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'Sweet Bliss' Strawberry

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'Sweet Bliss' is a new June-bearing (short-day) strawberry (*Fragaria ×ananassa* Duchesne ex Rozier) cultivar from the U.S. Department of Agriculture–Agricultural Research Service (USDA-ARS) breeding program in Corvallis, OR, released in cooperation with the Oregon Agricultural Experiment Station, Agriculture and Agri-Food Canada, and the Washington State University Agricultural Research Center. 'Sweet Bliss' is a high-yielding cultivar that produces large-sized fruit with outstanding fresh market and processed (primarily frozen, but fruit are also dried or canned) fruit quality, including a very sweet, full strawberry flavor. 'Sweet Bliss' provides fresh market growers with a high-quality cultivar suited for regional sales in the midseason where there are currently few cultivar choices.

Origin

'Sweet Bliss' was selected in 2000 from the cross B 753 × ORUS 1735-1 made in 1998 and was tested as ORUS 2180-1 (Figs. 1–4). The purpose of the cross was to combine the characteristics of elite eastern and western U.S. breeding material. B 753 (MDUS 5132 × NYUS 113) was an advanced selection in the USDA-ARS, Beltsville, MD, breeding program directed by G.J. Galletta (deceased), a friend and mentor, from 1977 to 1998 that was identified by C.E. Finn as being a potentially valuable germplasm for our breeding program in Oregon. ORUS 1735-1 was an advanced selection in the USDA-ARS Oregon program that was promising enough to be included in commercial trials but was not released. ORUS 1735-1 had high yields of very high-quality fruit in the early season but had berry weights and yield that were not commercially acceptable.

'Sweet Bliss' was tested at the Oregon State University–North Willamette Research and Extension Center (Aurora, OR), Washington State University Puyallup Research and Extension Center (WSU-Puyallup; Puyallup, WA), Washington State University–Mount Vernon Northwest Washington Research and Extension Center (WSU-Mount Vernon; Mount Vernon, WA), and Agriculture and Agri-Food Canada, Pacific Agri-Food Research Center (Abbotsford, B.C., Canada) and in grower fields in Washington, Oregon, and British Columbia. The most thorough commercial testing was with Goddik Farms (Dayton, OR), Kraemer Farms (Mount Angel, OR), Krause Berry Farms (Langley, B.C., Canada), and Sakuma Bros. Farms (Burlington, WA). At the public research facilities, 'Sweet Bliss' was planted in multiple nonreplicated and replicated trials established from 2001 to 2008. In all trials, the plants were grown in a matted row system in eight-plant plots with plants initially set 46 cm apart in the row in Oregon and 38 cm apart in Washington and British Columbia. The plantings were fertilized, renovated, and irrigated using standard commercial practices. Other than two spray applications during bloom to control botrytis fruit rot (*Botrytis cinerea* Pers.:Fr.), the plantings received no fungicide or insecticide applications. Fruit were harvested once a week. The average fruit weight for a season was calculated as a weighted mean based on the weight of a randomly selected subsample of 25 fruit from each harvest. In multiple-year trials, yield, average fruit weight, and average fruit rot were analyzed as a split-plot in time with cultivar as the main plot and year as the subplot. In the British Columbia and the WSU-Puyallup trials, the fruit were only harvested 1 year after planting; whereas multiple harvest seasons would be ideal, they are not affordable. Fruit firmness was measured in the WSU-Puyallup trial as the force required for a 4-mm-diameter cylinder (Hunter Spring Mechanical Force Gauge Series L; Ametek, Hatfield, PA) to penetrate to a depth of 6 mm in five randomly selected fruit from each harvest. The average fruit firmness for a season was calculated as a weighted mean. The plantings and the analyses (PROC GLM; SAS Institute, Cary, NC) included the industry standards 'Tillamook' and/or 'Totem' (Finn et al., 2004; Hokanson and Finn, 2000; P.P Moore, personal communication). Plant vigor and fresh fruit characteristics including appearance, firmness, external and internal color, capping (ease with which the calyx was removed), and flavor were rated subjectively at least three times each year in Oregon using a 1 to 9 scale (9 = best expression of each trait, except color where 9 = dark red). In multiple years, duplicate subsamples of ≈200 g each were taken randomly from frozen and thawed harvested fruit and were evaluated for °Brix, titratable acidity, and pH in the laboratory. Analysis of variance was conducted on the fruit chemistry and subjectively evaluated trait data after checking for normality (PROC UNIVARIATE, SAS Institute, Cary, N.C.). Fruit were also evaluated informally as a thawed, individually quick frozen (IQF)

