Mammoth™ Series Garden Chrysanthemum ‘Lavender Daisy’

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A new *Chrysanthemum* × *hybridum* Anderson garden chrysanthemum, ‘Lavender Daisy’ (U.S. Plant Patent No. 19,831), adds a new flower color to the Mammoth™ series, which are advanced interspecific hybrids from an open-pollinated cross between hexaploid *C. weyrichii* (Maxim.) Tzvelv. × *C. ×grandiflora* Tzvelv. This cultivar is early-blooming (Week 32) and exhibits single to duplex daisy-type

inflorescences with dark purple ray florets and gold disk florets with massive floral displays. ‘Lavender Daisy’ is a USDA Z3b (–34.4 to –37.2 °C) winter-hardy herbaceous perennial with a tight cushion shrub phenotype. In their second and successive years, ‘Lavender Daisy’ plants form mammoth spheres 0.91 m tall and up to 1.16 m wide. Additional ‘Lavender Daisy’ traits are butterfly attraction, frost-tolerant flowers, and genetic “self-pinching.” Mammoth™ ‘Lavender Daisy’ is clonally propagated, virus-indexed, protected by U.S. Plant Patent law, and available from Ball Seed Company, the exclusive North American licensee.

Cultivated chrysanthemums, *Chrysanthemum ×grandiflora* Ramat. (= *Dendranthema ×grandiflora* Tzvelv.), are grown commercially as potted flowering plants, cut flowers, and garden cultivars worldwide (Anderson, 2006). Garden types rank as the No. 1 herbaceous perennial in the top 15 U.S. producing states with a wholesale farm gate value of \$27.854 million in 2012 (U.S. Department of Agriculture, National Agricultural Statistics Service, 2013). Popularity of this product line is the result of fall flowering before a killing frost, winterhardiness (for some, but not all, series), a wide floral color and form palette, and an array of plant phenotypes (upright, cushion) (Anderson, 2004; Anderson and Gesick, 2003, 2004; Dole and Wilkins, 2005;

Kim and Anderson, 2006). The cushion plant phenotype, developed at the University of Minnesota in the 1950s, was possessed by the University of Minnesota’s first U.S. patented plant, ‘Minngopher’ (U.S. Plant Patent, No. 4327; Widmer, 1978). Cushion habit now predominates throughout the global market (Anderson, 2006). The chrysanthemum breeding program at the University of Minnesota is the oldest public sector chrysanthemum breeding program in the world (1926 to the present) and the only public sector chrysanthemum breeding program in the United States (Anderson et al., 2001). Trendsetting breeding endeavors, coupled with its germplasm base and genetic resources, continue to bring a wide range of colors and plant habits in hardy chrysanthemums for northern gardens.

Origin

Mammoth™ ‘Lavender Daisy’ (Minnesota Sel’n. No. MN00-100-382; U.S. Plant Patent 19,831) is a new flower color addition to the Mammoth™ series of winter-hardy garden chrysanthemums (Anderson and Gesick, 2008). The pedigree of this new cultivar (Fig. 1) shows a complex history of breeding (outcrossing and inbreeding) and selection for 11 generations between the years 1986 and 2000 from the original interspecific cross between two allohexaploid ($2n = 6x = 54$) species, *C. weyrichii* (Maxim.) Miyabe ‘Pink Bomb’ × [*C. ×grandiflora* Tzvelv. ‘Adorn’ (PP 6,059) or ‘Crusador’ (PP 6,531)] (Anderson et al., 2008). The new chrysanthemum was selected as unique for its single to duplex, daisy-type inflorescences with dark purple ray florets and gold disk florets combined with the characteristics that fit the objectives of the shrub chrysanthemum breeding program. Mammoth™ ‘Lavender Daisy’ is a descendent of a shrub chrysanthemum My Favorite™ ‘Autumn Red’—from a series predating Mammoth™—which was later renamed as Mammoth™ ‘Red Daisy’ (Anderson et al., 2008). The female parent (MN Sel’n. 89-98-13) of Mammoth™ ‘Lavender Daisy’ has semidouble inflorescences with ray florets that are deeper purple in color, whereas the male parent (MN Sel’n. 00-100-352) has single inflorescences with white ray florets.

