orchard. It is recommended to control weeds in the early stages of orchard establishment to ensure clean fields in the future. Irrigation is essential, especially during early orchard establishment, fruiting and drought periods; otherwise natural rainfall is considered adequate. About 35,440 gal/acre of water per year at 0.13 acre-ft of water per year can be used in a trickle irrigation system. For an extended lifespan, junberry orchards should receive proper pruning and maintenance. The enhancement of plant health, yield, and fruit quality is dependent on removing of damaged, diseased, and unproductive branches (Manitoba Agriculture, Food and Rural Development, 2015).

The objective of the junberry cultivar trial was to evaluate differences in plant size, plant yield, fruit diameter, fruit weight, and soluble solids content for 11 junberry cultivars under North Dakota environmental conditions, including a North Dakota native species biotype available from Towner State Nursery. The North Dakota State University-North Dakota Forest Service operates the Towner State Nursery to produce conservation plants for North Dakota citizens. Since specific cultivars may not be available from U.S. nurseries, producers need to know how native material available from Towner State Nursery compared with the most commonly grown cultivars in Canada.

Materials and methods

EXPERIMENTAL DESIGN. This cultivar trial was undertaken in 2010 and 2011. The experiment was conducted at the North Dakota State University Horticulture Research Arboretum, Absaraka, ND. The loam soil has a pH of 7.2 and 2% organic matter. Junberry cultivars consisted of Honeywood, Lee II, Martin, Northline, Parkhill, Pembina, Regent, Smoky,

Success, and Thiessen, along with a biotype native to North Dakota, generated from seed, which will be referred to as Native. The Native biotype will be considered as a cultivar for the purpose of table titling. One-year-old micropropagated materials purchased from a Canadian nursery were transplanted on 4-ft centers and 8-ft row spacing in 2004. The experimental design was a randomized complete block design with four plants of each cultivar within each experimental unit and four replicates.

DATA COLLECTION. All plants were established for 6 years when data were collected in 2010. The onset of fruiting in junberry generally occurs when plants are 3 years old with peak fruit production when plants reach an age of 8 years. These junberry plants did not receive supplemental watering past the initial year of establishment to mimic the growing conditions practiced by producers. Two plants were randomly selected within each experimental unit and all fruit were collected and packaged into 13 × 13 × 8-cm disposable containers when most of the fruit for all cultivars had turned a deep purple (ripe stage) and before any fruit drop. All fruit were collected from plants within 2 d. Packaged fruit were stored for less than 7 d in a cooler set at a temperature of 3 °C until all data were collected.

Total fruit weights from the sampled cultivars were taken before separation of shriveled, red, crushed, insect damaged, or diseased fruit. The diameter of 10 randomly selected marketable fruit were measured with an electronic caliper (L.S. Starrett Co., Athol, MA) and averaged. Plant heights and widths were measured for each harvested plant. The highest vertical branch was the point at which the height was taken, whereas the width covered the longest horizontal branches apart. A 50-fruit sample (from the marketable fruit group) was weighed for average individual fruit weights. Soluble solids concentration was measured with the aid of a refractometer (Pal-1; ATAGO USA, Bellevue, WA). The percent soluble solids concentration was obtained by squeezing the fluid from the 50-fruit sample into a small container and placing several droplets on the sample stage of the refractometer. After each sample was taken, the sample stage was thoroughly rinsed with deionized

water and dried with a tissue before the next measurement was taken.

STATISTICAL ANALYSIS. Data were subjected to analysis of variance using PROC GLM (SAS version 9.3; SAS Institute, Cary, NC). Test for homogeneity of variance was performed for the years before values were pooled together. The null hypothesis for the experiment stated that there were no differences among junberry cultivars for all measured characteristics. Years were considered a random effect, whereas cultivars were considered a fixed effect. Differences among the treatment means were separated using Fisher's protected least significant difference test at $P \leq 0.05$ where appropriate.

Results and discussion

YIELD. The interaction between year and cultivar for total fruit weight was statistically significant. The interaction between year and cultivar for marketable fruit weight, plant height, and plant width were not significant, thus were combined over years. The average total fruit weight for 2011 was more than three times the weight of 2010 for some cultivars (Table 1). All cultivars exhibited higher yields in 2011. Total yield differences between years were initially attributed to the higher rainfall that was recorded in 2011 compared with 2010. Rainfall from 1 Apr. until fruit harvest in 2010 and 2011 was 284 and 407 mm, respectively (North Dakota Agricultural Weather Network, 2015). However, Howe et al. (2012) reported that fruit production by junberry

Table 1. Effect of year and junberry cultivar for total yield per plant at Absaraka, ND.