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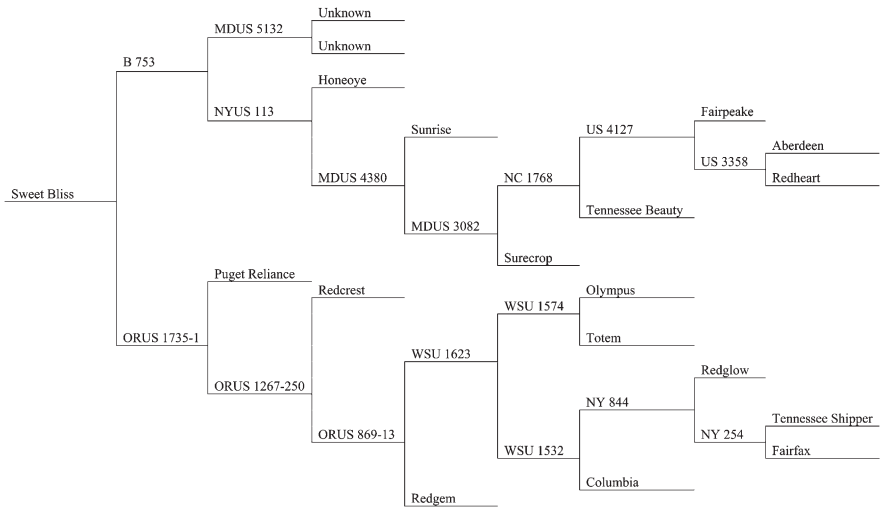

Fig. 1. Pedigree for 'Sweet Bliss'.

Fig. 2. Capped, harvested fruit of 'Sweet Bliss' for processing.

Fig. 3. Fruiting truss of 'Sweet Bliss'.

product by growers and processors with the strawberry industry and small fruit researchers.

Description and Performance

In general, 'Sweet Bliss' is a high-yielding cultivar with yields comparable to recent releases such as 'Tillamook' and 'Valley Red' and higher yielding than the long time standard in the Pacific Northwest, 'Totem' (Daubeny et al., 1993; Finn et al., 2004, 2009). In the 2001 planting, there was no genotype × environment interaction and 'Sweet Bliss's yield was comparable to that of the high-yielding 'Valley Red' and greater than that of 'Redcrest' and 'Totem' (Table 1). In the 2008 planting, there was a genotype × environment interaction for yield. 'Sweet Bliss' was significantly higher yielding than 'Puget Crimson' and 'Totem' in the first harvest year but not significantly different in the second harvest season (Table 2). Over both years, 'Sweet Bliss' had yields comparable to 'Tillamook' and 'Valley Red' and greater than 'Puget Crimson' and 'Totem'. In British Columbia in 2005, 'Sweet Bliss' was not as high-yielding as 'Nisgaa' but was similar to all the other cultivars in the trial including 'Totem' and 'Tillamook' (Table 3). In 2006, 'Sweet Bliss' was the highest yielding cultivar and had significantly greater yield than 'Puget Reliance', 'Tillamook', and 'Totem' (Table 3). In the WSU-Mount Vernon trial, there were few significant yield differences (Table 4). 'Sweet Bliss' had the highest yield in each year and over both years of harvest. It was only significantly different from 'Hood' in 2006 and overall (Table 4). At WSU-Puyallup, 'Sweet Bliss' was the highest yielding cultivar in the trial and was significantly higher yielding than 'Puget Summer', 'Totem', and 'Hood' (Table 5).

'Sweet Bliss' fruit are typically among the heaviest of any cultivar in trial but tend not to be as heavy as those of 'Tillamook'. In Oregon trials, 'Sweet Bliss' was usually significantly heavier than 'Totem', lighter than 'Tillamook', and comparable to 'Valley Red' (Tables 1 and 2). Although numerically greater, the fruit weight of 'Sweet Bliss' was not significantly different from the newly released 'Puget Crimson'. In the British Columbia trial, 'Sweet Bliss' was not as heavy as 'Tillamook' or 'Pinnacle' but was comparable to the other cultivars in the trial in 2005 (Table 3). Similarly, in 2006, 'Sweet Bliss' was lighter than 'Tillamook' but heavier than 'Totem' and 'Whonnock' (Table 3). The pattern followed a similar trend in the WSU-Mount Vernon trials where 'Sweet Bliss' was not as heavy as 'Tillamook' but was similar to most other cultivars. 'Tillamook' was not included in the WSU-Puyallup trial and in that trial, 'Sweet Bliss' was lighter than 'Puget Summer' but comparable to the other cultivars.