All cultivars in the Mammoth™ series possess a cushion phenotype in Year 1 (Fig. 2A), shrub-like plant growth habit in Year 2 onward (Fig. 2B), which distinguishes them from classic dwarfed forms of garden chrysanthemums classified as *Chrysanthemum ×grandiflora* Tzvelv. (= *C. ×morifolium* Ramatuelle; = *Dendranthema ×grandiflora* Tzvelv.) (Anderson et al., 2004, 2008, 2012a, 2012b). This cultivar is taxonomically designated as *Chrysanthemum ×hybridum* Anderson (= *Dendranthema ×hybrida* Anderson) Mammoth™ ‘Lavender Daisy’ (Anderson et al., 2004, 2008, 2012a, 2012b). Hybrid genotype MN Sel’n. 00-100-382 was later selected for release as Mammoth™ ‘Lavender Daisy’, which is now protected by a U.S. Plant Patent (PP 19,831; Anderson and Gesick, 2008).

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Description

Asexual reproduction of the new cultivar was first accomplished through stem cuttings in St. Paul, MN, in 2001. The characteristics

of this cultivar are stable and reproduce true to type in successive generations of clonal ramets (Anderson and Gesick, 2008). Traits for characterizing Mammoth™ 'Lavender Daisy' (n = 10 replications for quantitative

traits) were conducted on 1- and 2-year-old plants produced from rooted, vegetative tip cuttings, which had been treated with 998.9 mg·L⁻¹ indole-3-butyric acid (IBA) in 50% ethanol (EtOH), placed in Oasis wedges (Smithers-Oasis, Kent, OH), and placed under intermittent mist at 21 °C day/night (soil) in 2004 (for 2-year-old plants) and 2005 (for 1-year-old plants) until rooted. Tip cuttings rooted in ≈1 week. Hence, they were grown in greenhouse conditions (lat. 45° N; St. Paul, MN) for 4 weeks of vegetative growth (long days, 0800 to 1600 HR supplied by 400-W high-pressure sodium lamps + 2200- to 0200-h night interruption; 18.5/22.0 °C day/night) followed by transplanting into field trial beds in May of 2004 and 2005 for 2- and 1-year-old plants, respectively, at the Southern Research and Outreach Center, University of Minnesota, Waseca, MN (lat. 43.9° N). Plants were grown under natural daylength photoperiods until flowering in Sept. 2005 when the comparative trait data were collected.

The following is a detailed description of the new cultivar's above-ground plant parts as grown outdoors under natural lighting in a trial bed in Waseca, MN, and observed over a period of 2 years (2004–05). For the U.S. Plant Patent, the detailed botanical data (morphological traits) were collected from 1- and 2-year-old plants between 1300 and 1700 HR on 27 Sept. 2005. All descriptors using RHS Color Charts [Royal Horticultural Society (RHS), 2007] (except where general color terms of ordinary dictionary significance are used) were determined on the same date indoors under fluorescent lighting, 150 μmol·m⁻²·s⁻¹ (Anderson and Gesick, 2008). The phenotype of the new cultivar may vary with variations in environmental, climatic, and cultural conditions, because it has not been tested under all possible environmental conditions.

Stem color of Mammoth™ 'Lavender Daisy' in the first year of growth is RHS 144A with some hairy, faint striations of RHS 177B; second-year growth has a coloration of RHS 144B also with the same hairy faint striations of RHS 177B (Anderson and Gesick, 2008). Six lateral branches on average are produced per stem if the Mammoth™ 'Lavender Daisy' apical meristem is removed (pinched). Lateral branches grown an average length of 29 cm with an average diameter 2.5 mm; one lateral branch/node is initiated without removal of the apical meristem (pinching; Anderson and Gesick, 2008). A quantity of ≈52 shoots/plant crown in the second year arose from the same number of rhizomes. Internode lengths of Mammoth™ 'Lavender Daisy' average 1.3 cm.

