HortScience 59(1):105–107. 2024. https://doi.org/10.21273/HORTSCI17489-23

Two New Cultivars of *Cornus kousa*: Melissa's Mountain Snowfall and Sarah's Mountain Pixie

Sarah L. Boggess and Robert N. Trigiano
Department of Entomology and Plant Pathology, The University of Tennessee, 2505 E.J. Chapman Drive, 370 Plant Biotechnology Building, Knoxville, TN 37996-4560, USA

Keywords. Asian dogwood, bark, bracts, Chinese dogwood, variety

The genus *Cornus* contains 58 species of trees, shrubs, and herbs with *C. florida* L. and *C. kousa* F. Buerger ex Hance considered the most economically important to the ornamental tree industry (Wadl et al. 2014). These trees display various sized colorful bracts of white, pink, or red in the spring; vibrant green, red, or variegated foliage in the summer; and brilliant-red foliage in the fall. The showy foliage and colorful bracts make *Cornus* species prized ornamentals. *Cornus florida* is native to North America and grows wild as an important understory tree in many native forests. *Cornus kousa*, the Asian or Chinese dogwood, is native to east Asia and has the ability to hybridize with *C. florida* (Cappiello and Shadow 2005; Mattera 2016; Mattera et al. 2015; Molnar et al. 2017; Orton 1993; Shearer and Ranney 2013a, 2013b). Asian dogwood was introduced to North America primarily for ornamental purposes due to its showy bracts and tolerance to many pathogens, including powdery mildew [*Erysiphe pulchra* (Cooke & Peck) U. Braun & S. Takamatsu] and dogwood anthracnose (*Discula destructiva* Redlin) that plague *C. florida* (Holmes and Hibben 1989; Ranney et al. 1995; Wadl et al. 2014). As of 2020, there have been more than 70 cultivars of Asian dogwood developed, and some interspecific hybrids between *C. florida* and *C. kousa* have been released for use in home and commercial landscapes (Cappiello and Shadow 2005; Nowicki et al. 2018, 2020). The first interspecific hybrid was released in the early 1990s and is known as the *C.* × *rutgersensis* cultivar (Mattera 2016; Mattera et al. 2015; Molnar 2016). Together, sales of *C. kousa* and *C. florida* cultivars yield about $30 million in sales each year (Nowicki et al. 2018; US Department of Agriculture National Agricultural Statistics Service 2012, 2020). Both dogwood species and hybrids are primarily produced in Tennessee and New Jersey, USA, and sold as 1-year-old "liners" (Wadl et al. 2014).

Received for publication 18 Sep 2023. Accepted for publication 30 Oct 2023.
Published online 20 Dec 2023.
This work was supported by a Non-Assistance Cooperative Agreement between the University of Tennessee and the US Department of Agriculture, Agricultural Research Service (NACA 58-6062-6).
S.L.B. is the corresponding author. E-mail: sbogges1@vols.utk.edu.

Origin

'Melissa's Mountain Snowfall' (PP32706 P3) and 'Sarah's Mountain Pixie' were both developed alongside 'Pam's Mountain Bouquet' (Wadl et al. 2014) and were selected from a plot of 30-year-old trees at the University of Tennessee Forest Resources AgResearch and Education Center, Oak Ridge, TN, USA. The original plot was selected from ~400 seedlings for pathogen resistance screening as described in Augé et al. (2002). Specifically, the seeds were produced via open pollinated 'Big Apple', 'Snowbird', 'Steeple', and an unnamed accession by Polly Hill of Barnard's Inn Farm, MA, USA in 1989. In 1994, all the seedlings were evaluated for resistance to fungi causing dogwood anthracnose and powdery mildew and those exhibiting disease resistance were planted at the University of Tennessee Forest Resources AgResearch and Education Center in Oak Ridge, TN, USA (US Department of Agriculture Hardiness Zone 7a). Dogwoods were planted on 10-foot centers (~3 m) according to Witte et al. (1996). The trees at the site have been continuously monitored to the present date for disease and insect presence as well as unique physical characteristics.