'Sweet Bliss' has excellent overall fruit quality when evaluated as a fresh fruit. At WSU-Puyallup, where fruit firmness was measured objectively in 2004, 'Sweet Bliss' was comparable to 'Hood', 'Puget Summer', 'Puget Reliance', and 'Whonnock'; more firm than 'Stolo'; and less firm than 'Totem' (Table 5). In subjective trials over several years and several plantings in Oregon, 'Sweet Bliss' fruit were assessed as being firmer than 'Puget Reliance' and 'Totem' but not as firm as 'Tillamook' (Table 6). The fruit were well formed, symmetrical, and attractive and were scored similarly to those of 'Valley Red' and 'Puget Reliance' and better than 'Puget Crimson', 'Tillamook', and 'Totem' (Table 6; Figs. 2 and 3). The internal and external color for 'Sweet Bliss' are acceptable for processing and ideal for fresh market because they are not as dark as 'Valley Red' or 'Totem' and are comparable to 'Tillamook'. Although not scored, the fruit were also very glossy, and the combination of bright red color with good glossiness makes a very attractively colored fruit (Figs. 2 and 3). The fruit capped well, although they were more comparable to 'Tillamook' that has acceptable but not ideal capping for commercially processed fruit. The fruit had an excellent, full strawberry flavor that was scored comparable to the highly flavored 'Puget Crimson' and better than the more acidic or blander 'Puget Reliance', 'Totem', 'Tillamook', or 'Valley Red' (Table 6). 'Sweet Bliss' consistently was sold very successfully as fresh fruit in farmers' markets in Vancouver, B.C., Canada (A. Krause, personal communication).

In an evaluation by industry and research program personnel, processed 'Sweet Bliss' was comparable to 'Tillamook', 'Valley Red', and 'Puget Crimson', but it did not score as highly as 'Totem' in 2009 (data not shown). Soluble solids, pH, and titratable acidity are three traits of importance, especially for

Fig. 4. Fruiting plants of 'Sweet Bliss'.

Table 1. Fruit weight, percent fruit rot (*Botrytis cinerea* Pers.:Fr.), and yield for strawberry cultivars planted in 2001 in a replicated trial at Oregon State University–North Willamette Research and Extension Center (Aurora, OR).

	Fruit wt (g)[z]			Fruit rot (%)	Yield ($t \cdot ha^{-1}$)
Cultivar	2002	2003	Mean	2002–03	Mean
Valley Red	15.0 ab	9.4 a	12.2 ab	4.0 b	27.35 a
Sweet Bliss	15.9 ab	10.3 a	13.1 a	9.4 a	23.73 ab
Puget Reliance	16.6 ab	10.3 a	13.4 a	5.9 ab	19.52 a–c
Redcrest	14.2 ab	7.1 b	10.7 bc	11.1 a	11.82 cd
Totem	13.4 ab	7.2 b	10.3 c	3.3 b	9.89 d

[z]Means within a column followed by the same letter are not significantly different, $P > 0.05$, by least significant difference test.

Table 2. Fruit weight, percent fruit rot (*Botrytis cinerea* Pers.:Fr.), and yield in 2009–2010 for strawberry cultivars planted in replicated trial in 2008 at Oregon State University–North Willamette Research and Extension Center (Aurora, OR).