Leaf division of Mammoth™ 'Lavender Daisy' is simple and the leaf blade shape is ovate to obovate with a narrow region extending toward the cuneate base (Anderson and Gesick, 2008). The leaf apex is acute with an incised (*Morus* or mulberry-like incisions to 0.5-cm depth) leaf margin. Upper (adaxial) surface leaf venation (Fig. 3) is RHS 145C with RHS 144D on the undersurface (abaxial).

Fig. 1. Pedigree of *Chrysanthemum xhybrida* Mammoth™ 'Lavender Daisy' (MN. Sel'n. No. 00-100-382) (Anderson and Gesick, 2008). The female (seed) parents are listed first followed by the male (pollen) parent. Note: ♂ denotes self-pollinated.

Fig. 2. First- (A) and second- (B) year Mammoth™ 'Lavender Daisy' plants displaying the tight cushion plant habit. Bar = 1 m. Photo credits: Dave Hansen, Minnesota Agricultural Experiment Station.

Fig. 3. Adaxial (above) and abaxial (below) leaf profiles of MN Sel'n. 00-100-382, Mammoth™ 'Lavender Daisy'. Arrow denotes the fine extension of the leaf to the base of the petiole. Bar = 1 cm.

Table 1. Comparative plant characteristics of *Chrysanthemum* × *hybrida* Mammoth™ 'Lavender Daisy' grown with *C. ×grandiflora* 'Erin' (U.S. Plant Patent Pending) (Anderson and Gesick, 2008).²

Plant characteristic	Mammoth™ 'Lavender Daisy'	'Erin'
Plant shape	Cushion	Cushion
Plant height, Year 1	0.40 m	0.46 m
Plant height, Year 2	0.49 m	— ^y
Flowering response group		
No. of weeks of short days	6.0	7.0
Flower type	Daisy	Daisy
Flower diameter	9.4 cm	8.1 cm
Ray florets (mature), color		
Adaxial surface	RHS 70A	RHS 70A
Abaxial surface	RHS 84B	RHS 84B

²Quantitative traits are mean values based on 10 replications.

^yPlants did not survive the winter in USDA Zone 3–4. RHS = Royal Horticultural Society.

The leaf surface is glabrous (adaxial) with slight pubescence on the abaxial (lower) surface (Fig. 3). Like with other Mammoth™ cultivars, the phyllotaxy is alternate (one leaf/node). Unlike many chrysanthemums, however, the leaf attachment is sessile although it possesses a petiole. This sessile designation is the result of a narrow extension of the leaf all the way to the base of both sides of the petioles (Fig. 3, arrow designates this at petiole base). There are an average of 23 nodes or leaves per stem (= long-day leaf number). Mammoth™ 'Lavender Daisy' has a young foliage leaf color of RHS 137A (adaxial) and RHS 137B (abaxial); mature foliage; the upper surface has a corresponding coloration of RHS 137B and RHS 146B, respectively.

Average leaf sizes (fully expanded) are 5.2 cm (length) × 2.4 cm (width). A fragrance is emitted if the foliage is bruised.

As a member of the Asteraceae (= Compositae), each flower of Mammoth™ 'Lavender Daisy' is, technically, an inflorescence with numerous disc (200/flower on average) and ray (54/flower, mean) florets totaling 254 on average; flowers are classified as single daisies. In some cases, the single daisy (one row of ray petals) may have an additional row of petals creating double whorls (duplex) (Anderson and Gesick, 2008). Based on actual counts, Mammoth™ 'Lavender Daisy' flowers with as many as ≈6860 inflorescences (mean) per plant in Year 2.

As Mammoth™ 'Lavender Daisy' inflorescences open, they have a globose flower bud shape that is ≈7.4 mm (depth) × 9.4 mm (diameter) with an RHS 144D coloration and striped phyllaries (RHS 137C) (Anderson and Gesick, 2008). When mature, inflorescences are 3.9 cm (diameter) × ≈1 cm (width) × ≈1.3 cm (depth). The peduncle is held strongly at an angle of 55° to the stem with an hirsute texture; on average, the first peduncle is 6.5 cm (length) and the fourth peduncle is ≈7.7 cm (length) all of which have a RHS 138B color with the hairs RHS 138D. Involucral bracts (phyllaries) are crenulate in appearance, RHS 137B in color, 2 to 5 mm (length) × less than 1 mm (width), and glabrous in texture. Ray florets have a spatulate shape, being held upright at an angle of 45°, averaging 1.8 cm × 4.4 cm (length × width). Each ray floret (petal) possesses a retuse apex and a cuneate base; margins are entire. Ray florets (strictly gynoeceous) during elongation (opening) are RHS 75A with markings of RHS N79C (adaxial) and RHS 75B (abaxial) with markings of RHS N79D. At maturity (anthesis), ray florets are RHS