'Melissa's Mountain Snowfall' Description

'Melissa's Mountain Snowfall' (PP32706 P3) is a multistem tree that develops an inverted pyramidal shape growing 16 to 20 feet (5 to 6 m) high and ~23 feet (7 m) wide (Fig. 1A). Exfoliating bark on the main stem is bicolored: Greyed-Orange Group 198B and Green Group 143C and exfoliating areas are Greyed-Brown 190–199D (all colors for the cultivars are made with comparison with those provided by the Royal Horticultural Society 2001 Color Chart) and gives the trunks an exaggerated textured appearance (Fig. 1B). Leaves (Green Group 137D) are obovate-shaped, nonrolling, and average ~3.5

Fig. 1. 'Melissa's Mountain Snowfall'. (**A**) Reversed pyramidal form of the 30-year-old tree. (**B**) Multiple stems and exfoliating bark. (**C**) Variously fused bracts. (**D**) Fall fruit with "collar" of fused bracts subtending and circling the pedicle of the fruit.

(~8.7 cm) inches long by ~2 inches (~4.4 cm) wide. The major veins are Yellow-Green 145B (Fig. 1C). Peak fall foliage is Red Group 46A. The four bracts are pure white and variously fused (2 to 4) (Fig. 1C). Globose fruit (1.2 inches or 3 cm diameter) are muted red (Red-Purple Group 60D–61A) in the fall and often subtended by a "collar" of fused bracts encircling the fruit pedicle (Fig. 1D). 'Melissa's Mountain Snowfall' (PP32706 P3) is perhaps a half-sibling of 'Pam's Mountain Bouquet' (PP25,575 P3) because of the fused bracts characteristic (Moreau 2022; Wadl et al. 2014). All *C. kousa* cultivars developed by the University of Tennessee contain "Mountain" in the cultivar name.

'Sarah's Mountain Pixie' Description

'Sarah's Mountain Pixie' is a short, bushy, single trunk, Grey Group (201A) tree, growing only 12 to 15 feet (4 to 5 m) in 30 years (Fig. 2A). The widely ovate leaves are green (Green Group 137D) with 3 inches (~7 cm) wide. The wide leaves have Yellow-Green 151D major veins (Fig. 2B). The pure white, small (2 inches or 5 cm) bracts are spade-shaped, taper to a point, slightly overlapping but never fused (Fig. 2C). The large (mean 1.5 inches or 3.8 cm in diameter, but often larger) fruits are a bright red-purple (Red-Purple Group 58C) when mature in the fall.

Fig. 2. 'Sarah's Mountain Pixie'. (**A**) Bushy tree form of 'Sarah's Mountain Pixie'. (**B**) Large leaves. (**C**) Spade-shaped bracts. (**D**) Large fruits in the fall.

Table 1. Primers used to analyze cultivars and accession of *Cornus kousa*.

Primer name[i]	GenBank	Primer codes	Motif
CK005	EU544308	F:GCATTTGTCCTTTGTTTGACAT R:TTTTTCGCGAAGTGTTCTCTAC	$(AC)_{20}$
CK015	EU125523	F:GTCAAATTTTTGATCTTTCTCTCT R:GGAGAGACAGAGTACAGTAGAGGT	$(CT)_{10}$
CK031	EU125525	F:TGTCACTGCTTACAGAAACAAT R:TATGACGAGATTGTATAAGTTGCT	$(CT)_{7}$
CK040	EU125526	F:CCAAGTCAGTTTGGTAGTAATTC R:AGTGCAACTTTTACTTGCTATGT	$(GT)_{16}$
CK048	EU125529	F:ACCAACCAAAAGAAGTATAAAGAA R:CCTATAAATAAGGAGTGATTTGGT	$(TA)_{6}$
CK058	EU544309	F:CTTAAGTCACAAAGACAATGAAAT R:AAGAGAGTTCAGATTTATCTTTGC	$(GT)_{10}$
CK068	EU821755	F:GTACAAGTTGATTGACTGATTGTT R:TTTACAATAGGGAGTGTTTAATGA	$(AC)_{14}$
CK072	EU544312	F:AGCACTCATAGTCCTTGCAC R:GTTAAAACGAAGAAGATACAACAA	$(GT)_{10}$

[i] All primer codes are published in Wadl et al. (2008) except CK068, which was published in Wadl (2009).

Table 2. Characterization of *Cornus florida* cultivars using simple sequence repeats. Numbers are base pairs in alleles.

