Chrysanthemum × *hybridum* Mammoth™ ‘Dark Bronze Daisy’ Garden Chrysanthemum

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Additional index words. Asteraceae, chrysanthemum breeding, *Dendranthema*, herbaceous perennials, winterhardiness

Garden chrysanthemums, *Chrysanthemum* × *grandiflorum* Tzvelv. (= *Dendranthema* × *grandiflora* Tzvelv.; = *C. ×morifolium* Ramatuelle), are the number one herbaceous perennial in the top 15 U.S. producing states with a wholesale farm gate value of \$27.854 m in 2012 (USDA NASS, 2013). Greenhouse chrysanthemum cultivars of the same species are also widely produced as cut flowers and flowering potted indoor plants

worldwide in an extensive range of flower forms, patterns and colors (Anderson, 2006). Fall flowering is a popular trait of all garden types (Anderson, 2006; Dole and Wilkins, 2005). Typical plant habits or phenotypes of garden chrysanthemums are cushion (spherical shape completely covered with flowers obscuring most foliage) and upright (cut flower types) (Langevin, 1992; Widmer, 1980). The cushion habit is the dominant market share form (Anderson, 2004, 2006; Anderson and Gesick, 2003, 2004; Kim and Anderson, 2006), first developed in the 1950s–1970s at the University of Minnesota with the ‘Minn’ series; ‘Minngopher’ (PP 4,327) was the first patented cushion cultivar (Widmer, 1978). Mammoth™ ‘Dark Bronze Daisy’ garden chrysanthemum was bred, selected, and introduced to continue this outstanding phenotype along with its expansive “shrub” size.

Origin

Mammoth™ ‘Dark Bronze Daisy’ (Minnesota Sel’n. no. 95-169-8; U.S. Plant Patent 19,043) possesses a new flower color for this series of winter-hardy garden chrysanthemums (Anderson and Ascher, 2008). The Mammoth™ series now has a flower color

palette including dark bronze, red, white, yellow, coral, lavender, twilight pink, and dark pink cultivars (Anderson and Ascher, 2008; Anderson et al., 2004, 2008, 2012a, 2012b, 2014a, 2014b). The pedigree of Mammoth™ ‘Dark Bronze Daisy’ (Fig. 1) is the result of three generations of crosses between named cultivars and numbered chrysanthemum seedling parents from 1989 to 1994 after the original interspecific cross between allohexaploid ($2n = 6x = 54$) species, *C. weyrichii* (Maxim.) Miyabe ‘Pink Bomb’ × [*C. ×grandiflorum* Tzvelv. ‘Adorn’ (PP 6059) or ‘Crusador’ (PP 6531)] (Anderson and Ascher, 2008; Anderson et al., 2008). The new cultivar was created with crosses made during 1990–94 using proprietary selections (Anderson and Ascher, 2008). Mammoth™ ‘Dark Bronze Daisy’ was ultimately derived from the cross-pollination made in 1994 between the female parent ‘Mirage’ (U.S. Plant Patent no. 6388) and the male parent Mammoth™ ‘Autumn Red’ (MN Sel’n. ‘92-333-2’; U.S. Plant Patent no. 14,197). Mammoth™ ‘Dark Bronze Daisy’ was selected as a single hybrid plant (ortet) within the progeny of the stated cross (95-168 as plant no. 8) in 1995 by the inventors Neil Anderson and Peter Ascher in St. Paul, MN (Anderson and Ascher, 2008). Mammoth™ ‘Dark Bronze Daisy’ (MN Sel’n. 95-169-8) has unique quadriplex (four rows of ray petals or florets) daisy-type inflorescences with dark bronze daisy flowers and gold disk florets, positioned at varying levels on the cushion habit (Fig. 2); in 1996, the second year plant growth of the original ortet exhibited the large shrub growth form with a cushion habit (Fig. 2).

The cushion phenotype, a distinct feature of all Mammoth™ series cultivars is coupled with the unique shrub habit occurring in Year 2 and older plants (Fig. 2). This latter trait distinguishes them from classic, smaller cushion forms resembling the Mammoth™ series in Year 1 plants (Anderson et al., 2004, 2008, 2012a, 2012b). Seedling MN Sel’n. 95-169-8 was selected and approved for release in 2001, by the Minnesota Agricultural Experiment Station, Horticultural Variety Release Committee, as Mammoth™ ‘Dark Bronze Daisy’ that is now protected by a U.S. Plant Patent (PP 19,043; Anderson and Ascher, 2008). This cultivar is taxonomically designated as *Chrysanthemum* × *hybridum* Anderson (= *Dendranthema* × *hybrida* Anderson) Mammoth™ ‘Dark Bronze Daisy’ (Anderson and Ascher, 2008).