70A and RHS 84B (adaxial and abaxial, respectively) while fading to RHS 75A and RHS 75B, respectively. There is one ovule per each ray and disc floret.

Disk florets (perfect, hermaphroditic) of Mammoth™ 'Lavender Daisy' are tubular with an average of 200/inflorescence (Anderson and Gesick, 2008). When mature (at anthesis), the disk florets are 0.4 cm × 0.1 cm (length × width) with a style color of RHS 13C. Both immature and mature disk florets have a color of RHS 1C with tip coloration of RHS 13B. There is one set of fused stamens/disk floret surrounding the style with RHS 13B anther color. Trinucleate pollen grains are shed in small quantities with RHS 12A coloration.

Each indehiscent fruit is a dry achene with a single seed attached to the ovary wall. Seeds lack pappi (awns or bristles), have a compressed oval shape with pointed ends, averaging 0.2 to 0.5 cm (length) × 0.1 to 0.2 cm (width) with a ridged texture and RHS 200D in color (Anderson and Gesick, 2008). A half-inflated football, oval shape with ridged textures characterizes the shape of each achene. As many as 254 ovules/inflorescence could be produced, on average.

Performance

Mammoth™ 'Lavender Daisy' exhibits cushion plant habits in the first (Fig. 2A) and second (Fig. 2B) years after planting in fields (Table 1), landscapes, or containers; this habit is maintained thereafter for the life of the plant. Like all other cultivars in the Mammoth™ series have exhibited (Anderson et al., 2004, 2008, 2012a, 2012b), Mammoth™ 'Lavender Daisy' has extreme plant growth vigor displayed in Year 2 and thereafter attains a mean shrub plant habit of ≈49 cm in height (some plants may attain a height of 91 cm) and 116 cm in width (Anderson and Gesick, 2008) compared with a Year 1 plant height of 0.4 m (Table 1).

A side-by-side comparison of Mammoth™ 'Lavender Daisy' with 'Erin' (U.S. Plant Patent Pending) showed 6- and 7-week short-day response groups, respectively (Table 1). As an early-season cultivar, Mammoth™ 'Lavender Daisy' blooms as early as Week 32 in Grand Rapids, MN (USDA Zone 3b), surviving through frosts and flowering until early October (Week 40) until a killing freeze has occurred (Anderson and Gesick, 2008). In Waseca, MN (USDA Zone 4b), Mammoth™ 'Lavender Daisy' flowers as early as Week 30 and ending also in Week 40. All flower petals are frost-tolerant. The flower colors and plant habits of 'Erin' and Mammoth™ 'Lavender Daisy' are the same, but Mammoth™ 'Lavender Daisy' differs from 'Erin' by being winter hardy, surviving as a perennial in northern climates. Likewise, in the second and successive years of growth, the cushion habit remains unchanged in Mammoth™ 'Lavender Daisy' but the plant size (height, width) increases to form a shrub habit (Fig. 2B) and supersedes the plant size of 'Erin'.

Like with other winter-hardy Mammoth™ garden chrysanthemum cultivars, snow cover throughout the winter is required for survival in northern latitudes (Anderson et al., 2012a, 2012b). Winter survival will be increased with the addition of a soil surface cover of mulch (Anderson et al., 2012b). Garden performance and winter survivorship were determined at multiple locations [seven sites in USDA Zone 3b (Grand Rapids, MN), 3b/4a (Morris, MN), 4a (St. Paul, MN), 4b (Lamberton, MN; Waseca, MN), 5a (Verona, WI), and 6b (Institute, WV)] and years (2001–08) (Table 2), although Mammoth™ ‘Lavender Daisy’ was not planted at each site every year. All field trials were done in open fields or garden plots without protective mulch or covering. Mean percent winter survival ranged from 0% (2001, St. Paul, MN) to 100% (2003, Morris and Waseca, MN, Verona, WI; 2004, Waseca, MN; 2006, Institute, WV; 2008, Waseca, MN) with an overall grand arithmetic mean of 76.9% for the tested years and locations (Table 2). The lowest annual arithmetic means of 60% were in years 2007 and 2008 at two sites each year (Table 2); the highest 2 years were 2003–04 (96.2% and 95%, respectively).