Sample ID	CK015	CK031	CK040	CK048	CK058	CK068	CK072
PHK2	121:138	116:140	107:107	155:162	149:149	119:126	98:117
PHK3	121:121	140:140	0:0	172:172	153:153	123:132	114:123
PHK6	118:124	116:140	88:88	162:172	153:153	123:132	114:123
PHK7	118:124	116:116	100:100	163:172	149:153	128:132	114:134
PHK8	118:136	116:140	102:107	153:172	149:153	119:123	114:114
PHK100	136:141	140:140	96:96	144:153	149:149	119:123	114:114
PHK101	128:132	116:116	107:107	144:153	149:153	119:123	114:114
'Mountain Bouquet'	130:136	116:140	92:92	144:153	149:149	119:123	114:117
'Greensleeves'	112:118	140:140	95:95	183:183	149:149	128:149	114:117
'Mountain Pixie'	121:121	116:140	102:102	172:183	153:175	123:123	117:136
'Mountain Snowfall'	121:128	140:140	102:102	172:172	153:153	123:132	114:122

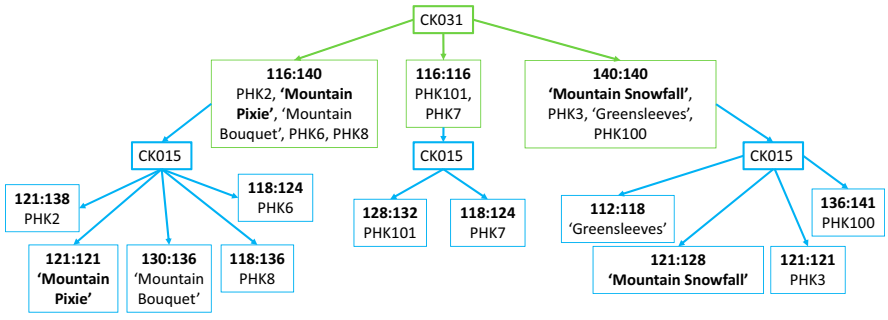

Fig. 3. Separation of *Cornus kousa* cultivars and unnamed accessions (PHKxxx) using simple sequence repeats (SSRs). 'Mountain Snowfall' and 'Mountain Pixie' are identifiable using two SSRs.

Molecular Identification (Genetic Analyses) of Cultivars Using Microsatellite Markers

Microsatellite markers [simple sequence repeats (SSRs)] were used to compare 'Melissa's Mountain Snowfall' and 'Sarah's Mountain Pixie' to other closely related cultivars and unnamed accessions in the University of Tennessee Forest Resources AgResearch and Education Center planting (Table 1) (Wadl 2009; Wadl et al. 2008). 'Melissa's Mountain Snowfall' and 'Sarah's Mountain Pixie' were compared with eight trees at seven loci from the same plot and two commercially available cultivars. Data were analyzed using Qiagen ScreenGel (Qiagen, Germantown, MD, USA) and binned using the method of Amos et al. (2007). The raw data from the SSR analyses is presented in Table 2. 'Sarah's Mountain Pixie' and 'Melissa's Mountain Snowfall' differ greatly at these loci (Table 2) and were easily differentiated from all other samples included in the study when comparing the data from only two SSR markers (Fig. 3).

Availability. For additional information and availability of the cultivars, contact R. N. Trigiano (rtrigian@utk.edu).

References Cited

Amos W, Hoffman J, Frodsham A, Zhang L, Best S, Hill A. 2007. Automated binning of microsatellite alleles: Problems and solutions. Mol Ecol Notes. 7:10–14. https://doi.org/10.1111/j.1471-8286.2006.01560.x.

Augé RM, Windham MT, Moore JL, Witte WT, Kubikova E, Klingeman WE, Evans RM, Reiss JH, Flanagan PC, Saxton AM. 2002. Leaf curl and water relations of kousa dogwoods showing resistance to summer stress. J Environ Hortic. 20:143–147. https://doi.org/10.24266/0738-2898-20.3.143.

Cappiello P, Shadow D. 2005. Dogwoods: The genus *Cornus*. Timber Press, Portland, OR, USA.

Holmes F, Hibben C. 1989. Field evidence confirms *Cornus kousa* dogwood's resistance to anthracnose. Arboriculture and Urban Forestry. 15(12):290–291. https://doi.org/10.48044/jauf.1989.062.

