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‘Keepsake’ Strawberry

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‘Keepsake’, a midseason, “spring-bearing” or ‘‘short-day’’ strawberry (*Fragaria ×ananassa* Duch. ex Rozier), is a result of a U.S. Department of Agriculture Agricultural Research Service (USDA-ARS) effort at Beltsville, MD, to develop strawberries with increased shelf life. Compared with other current cultivars and breeding selections evaluated after 2 weeks in cold storage, ‘Keepsake’ strawberries had a low proportion of degraded and decayed fruits. The fruits have outstanding flavor with high soluble solids and moderate acidity. They have a pleasing texture and are juicy when eaten. ‘Keepsake’ has consistently provided competitive yields and low field decay with no fumigation or fungicides in annual plasticulture at Beltsville, MD. ‘Keepsake’ fruits are attractive, with good size, color, gloss, and a showy calyx. They are firm and tough enough for handling. ‘Keepsake’ is expected to be best adapted to the Mid-Atlantic and Northeastern United States and adjacent areas.

Origin

‘Keepsake’ was derived from a cross pollination of B1031 by B1181 (Fig. 1), planned in 2005 by Dr. Kim Lewers and executed in 2006 by Mr. John Enns. B1031 is a full sibling of ‘Flavorfest’ (Lewers et al., 2017). There is a high degree of relatedness in the ‘Keepsake’ pedigree. The maternal parent (B759) of B1031 is a full sibling of the paternal parent (B755) of B1181. The paternal parent of both B1031 and ‘Flavorfest’ is a full sibling to the maternal parent of B1181. In the sixth generation of the ‘Keepsake’ pedigree, ‘Raritan’ was crossed as maternal parent with MDUS3413; in the fifth generation back, ‘Raritan’ was crossed as paternal parent with MDUS3399, a full sibling to MDUS3413; and in the seventh generation back, ‘Raritan’ was crossed with MDUS2992. ‘Tennessee Shipper’ appears in the pedigrees of MDUS2992, MDUS3399, and MDUS3413. Inbreeding is generally expected to result in progeny with low vigor in highly heterozygous species like cultivated strawberry, but ‘Keepsake’ has good vigor. The high degree of relatedness within the ‘Keepsake’ pedigree does not necessarily contradict the expectation because no step in the pedigree resulted from self-pollination(s), and each selection in the pedigree showed sufficient vigor as a prerequisite for selection.

‘Keepsake’ was selected in a Beltsville seedling field in an annual plasticulture production system (Black et al., 2002) in Spring 2007 by Lewers and Enns and was given the selection number B1806. Plants clonally propagated from stolons or “runners” of B1806 were evaluated in observation plots in plasticulture in 2008 at Beltsville. After selection in observation plots, the original mother plant of B1806, which had been maintained in a greenhouse, was tested using reverse transcriptase polymerase chain reaction for *Strawberry mild yellow-edge virus* (Thompson et al., 2003) and *Strawberry pallidosis–associated virus* (Tzanetakis et al., 2006). B1806 tested negative for both viruses and was further propagated in an outdoor structure covered with screening designed to exclude virus-vector insects. These plants were used in annual replicated evaluations and companion observation plots starting in 2010.

Technical Description

Plants. ‘Keepsake’ produces an open globose plant with moderate density and vigor, slightly less than the related ‘Flavorfest’. Royal Horticultural Society (RHS) petiole color (RHS and Flower Council of Holland, 1986) is light yellow-green (RHS86 yellow-green group 144B) with very sparse pubescence, less so than ‘Flavorfest’. Leaves uniformly comprise three leaflets. Individual leaves are slightly folded to open and medium green in color (RHS86 green group 137A upper surface, RHS86 green group 137C lower surface). The terminal leaflets are 1.2 times longer than wide with an average of 27.2 apiculate leaf serrations per leaflet. Stolon production at Beltsville (≈10 per plant) is slightly greater than that of ‘Flavorfest’ (≈8 per plant) with similar moderate levels of anthocyanin pigmentation where exposed to sunlight. Flowers are slightly below the canopy with an average of 5.2 overlapping petals which are slightly wider than long. Flowers have an average of 19.2 anthers per flower, fewer than those of ‘Flavorfest’ with an average of 24.6 anthers per flower.

Fruits. Fruits are medium-large, firm, glossy, and red (RHS86 red group 44A, RHS86 red group 45A, RHS86 red group 46A) (Fig. 2). Fruits are conic to oblate with less difference in shape between primary and secondary fruits than ‘Flavorfest’. The firmly attached calyx is generally showy, larger than (primary fruit) or the same diameter as the fruit, reflexed to spreading, and mostly even to very slightly inserted. There is no neck and only a narrow band with no achenes. Achenes, which are flush with the fruit surface, are less dense than those of ‘Flavorfest’, and red (RHS86 red group 45A) to yellow-green (RHS86 yellow-green group 151B). Interior flesh is mostly orange-red (RHS86 orange-red group 33A) with some white (RHS86 white group 155D), especially near the proximal end, and is creamy, very sweet, and aromatic.