	Fruit wt (g)[z]			Fruit rot (%)			Yield ($t \cdot ha^{-1}$)		
Cultivar	2009	2010	Mean	2009	2010	Mean	2009	2010	Mean
Sweet Bliss	16.3 b	14.1 ab	15.2 b	16.9 a	23.6 a	20.3 a	34.56 a	21.43 ab	28.00 a
Valley Red	14.5 bc	12.7 b	13.6 b	6.0 b	14.0 b	10.0 c	29.44 ab	24.13 a	26.79 a
Tillamook	20.0 a	16.6 a	18.3 a	6.0 b	11.7 c	16.1 ab	29.68 ab	21.27 ab	25.47 ab
Puget Crimson	13.1 c	13.5 b	13.3 b	11.9 ab	20.3 ab	16.1 ab	28.72 b	15.48 b	22.10 bc
Totem	15.1 bc	9.5 c	12.3 c	16.2 a	14.5 b	15.4 bc	23.48 b	17.69 b	20.58 c

[z]Means within a column followed by the same letter are not significantly different, $P > 0.05$, by least significant difference test.

processing quality. Over the years, there were differences resulting from year and cultivar, but there was no significant year × cultivar interaction (Table 7). The fruit of 'Sweet Bliss' were less sweet than those of 'Hood' and 'Puget Crimson' but as sweet as all other commercial cultivars in the Northwest (Table 7). Ideally fruit for processing are below pH 3.50, and the pH of the fruit of 'Sweet Bliss' was 3.33, also comparable to other Northwest cultivars (Table 7) (Wrolstad et al., 2008). Finally, the titratable acidity for 'Sweet Bliss' was relatively high, comparable to 'Puget Crimson' and better than most other Northwest cultivars (Table 7).

Table 3. First year fruit weight, percent fruit rot (*Botrytis cinerea* Pers.:Fr.), and yield for strawberry cultivars planted in 2004 and 2005 and harvested in 2005 and 2006 in replicated trials in Abbotsford, B.C., Canada.

Cultivar	Fruit wt (g)[z]	Fruit rot (%)	Yield ($t \cdot ha^{-1}$)
2004 planted, 2005 harvest			
Nisgaa	10.1 d	34.8 a	19.91 a
Tillamook	14.8 a	10.7 b	15.87 ab
Stolo	10.8 cd	18.8 b	15.83 ab
Valley Red	10.9 cd	11.5 b	15.58 ab
Firecracker	12.3 bc	11.4 b	14.60 ab
Sweet Bliss	10.8 cd	18.0 b	13.69 b
Totem	10.3 cd	18.5 b	13.12 b
Pinnacle	14.0 ab	14.9 b	12.12 b
Puget Reliance	11.5 cd	12.1 b	10.47 b
2005 planted, 2006 harvest			
Sweet Bliss	11.3 bc	9.4 a–c	28.30 a
Whonnock	8.7 de	9.8 a–c	23.40 ab
Stolo	9.0 c–e	15.3 a	23.30 ab
Pinnacle	13.6 ab	10.0 a–c	19.90 a–c
Rainier	13.0 ab	11.5 ab	19.70 a–c
Puget Reliance	11.1 b–d	10.1 a–c	15.00 bc
Tillamook	14.3 a	5.1 c	11.70 c
Totem	8.2 e	7.1 bc	11.40 c

[z]Means within a column followed by the same letter are not significantly different, $P > 0.05$, by least significant difference test.

'Sweet Bliss' fruit consistently ripened with 'Totem' and 'Tillamook' in Oregon and British Columbia and were a couple days later ripening in Washington (data not shown). 'Sweet Bliss' ripened well ahead of 'Stolo' and 'Puget Summer' (data not shown).

'Sweet Bliss' plants were vigorous (Fig. 4; Table 6). The plants were not as vigorous and dense as 'Puget Crimson' and were comparable to 'Totem' and 'Valley Red'. Although the vigor scores for 'Sweet Bliss' were comparable to 'Tillamook' and the fruit was very visible for pickers, they were not as open and burly as 'Tillamook'. In commercial trials, the plants were harvested by professional pickers who assessed the genotype as acceptable for economical hand-harvesting.

'Sweet Bliss' appears to have good virus tolerance with plants having good vigor and fruit size in the second harvest season. Under our minimal spray program, 'Sweet Bliss' did not show any particular susceptibility to pests with a couple of exceptions discussed subsequently. The occurrence of fruit rot is very dependent not only on year–to-year weather differences but also greatly depends on the weather within a given year. With this in mind, 'Sweet Bliss' typically experienced moderate fruit rot levels in all trials. In 2002–2003, which were years with a low incidence of fruit rot in Oregon, 'Sweet Bliss' had one of the highest incidences of fruit rot, but it was still commercially acceptable (Table 1). In 2009–2010, the amount of fruit rot tended to be high

Table 4. Fruit weight, percent fruit rot (*Botrytis cinerea* Pers.:Fr.), and yield in 2005–2006 for strawberry cultivars planted in a replicated trial in 2004 at Washington State University, Northwest Research and Extension Center (Mt. Vernon, WA).