Mattera R III. 2016. The Rutgers hybrid dogwood: Naming and genetic diversity analysis (Master's Thesis). School of Graduate Studies, Rutgers The State University of New Jersey, New Brunswick, NJ, USA. https://doi.org/10.7282/T3125VVJ.

Mattera R, Molnar T, Struwe L. 2015. *Cornus* × *elwinortonii* and *Cornus* × *rutgersensis* (Cornaceae), new names for two artificially produced hybrids of big-bracted dogwoods. PhytoKeys. 93. https://doi.org/10.3897/phytokeys.55.9112.

Molnar TJ. 2016. Going nuts: Continuing a 40-year-old woody ornamental breeding program. Acta Hortic. 1174:305–312. https://doi.org/10.17660/ActaHortic.2017.1174.62.

Molnar TJ, Muehlbauer M, Wadl PA, Capik JM. 2017. 'Rutpink' (Scarlet Fire®) Kousa Dogwood. HortScience. 52:1438–1442. https://doi.org/10.21273/HORTSCI12242-17.

Moreau E. 2022. Big-bracted dogwood genetic diversity and powdery mildew disease resistance investigation using genomic tools (PhD Dissertation). School of Graduate Studies, Rutgers The State University of New Jersey, New Brunswick, NJ, USA. https://doi.org/10.7282/t3-0v2z-0k73.

Nowicki M, Boggess SL, Saxton AM, Hadziabdic D, Xiang Q-YJ, Molnar T, Huff ML, Staton ME, Zhao Y, Trigiano RN. 2018. Haplotyping of *Cornus florida* and *C. kousa* chloroplasts: Insights into species-level differences and patterns of plastic DNA variation in cultivars. PLoS One. 13:e0205407. https://doi.org/10.1002/ece3.6537.

Nowicki M, Houston LC, Boggess SL, Aiello AS, Payá-Milans M, Staton ME, Hayashida M, Yamanaka M, Eda S, Trigiano RN. 2020. Species diversity and phylogeography of *Cornus kousa* (Asian dogwood) captured by genomic and genic microsatellites. Ecol Evol. 10:8299–8312. https://doi.org/10.1002/ece3.6537.

Orton E Jr. 1993. A family of dogwoods: Three showy relatives welcome spring with clouds of bloom. Fine Gardening. March/April:35–39.

Ranney TG, Grand LF, Knighten JL. 1995. Susceptibility of cultivars and hybrids of kousa dogwood to dogwood anthracnose and powdery mildew. J Arboric. 21:11–16. https://doi.org/10.48044/jauf.1995.003.

Shearer K, Ranney TG. 2013a. Cytometric and cytological analyses of cultivated dogwoods. *Cornus* spp. SNA Research Conf 58.

Shearer, K and Ranney TG. 2013b. Ploidy levels and relative genome sizes of species, hybrids, and cultivars of dogwood (*Cornus* spp.). HortScience. 48:825–830. https://doi.org/10.21273/HORTSCI.48.7.825.

US Department of Agriculture–National Agricultural Statistics Service. 2012. Census of horticultural specialties. Table 21: Deciduous flowering trees.

US Department of Agriculture–National Agricultural Statistics Service. 2020. Census of Horticulture Specialties.

Wadl PA. 2009. Simple sequence repeats (SSRs) and their application to breeding *Cornus* species (PhD Dissertation), University of Tennessee, Knoxville, TN, USA. https://trace.tennessee.edu/utk_graddiss/6045.

Wadl PA, Wang X, Scheffler BE, Rinehart TA, Trigiano RN. 2008. Microsatellites from kousa dogwood (*Cornus kousa*). Mol Ecol Resour. 8:780–782. https://doi.org/10.1111/j.1755-0998.2007.02062.x.

Wadl PA, Windham MT, Evans R, Trigiano RN. 2014. Three new cultivars of *Cornus kousa*: 'Empire', 'Pam's Mountain Bouquet', and 'Red Steeple'. HortScience. 49:1230–1233. https://doi.org/10.21273/HORTSCI.49.9.1230.

Witte WT, Windham MT, Schlarbaum S. 1996. Variation of dogwood anthracnose resistance in half-sib families of *Cornus kousa*. Proc of the Southern Nursery Research Conf. 41:194–196.