Cultivar	Yield (g) ^z	
	2010	2011
Honeywood	29.3 c ^y	200.5 e
Lee II	15.3 c	182.6 e
Martin	182.5 a	593.2 c
Native	150.4 a	369.3 d
Northline	5.3 c	164.1 e
Parkhill	138.2 ab	919.7 a
Pembina	162.4 a	422.6 d
Regent	155.3 a	378.7 d
Smoky	5.1 c	29.6 f
Success	73.5 bc	162.8 e
Thiessen	176.9 a	790.6 b

^z1 g = 0.0353 oz.

^yMeans within a column followed by the same letter are not significantly different based on Fisher's protected least significant difference at $P \leq 0.05$.

was inversely related to production in the previous year and that these effects were independent of weather conditions. Thus, alternating bearing should be expected unless judicious crop load management is practiced.

In 2010, 'Martin', Native, 'Parkhill', 'Pembina', 'Regent', and 'Thiessen' were the highest yielding cultivars, producing more fruit than the other cultivars (Table 1). In 2011, 'Parkhill' had the highest total yield, followed by 'Thiessen' and then 'Martin'.

The marketable fruit yield, which comprised only the ripe (deep purple) and unblemished fruit, did not vary among years for the selected cultivars and thus was averaged over the 2 years. Marketable yield for 'Thiessen' was highest but not significantly different from 'Martin' or 'Parkhill' (Table 2). Results suggest that producers in North Dakota should grow one of these three cultivars instead of the native biotype for higher marketable yields.

Comparison between the total and the marketable weight helped to identify high-yielding cultivars, but also gives producers an idea of what would be sold after the elimination of undesirable fruit. Uniform fruit ripening will reduce repeated harvests required to collect the ripe fruit and is more conducive to mechanical harvesting. 'Parkhill' for instance, had an averaged total weight of 529 g, but only a mean marketable weight of 163 g. The majority of the discarded fruit were red (unripe) with a few shriveled (overripe). 'Parkhill' was unique in that this cultivar had a large amount of unripe fruit, an undesirable characteristic for mechanical harvesting, but

a desirable characteristic for you-pick operations as nonuniform ripening would extend the harvest period.

Zatylny et al. (2002) listed 'Honeywood', 'Northline', and 'Smoky' among their highest yielding cultivars in their experiment conducted in University of Saskatchewan and Moon Lake, SK, Canada. St-Pierre et al. (2005) also had 'Honeywood', 'Northline', and 'Smoky' among their highest yielding cultivars. However, in North Dakota, 'Honeywood', 'Northline', and 'Smoky' were among the least productive cultivars. Environmental factors most likely contributed to these differences. Weather can play an important role in any spring-blooming fruit crop, even if pollinators are not required. The presence of frost during flowering will increase fruit abscission depending on the reproductive stage and the duration of the low temperatures. The ripening period has been designated as early season to midseason for 'Northline' and 'Smoky', midseason for 'Honeywood' and 'Parkhill', and midseason to late season for 'Martin' and 'Thiessen' (Bors et al., 2010). In general, there is positive correlation between ripening time and fruit weight. Thus, cultivars that take longer to mature fruit have a greater yield potential with conducive weather compared with short-season cultivars that mature their fruit in a shorter time span. All these factors may help to explain cultivar yield differences in a different environment.

PLANT HEIGHT AND WIDTH. Plant height and plant width varied among the cultivars. 'Thiessen', was the

tallest cultivar, but plant height was similar to 'Martin', Native, 'Parkhill', and 'Regent'. 'Smoky' was the shortest cultivar, but plant height was similar to 'Honeywood', 'Lee II', 'Northline', 'Pembina', and 'Success' with an average range of 0.85 to 1.34 m. Davidson and Mazza (1991) reported that 11-year-old 'Smoky' plant height ranged from 1.60 to 2.40 m. 'Smoky' plants in the current study were almost one-half the age and height of those reported by Davidson and Mazza (1991), which may help to explain some of the reported yield differences.

The Native plants were the widest with more spreading branches, but plant width was similar to 'Martin', 'Parkhill', 'Regent', and 'Thiessen' (Table 2). 'Smoky' was the narrowest cultivar, similar only to 'Northline' for plant width. Generally, the taller cultivars also had longer branches, which should support more fruit due to their larger stature, even though branches bend easily. However, tall plants pose a problem when fruit are harvested by handpicking.

SOLUBLE SOLIDS CONTENT. Juneberry has been reported to contain $\approx 18\%$ sugar and 80% water (Cornell University Cooperative Extension, 2011). The juneberry cultivars had a mean range of 15.3% to 18.8% soluble solids averaged over years, which was not statistically different between the selected cultivars (Table 3). Rogiers and Knowles (1997) reported that 'Smoky' exhibited greater soluble solids content than 'Northline', 16.4% vs. 14.0%, respectively. Although 'Smoky' fruit soluble solids content was numerically higher than 'Northline' in the current study, there were no significant differences in fruit soluble solids content for all cultivars evaluated.