Similar to Anderson et al. (2012b), we calculated geometric means to show trends in winter survival over multiple years and locations for these trials, because they measure mean survival ratings (%), determining the normalized value of a range of positive numbers such that no particular data set for any location or year dominates the mean weighting (Ouellet, 1976). The geometric mean (G) for winter survival at and l (locations) in y (years) formula is:

$$G_{ly} = \sqrt[n]{ly_1 * ly_2 * ly_3 \dots * ly_n}$$

where n represents the number of replications per ly site. These geometric means have been used to express winter survival of insect eggs (Higashiura, 1989) and forage (Ouellet, 1976). Although garden chrysanthemum winterhardiness (% survivorship)

has classically used arithmetic means (where values are added rather than multiplied), geometric means were first used by Anderson et al. (2012b) as a more accurate gauge of winter survival. Annual geometric means (G_{ly}) for years and locations ranged from 44.7% (2008) to 95.9% (2003)—both were years with less than adequate snow cover (Table 2); all G_{ly} were lower than the corresponding arithmetic means with the exception of 2007 when both were identical (60%; Table 2). G_{ly} could not be calculated for 2001 because this year contained 0.0% winter survival (Table 2); G_{ly} includes only positive numbers greater than 0. In 2002 and 2005, neither arithmetic means nor G_{ly} could be determined because there was only one average at one location (Table 2). The grand G_{ly} for all years and locations could not be calculated for Mammoth™ ‘Lavender Daisy’ because, again, the data included zeroes. Occasional occurrences of 0.0% winter survival limit the use of G_{ly} in these years. The grand arithmetic mean was 76.9% for all years (Table 2). Winter survival in lower latitudes (data not shown) demonstrated that Mammoth™ ‘Lavender Daisy’ survives to USDA 9 (Southeast)/Zone 10 (West). Thus, the complete winterhardiness range of Mammoth™ ‘Lavender Daisy’ is USDA Zone 3b to Zone 9 (Southeast)/Zone 10 (West) (Anderson and Gesick, 2008; Table 2).

Propagation and Production

Certified, virus-indexed stock plants are used for commercial propagation of Mammoth™ ‘Lavender Daisy’. Asexual propagation is routinely conducted to ensure the morphological traits in clonal ramets are firmly fixed each year. Mammoth™ ‘Lavender Daisy’ is vegetatively propagated through herbaceous stem tip cuttings, which root in ≈ 1 week under intermittent mist or fog propagation after treatment with 1000 ppm IBA in 50% EtOH (Anderson et al.,

2008, 2012 a, 2012b). Rooted cuttings can be programmed to flower by potting in a high-porosity soilless medium followed by 3 to 4 weeks of a long-day photoperiod (0800 to 1600 HR + 2200 to 0200 HR night interruption lighting) at 18.5/22.0 °C day/night to encourage vegetative growth (Dole and Wilkins, 2005). These conditions are subsequently replaced with 6 weeks of short-day photoperiods [8 h (0800 to 1600 HR); black cloth pulled closed at 1600 HR and opened at 0800 HR] at 18.5/22.0 °C day/night with 1361 g/30.48 m² of 5N–20P–20K preplant fertilizer or 300 ppm N 20N–10P–20K weekly liquid feed based on weekly soil tests and monthly fungicide drenches (Langevin, 1992). To maximize summer growth potential in containers or direct-planted, full sun is required along with high fertilization and irrigation levels (Anderson, 1999, 2006; Anderson et al., 2004, 2008, 2012a, 2012b).