	Fruit wt (g)[z]		Fruit rot (%)		Yield ($t \cdot ha^{-1}$)		
Cultivar	2005	2006	2005	2006	2005	2006	Mean
Sweet Bliss	14.7 b	14.4 ab	23.2 bc	14.0 a	19.52 a	42.02 a	30.77 a
Valley Red	13.3 b	11.7 bc	23.7 bc	18.1 a	19.52 a	40.09 ab	29.80 ab
Stolo	16.9 b	13.6 ab	47.0 b	17.8 a	16.99 a	38.00 ab	27.53 ab
Puget Reliance	14.8 b	12.0 bc	31.5 bc	18.5 a	14.23 a	35.69 ab	24.92 ab
Pinnacle	21.4 ab	15.1 ab	23.4 bc	27.5 a	16.17 a	28.91 ab	22.54 ab
Totem	12.1 b	9.6 c	65.7 a	18.5 a	7.23 a	35.54 ab	21.38 ab
Tillamook	22.3 a	16.1 a	14.6 c	19.6 a	12.37 a	28.39 ab	20.42 ab
Nisgaa	13.4 b	9.3 c	38.2 bc	43.2 a	19.15 a	20.34 ab	19.75 ab
Puget Summer	15.5 b	10.0 c	31.5 bc	8.2 a	13.26 a	24.07 ab	18.67 ab
Hood	16.2 b	8.7 c	34.4 bc	26.4 a	17.44 a	17.06 b	17.25 b

[z]Means within a column followed by the same letter are not significantly different, $P > 0.05$, by least significant difference test.

Table 5. First year fruit weight, percent fruit rot (*Botrytis cinerea* Pers.:Fr.), yield. and fruit firmness for strawberry cultivars planted in 2003 and harvested in 2004 in replicated trial at Washington State University (Puyallup, WA).

	Fruit			
Cultivar	Wt (g)[z]	Rot (%)	Firmness (g)	Yield ($t \cdot ha^{-1}$)
Sweet Bliss	12.1 bc	10.0 a	201 bc	35.44 a
Stolo	13.0 bc	7.9 a	155 d	32.94 a
Puget Reliance	11.6 bc	2.6 a	221 a–c	31.80 a
Whonnock	11.9 bc	8.4 a	242 ab	25.54 ab
Puget Summer	16.4 a	1.8 a	222 a–c	19.33 b
Totem	13.7 b	8.4 a	245 a	19.29 b
Hood	10.5 c	3.7 a	194 cd	18.09 b

[z]Means within a column followed by the same letter are not significantly different, $P > 0.05$, by least significant difference test.

Table 6. Mean scores for subjectively evaluated characteristics, in the field, of strawberry cultivars planted at the Oregon State University–North Willamette Research and Extension Center (Aurora, OR).

		Fresh fruit characteristics					
				Color			
Cultivar	Plant vigor[z]	Appearance	Firmness	External	Internal	Capping	Flavor
Sweet Bliss	7.3 b[y]	7.9 a	7.7 ab	7.2 cd	7.0 c	7.3 c	7.6 a
Puget Crimson	8.0 a	7.1 b	8.0 b	7.6 ab	7.3 bc	8.3 a	7.9 a
Puget Reliance	7.4 b	8.1 a	5.8 d	7.0 d	6.6 d	8.1 ab	6.7 b
Tillamook	6.9 b	7.2 b	8.2 a	7.5 bc	7.2 bc	7.3 c	6.7 b
Totem	7.3 b	7.3 b	7.0 c	7.6 ab	7.4 ab	7.6 bc	6.8 b
Valley Red	7.4 b	8.2 a	7.2 bc	7.8 a	7.7 a	8.0 ab	6.9 b

[z]Traits scored on a 1 to 9 scale: 1 = poor vigor, uneven rough appearance, soft fruit, very light-colored, poor separation of calyx from receptacle ("capping"), and poor flavor and 9 = very vigorous, very uniform and attractive, very firm, dark red, calyx separates easily from the receptacle, and intense flavor, respectively.
[y]Means within a column followed by the same letter are not significantly different, $P > 0.05$, by least significant difference test.