FRUIT DIAMETER. The fruit diameter varied among cultivars. 'Thiessen' had numerically the largest fruit and significantly larger fruit compared with 'Honeywood', 'Lee II', Native, 'Pembina', 'Smoky', and 'Success' (Table 3). This result was somewhat consistent with the results by Zatylny et al. (2002) which classified 'Martin' and 'Thiessen' as having the largest fruit. 'Martin', 'Northline', 'Parkhill', and 'Regent' were similar to 'Thiessen' for fruit size. 'Lee II' produced the smallest fruit,

Table 2. Mean marketable yield per plant, plant height, and plant width for juneberry cultivars averaged across 2 years (2010 and 2011) at Absaraka, ND.

Cultivar	Marketable yield (g) ^z	Plant ht (m) ^z	Plant width (m) ^z
Honeywood	45.3 cd ^y	1.16 cde	0.85 bcd
Lee II	54.0 cd	1.13 cde	0.76 cd
Martin	236.1 ab	1.74 ab	1.07 abc
Native	97.3 cd	1.86 ab	1.19 a
Northline	43.0 cd	1.04 de	0.64 de
Parkhill	163.4 abc	1.65 abc	1.01 abc
Pembina	155.4 bc	1.34 bcde	0.73 cde
Regent	144.0 bcd	1.52 abcd	0.98 abcd
Smoky	8.3 d	0.88 e	0.40 e
Success	64.8 cd	1.04 de	0.79 cd
Thiessen	295.7 a	1.94 a	1.16 ab

^z1 g = 0.0353 oz, 1 m = 3.2808 ft.

^yMeans within a column followed by the same letter are not significantly different based on Fisher's protected least significant difference at $P \leq 0.05$.

Table 3. Mean soluble solids, pome diameter, and fruit weight for 11 juneberry cultivars averaged across 2 years (2010 and 2011) at Absaraka, ND.

Cultivar	Soluble solids (%)	Pome diam (cm) ^a	50-fruit wt (g) ^a
Honeywood	18.2 a ^y	1.0 bcde	30.0 cde
Lee II	17.1 a	0.6 f	26.1 de
Martin	16.4 a	1.2 abc	48.5 ab
Native	17.9 a	0.9 def	21.5 e
Northline	17.7 a	1.1 abcd	29.9 cde
Parkhill	16.5 a	1.2 abc	39.9 bc
Pembina	18.8 a	0.9 cdef	28.3 cde
Regent	17.3 a	1.2 ab	37.4 bcd
Smoky	18.1 a	0.8 ef	26.8 de
Success	15.3 a	1.0 bcde	27.4 de
Thiessen	16.5 a	1.3 a	55.2 a

^a1 cm = 0.3937 inch, 1 g = 0.0353 oz.

^yMeans within a column followed by the same letter are not significantly different based on Fisher's protected least significant difference at $P \leq 0.05$.

but this was similar to the fruit size for Native, 'Pembina', and 'Smoky'. St-Pierre et al. (2005) also reported that the fruit of 'Martin' and 'Thiessen' were the largest, followed by 'Northline', 'Honeywood', and 'Smoky' in the medium category and 'Success' in the smallest category.

FRUIT WEIGHT. The 50-fruit weight differed among the cultivars. Cultivars, Martin and Thiessen produced the heaviest fruit, whereas Lee II, Native, Smoky, and Success fruit were the lightest (Table 3). The ranking of fruit weight for a cultivar differed slightly from the fruit diameter, suggesting that the fruit from 'Martin' were denser than fruit produced by 'Honeywood', 'Northline', and 'Success'. Both fruit diameter and weight are influenced by rainfall patterns (suitable environment) and specific cultivar potentials.

Conclusions

The juneberry cultivar trial indicated significant differences for fruit yield, individual fruit weight, fruit diameter, plant height, and plant width. 'Martin', Native, 'Parkhill', 'Pembina', 'Regent', and 'Thiessen' were high yielding cultivars for total yield in 2010, whereas 'Parkhill' had the highest total yield, followed by 'Thiessen' and then 'Martin' in 2011. Only 'Martin', 'Parkhill', and 'Thiessen' maintained a high marketable yield with 'Martin' and 'Thiessen' having more uniform ripening pomes, which is a desirable trait for mechanical harvesting. The less uniform but high yield with 'Parkhill' would be a desirable trait for you-pick

operations as it would extend the harvest period. 'Martin', 'Northline', 'Parkhill', 'Regent', and 'Thiessen' had the largest fruit, whereas 'Martin' and 'Thiessen' fruit were heavier than the rest. The largest cultivars (plant height and width) were Martin, Native, Parkhill, Regent, and Thiessen. 'Honeywood', 'Lee II', 'Northline', 'Pembina', 'Smoky', and 'Success' were smaller in stature. The Native plants had a lower marketable yield even though they were among the largest in plant stature. These two characteristics are not desirable in a commercial fruiting cultivar and likely why the biotype is available as a conservation plant and not a fruiting cultivar. There were no cultivar differences for soluble solids content.