Like with all other cultivars in this series, Mammoth™ ‘Lavender Daisy’ is a facultative short-day plant (Anderson et al., 2008). Similar to previously released Mammoth™ cultivars, Mammoth™ ‘Lavender Daisy’ can be grown for Mother’s Day spring bedding plant sales in packs or liners for subsequent direct planting in gardens or containers for growth and fall flowering (Fig. 2A–B). Mammoth™ ‘Lavender Daisy’ may also be produced in “mum pans” outdoors for fall sales. Full sun is required, regardless of outdoor planting or production types as well as high fertilization and irrigation (Widmer, 1980). All Mammoth™ cultivars are “heavy” feeders. Plants will display the shrub habit in Year 2 onward (Fig. 2B).

Use

Mammoth™ ‘Lavender Daisy’ garden chrysanthemum is a winter-hardy herbaceous perennial shrub that attracts butterflies. All Mammoth™ cultivars have flower petal

Table 2. Test sites, geographic locations, U.S. Department of Agriculture (USDA) plant hardiness zones, and mean percent winter survival of Mammoth™ ‘Lavender Daisy’ (MN. Sel’n. No. 00-100-382) over multiple trial locations in Minnesota, WI, and West Virginia.²

Test sites	Latitude, longitude	USDA hardiness zone ^y	Percent winter survival over years							
			2001	2002	2003	2004	2005	2006	2007	2008
Grand Rapids, MN	47.24739° N, 93.54444° W	3b	—			90.0		30.0 ^x		
Lamberton, MN	44.23111° N, 95.26389° W	4b		—					60.0	—
Morris, MN	45.62820° N, 95.88908° W	3b/4a	—		100.0		—	90.0	—	—
St. Paul, MN	44.98776° N, 93.13700° W	4a	0.0 ^x	32.0 ^x	84.6	95.0				20.0 ^x
Waseca, MN	43.90669° N, 93.43338° W	4b	—		100.0	100.0			60.0	100.0
Verona, WI	43.06048° N, 89.52742° W	5a	—		100.0					
Institute, WV	38.41981° N, 81.8339° W	6a					—	100.0		
Annual geometric means (grand mean = — ^w)			— ^w	N/A ^v	95.9	94.9	N/A ^v	64.6	60.0	44.7
Annual arithmetic means (grand mean = 76.9)		—	N/A ^v	N/A ^v	96.2	95.0	N/A ^v	73.3	60.0	60.0

²Data were collected in the spring (April to May) of the years listed. When winters had adequate snow cover, years are noted in bold. There were $n = 10$ replications (clonal ramets) in each site each year (except for 2008, which had $n = 5$ at all tested sites); blanks denote the genotype was not planted at this location during that specific year.

³Low air temperature ranges: Zone 3b (–34.4 to –37.2 °C), 4a (–31.7 to –34.4 °C), and 4b (–28.9 to –31.7 °C) (<<http://www.usna.usda.gov/Hardzone/hzm-nm1.html>>).

⁴Little snow during this winter, coupled with a lack of mulch and dry conditions, resulted in higher mortality.

⁵Geometric mean could not be calculated as data includes a non-positive number, i.e., zero.

⁶N/A = means are irrelevant because there is only one average at one location for this year.

frost tolerance and standard plant dimensions in the first year (Anderson et al., 2008) but achieve shrub status in Year 2 onward (Anderson et al., 2004, 2008, 2012a, 2012b). All Mammoth™ cultivars are low maintenance because they do not require pinching to encourage lateral shoots and enhanced plant size as a result of their genetic “self-pinching” (Anderson et al., 2008). When growing individual specimens of Mammoth™ ‘Lavender Daisy’, space the plants 1 m or greater on center (OC). To produce a flowering hedge, space plants 0.3 to 0.6 m OC.

Availability

Chrysanthemum × *hybridum* Mammoth™ ‘Lavender Daisy’ (U.S. Plant Patent 19,831) is available as certified, unrooted or rooted cuttings from Ball Seed Company (622 Town Road, W. Chicago, IL, 60185; <<http://www.ballseed.com>>) under the Mammoth™ brand. European distribution rights are currently under negotiation.

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