Molecular markers. ‘Keepsake’ was characterized with two simple sequence repeat molecular markers linked to repeat fruiting, ChFaM011 and FxaACA02I08C, using the methods of Castro and Lewers (2016). The only reaction product obtained from ChFaM011 was 163 bp long; the 163 bp product is associated with repeat fruiting in a mapping population using the cultivars Tribute and Honeoye (Castro et al., 2015). The reaction products from using FxaACA02I08C were 138, 142, 143, and 145 bp long; the 145 bp product is associated with repeat fruiting, as a dominant trait, in a mapping population using the cultivars Delmarvel and Selva (Castro and Lewers, 2016). ‘Keepsake’ is not repeat fruiting, but families segregating for repeat-fruiting have resulted from crosses between ‘Keepsake’ and repeat-fruiting genotypes or once-fruiting genotypes with repeat-fruiting progenitors.

Evaluation

Production system. ‘Keepsake’ was evaluated with other selections and cultivars on the Beltsville Agricultural Research Center farm on Rumford series, course-loamy, siliceous, thermic Typic Hapludults soils. Plantings were established in plasticulture production (Black et al., 2002) using raised beds with two lines of trickle irrigation 7 cm below the surface. The plasticulture system uses black plastic mulch, and six-plant plots were established in August before each evaluation year. Fertigation supplied nitrogen at a rate of 34 kg·ha^{-1} N per year as ammonium nitrate, potassium nitrate, or calcium nitrate on soils with existing high levels of P and moderate levels of K. Calcitic lime was used to adjust soil pH to 6.3 to 6.5. No fungicides were used. Frost protection of spring flowers was provided from microsprinklers on 30.5-cm stakes (SuperNet Jr., Netafim, Fresno, CA) when temperatures dropped below 2 °C and from overhead impact sprinklers at 1 m elevation when temperatures dropped below 1 °C.

Subjective evaluations of observation plots. Observation plots were evaluated annually in October after planting and again in April. Individual plots were given subjective scores. Subjective scores for most traits could have ranged from 0.0 (worst) to 9.0 (best), with 7.0 being ‘‘cultivar quality.’’ Scores of

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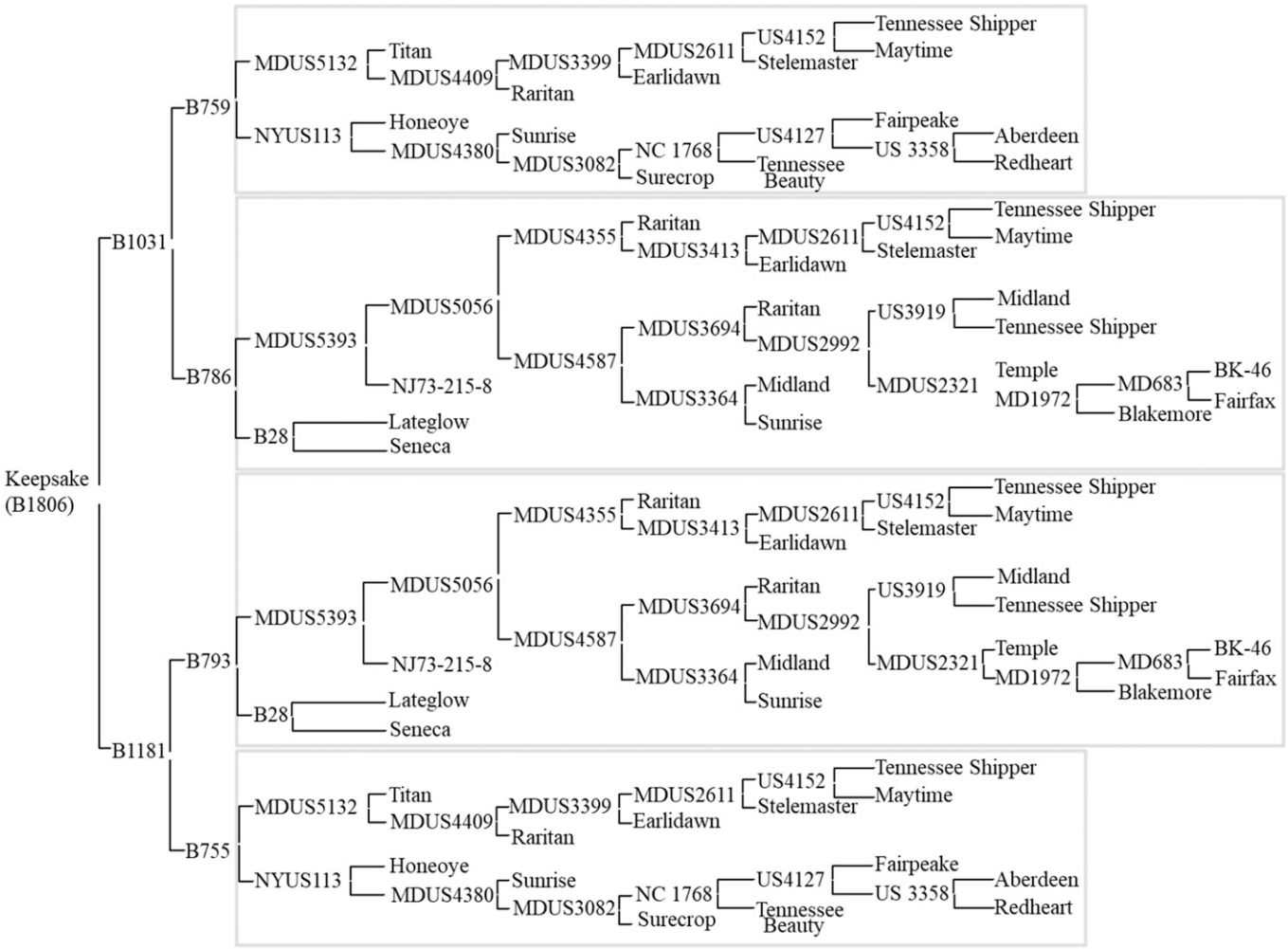