Table 7. Soluble solids, pH, and titratable acidity for fruit purees of nine strawberry cultivars grown at the Oregon State University–North Willamette Research and Extension Center (Aurora, OR) from 2001 to 2008.

Cultivar	Soluble solids (°Brix)[z]	pH	Titratable acidity ($g \cdot L^{-1}$ as citric)
Hood	10.06 a	3.56 a	8.39 bc
Sweet Bliss	8.22 b	3.33 a	11.63 a
Pinnacle	7.88 b	3.50 a	7.68 c
Puget Crimson	9.87 a	3.37 a	10.74 a
Puget Reliance	8.37 b	3.40 a	9.07 b
Tillamook	7.85 b	3.44 a	8.73 bc
Totem	8.60 b	3.52 a	8.53 bc
Valley Red	7.74 b	3.53 a	8.45 bc
Significance (*P*)			
Year	0.980	0.044	0.826
Cultivar	0.001	0.290	0.001
Year × cultivar	0.418	0.310	0.665

[z]Means within a column followed by the same letter are not significantly different, $P > 0.05$, by least significant difference test.

and once again 'Sweet Bliss' had a higher incidence of rot, but levels were comparable to those observed in 'Tillamook' (Table 2). In the Canadian trials, 'Sweet Bliss' could not be differentiated from most of the other cultivars for rot with the only difference being that it was better than 'Nisgaa' in 2005 (Table 3). At WSU-Mount Vernon, 'Sweet Bliss' was also comparable to most cultivars in 2005 and 2006 with the only difference being that it had less fruit rot than 'Totem' in 2005 (Table 4). Finally, although 'Sweet Bliss' had the highest incidence of fruit rot in 2004 at WSU-Puyallup, it was not significantly different from the other cultivars. Overall, 'Sweet Bliss' is susceptible to Botrytis fruit rot and appropriate cultural and chemical controls should be used to manage this disease. Further under our minimal spray program, 'Sweet Bliss' did not show any particular susceptibility other than an occasional incidence of anthracnose fruit rot (*Colletotrichum acutatum* Simmonds) and crown rot [*Phytophthora cactorum* (Lebert & Cohn) J. Schröt.]. In the case of anthracnose, this disease has only been observed in years with weather that favors this disease and can be relatively easily controlled. The challenge in interpreting our observations of crown rot in 'Sweet Bliss' has been the inconsistency with which it has occurred. In a 25-plant, 2004 planted research plot in Oregon, the plants produced high yields in 2005 but were all dead in 2006. In small plots planted in 2007 at WSU-Puyallup, the plants were injured substantially in 2008. These challenges caused us to slow the pace we were advancing 'Sweet Bliss' in the cultivar development program. However, in subsequent and much larger plantings in grower fields in Oregon, Washington, and British Columbia, crown rot has been viewed as a minor problem, affecting only a few plants at most. If this disease has been a problem historically for someone interested in trialing this cultivar, we would urge caution and testing before planting commercial quantities of plants.

'Sweet Bliss' should be grown by commercial growers producing fruits for processing or the fresh market in perennial, matted-row production systems. This cultivar is high-yielding and vigorous with very uniformly shaped, medium- to large-sized fruit that have outstanding fruit quality, including flavor, in either fresh or processed applications.

Availability

'Sweet Bliss' is not protected by a plant patent. However, when this germplasm contributes to the development of a new cultivar, it is requested that appropriate recognition be given to the source. The nuclear stock plants for propagation have tested negative for *Tomato ringspot*, *Strawberry mild yellow edge*, *Tobacco streak virus*, and *Strawberry necrotic shock* viruses by enzyme-linked immunosorbent assay and have indexed negative when grafted onto *F. vesca* L. and *F. virginiana* Duch. Further information or a list of nurseries propagating 'Sweet Bliss' is available on written request to C. Finn as is

contact information for commercial laboratories that are able to genetically fingerprint vegetative tissue to determine whether a genotype is 'Sweet Bliss'. The USDA-ARS does not have commercial quantities of plants to distribute. In addition, plants of this release have been deposited in the National Plant Germplasm System, accession number CFRA 1981.001 (PI 660761), where they will be available for research purposes, including development of new cultivars.

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