There was an interaction for total weight between the cultivar and year. The year 2011 was a more productive year than 2010, with greater yields for all cultivars, except 'Smoky'. Crop load management must be practiced with juneberry cultivars to reduce alternate bearing. Cultivars with high marketable yields and large fruit size are needed when initiating commercial juneberry production in North Dakota.

Literature cited

Bhagwat, S., D.B. Haytowitz, and J.M. Holden. 2014. USDA database for the flavonoid content of selected foods. Release 3.1. 15 May 2015. <<http://www.ars.usda.gov/nutrientdata/flav>>.

Bors, B. 2010. Prairie fruit summary: Some key considerations for the homeowner. 15 May 2015. <<http://www.fruit.usask.ca/Documents/PrairieFruit%20Summary2010.pdf>>.

fruit.usask.ca/Documents/PrairieFruit%20Summary2010.pdf>.

Bors, B., R. Sawatzky, and C. Peters. 2010. Popular fruit varieties. 15 May 2015. <<http://www.fruit.usask.ca/Documents/Popular%20fruit%20Varieties%202010.pdf>>.

Cornell University Cooperative Extension. 2011. Fruit nutritive qualities. Crop profile: Juneberries (saskatoon berries). 15 May 2015. <<http://cceontario.org/cce-site-documents/juneberry/juneberry-crop-profile.pdf>>.

Davidson, C.G. and G. Mazza. 1991. Variability of fruit quality and plant height in populations of saskatoon berries (*Amelanchier alnifolia* Nutt.). Fruit Var. J. 45:162–165.

Government of Saskatchewan Agriculture. 2004. Costs and returns for a saskatoon berry orchard. 23 Sept. 2015. <<http://www.agriculture.gov.sk.ca/Default.aspx?DN=6b8ffe92-0a86-45b1-95d9-302c42c726f0>>.

Howe, E.J., M.E. Obbard, and J. Bowman. 2012. Prior reproduction and weather affect berry crops in central Ontario, Canada. Popul. Ecol. 54:347–356.

Manitoba Agriculture, Food and Rural Development. 2015. Saskatoon. 25 Sept. 2015. <<http://www.gov.mb.ca/agriculture/crops/production/fruit-crops/saskatoon-berries.html>>.

Mazza, G. and C.G. Davidson. 1993. Saskatoon berry: A fruit crop for the prairies, p. 516–519. In: J. Janick and J.E. Simon (eds.). New crops. Wiley, New York, NY.

North Dakota Agricultural Weather Network. 2015. Total rainfall data. 15 May 2015. <https://ndawn.ndsu.nodak.edu/get-table.html?station=44&variable=mdr&dfn=&year=2015&tttype=monthly&quick_pick=&begin_date=2011-04&count=4>.

Pruski, K., J. Nowak, and G. Grainger. 1990. Micropropagation of four cultivars of saskatoon berry (*Amelanchier alnifolia* Nutt.). Plant Cell Tissue Organ Cult. 21:103–109.

Rogiers, S.Y. and N.R. Knowels. 1997. Physical and chemical changes during growth, maturation, and ripening of saskatoon (*Amelanchier alnifolia*) fruit. Can. J. Bot. 75:1215–1225.

Saskatchewan Ministry of Agriculture. 2010. The fruit industry in Saskatchewan. 15 May 2015. <<http://www.agriculture.gov.sk.ca/Default.aspx?DN=73a4d1ee-b552-4d07-a89d-de9e7ebf2258>>.

St-Pierre, R.G. 2005. Growing saskatoons: A manual for orchardists. 15 May

2015. <<http://www.prairie-elements.ca/saskatoons.html>>.

St-Pierre, R.G., A.M. Zatylny, and H.P. Tulloch. 2005. Evaluation of growth and fruit production characteristics of 15 saskatoon (*Amelanchier alnifolia* Nutt.)

cultivars at maturity. Can. J. Plant Sci. 85:929–932.

Zatylny, A.M., R.G. St-Pierre, and H.P. Tulloch. 2002. Comparative agronomic performance of 15 saskatoon (*Amelanchier alnifolia* Nutt.) cultivars during

their first seven years of growth. J. Amer. Pomol. Soc. 56:118–128.

Zatylny, A.M. and R.G. St-Pierre. 2003. Revised international registry of cultivars and germplasm of the genus *Amelanchier*. Small Fruit Rev. 2:51–80.