Fig. 1. Pedigree of 'Keepsake' strawberry, developed at the U.S. Department of Agriculture Agricultural Research Service Beltsville Agricultural Research Center, Beltsville, MD. Seed parents are represented above pollen parents.

6.5 for vigor, disease, or fruit quality were cause for concern, and scores of 6.0 or below were possible cause for rejection as a cultivar. Selections were not rejected for season scores, which also could have ranged from 0.0 (late) to 9.0 (early). Stolon production scores ranged from 0.0 (no stolons) to 5.0 (too many stolons). A score of 2.0 to 2.5 was considered a good balance because strong runner production is valued by matted-row growers and by nurseries propagating plants for sale, but too many runners can lead to high labor expenses for removing runners in the plasticulture system.

Plots were evaluated subjectively in fall for vigor, disease, and runner production, then evaluated for relative flowering and fruiting season in April. Plots were again rated after fruiting for vigor and disease. Plots were rated subjectively for incidence and severity of unspecified crown rot, as well as powdery mildew [*Podosphaera aphanis* (Wallr.) U. Braun & S. Takam], leaf scorch [*Diplocarpon earlianum* (Ellis & Everh.) F.A. Wolf], leaf blight [*Phomopsis obscurans* (Ellis & Everh.) Sutton], and bacterial angular leafspot disease (*Xanthomonas fragariae* Kennedy and King).

During the fruiting season, observation plots were subjectively evaluated at the peak of their season for yield, size, appearance, symmetry, firmness, skin toughness (resistance to abrasion when rubbed with a thumb), skin color, flesh color, and flavor. Plots also were rated for the specific diseases of anthracnose fruit rot (*Colletotrichum acutatum* J.H. Simmonds), botrytis fruit rot (*Botrytis cinerea* Pers.:Fr.), and unspecified soft rot and fruit degradation. The juice of three to five fruits from a six-plant plot, hand squeezed in the field, was measured with a Pocket refractometer PAL-1 (ATAGO USA, Inc., Bellevue, WA) to obtain estimates of percentage soluble solids, and a LAQUAtwin-pH-22 (HORIBA Scientific, Edison, NJ) to obtain estimates of acidity (pH). Means and ranges were determined in lieu of analyses of variance (ANOVA) estimates due to the subjective nature of the measures, the broad range environmental conditions during measurement, and/or the number of measures (n) for each genotype.

Replicated evaluations. Replicated yield evaluations were made in a randomized complete block design with one replication in each of three blocks. Plots were harvested twice weekly. For each plot at each harvest, decayed fruits were harvested into separate containers from fruits that showed no sign of decay. The containers were weighed separately. Yields were adjusted for plant stands. Ten randomly selected fruits from the container showing no signs of decay were weighed to obtain an average fruit weight for that plot and harvest. If fewer than 10 fruits were available, the average fruit weight was determined from the number available and was not adjusted for fruit number or plot yield. Also from the container showing no signs of decay, up to 12 fruits were selected for shelf-life evaluation and placed in a labeled clear plastic egg carton, calyx down. These fruits were further selected to be free of signs of injury and relatively uniform in size, shape, and maturity. Fruits in the egg cartons were stacked in plastic egg boxes, stacked two boxes high, and covered loosely in a black plastic trash bag. The fruits were stored in a walk-in cooler set at 0 °C. At 1 week and 2 weeks, the numbers of fruits in each egg carton that showed signs of decay or degradation were recorded. A single fruit could be both decayed and degraded. A decayed fruit would show signs of fungal growth. Signs of degradation included desiccation, loss of gloss, dark blotches resembling bruises, a fruit turning all dark, soft wet spots, soft dry spots, small depressions between achenes, and small dark depressions. Each year's