Description

After the ortet, MN Sel’n. 95-169-8 (Mammoth™ ‘Dark Bronze Daisy’), was selected as a shrub chrysanthemum in Fall 1996 (its second year of growth), one-third of its crown was dug from the field on 30 Oct. 1996 (St. Paul, MN; 45°N lat.). The crown section was stored at 4 °C for 1000 h (dark) and then potted into a peatmoss substrate (Sunshine no. 8/LC8 Professional Growing Mix; Sun Gro Horticulture, Bellevue, WA) and greenhouse forced to prompt vegetative

Received for publication 25 Nov. 2014. Accepted for publication 26 Jan. 2015.

This research has been supported by the Minnesota Agricultural Experiment Station and a grant from the Ball Horticultural Company, West Chicago, IL.

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Fig. 1. Pedigree of *Chrysanthemum ×hybridum* Mammoth™ 'Dark Bronze Daisy' (MN. Sel'n. No. 95-169-8) (Anderson and Ascher, 2008). The female (seed) parents are listed first, followed by the male (pollen) parent.

Fig. 2. Second year Mammoth™ 'Dark Bronze Daisy' plant displaying the cushion and shrub plant habits. Bar = 0.4 m. Photo credit: Neil Anderson.

shoots from the rhizomes (long days, 0800–1600 HR supplied by 400 W high-pressure sodium lamps + 2200 to 0200 HR night interruption; 18.5/22.0 °C day/night). In 1996, clonal ramets (asexual stem tip cuttings) of the new hybrid were taken in St. Paul, MN and the traits were deemed to be stable and true to type in successive generations of clonal ramets (Anderson and Ascher, 2008). Cuttings were dipped in 1000 ppm indole-3-butyric acid (IBA) in 50% ethanol (EtOH), inserted into phenolic foam (Oasis wedge; Smithers-Oasis, Kent, OH) for rooting under intermittent mist and 21 °C day/night (substrate temperature). Cuttings rooted (100%) in ≈1 week and were grown in greenhouses (St. Paul, MN) for vegetative growth (4 weeks of long days, 0800–1600 HR supplied by 400 W high-pressure sodium lamps + 2200 to 0200 HR night interruption; 18.5/22.0 °C day/night), followed by transplanting at sites in North America for field testing during 2000–08 trials. For the U.S. Plant Patent filings (Anderson and Ascher, 2008), cuttings were planted in May of 2004 and 2005 for two- and one-year-old plants, respectively, at the Southern Research and Outreach Center, University of Minnesota, Waseca, MN (43.9°N lat.). Plants were flowered under natural daylengths until Sept. 2005 for comparative trait data collection of plant growth (habit, height, width, etc.).

Aboveground botanical and phenotypic trait data for Mammoth™ 'Dark Bronze

Daisy' were recorded on plants under natural lighting in greenhouses (St. Paul, MN; 45°N lat.) from one year-old plants between 1300–1500 HR on 18 Jan. 2001. Color descriptors using RHS Color Charts [Royal Horticultural Society (RHS), 1995] characterized numerous traits, except where general color terms of ordinary dictionary significance are used (Anderson and Ascher, 2008). Color readings were accomplished under fluorescent lighting, at 150 μmol·m⁻²·s⁻¹, on the same date (18 Jan. 2001). Taxonomic descriptors followed those published by Harris and Harris (1994). Plant growth habit measurements and flower counts were taken on first and second year plants growing side by side in field trials (St. Paul, MN; 45°N lat.) in mid-Sept. 2000. Expression of all phenotypic traits was stable (Anderson and Ascher, 2008).

Stems and Leaves

Mammoth™ 'Dark Bronze Daisy' stem coloration is RHS Yellow Green Group 145A. Lateral branches range from 15.2 to 35.6 cm in length (Anderson and Ascher, 2008). There is one lateral branch/node when apical dominance is broken via pinching with an average internode length and lateral branch diameter of 1.3 and 0.025 cm, respectively.

As is characteristic of the species and all related ancestral ones, the phyllotaxy (leaf arrangement) of this cultivar is alternate with a wide range in leaf numbers or nodes (5–23) per lateral branch (Anderson and Ascher, 2008). Mammoth™ 'Dark Bronze Daisy' has simple leaf division with an ovate leaf blade shape and a narrow region extending toward the base of each leaflet (Harris and Harris, 1994). Average sizes of fully expanded leaves are 8.5 × 3.7 cm (length × width) and emit a fragrance when bruised. Each leaf base is cuneate with a truncate and dentate leaf apex with incised leaf margins (*Morus* or mulberry-like incision). Leaf surfaces of Mammoth™ 'Dark Bronze Daisy' are slightly hirsute on both the adaxial and abaxial surfaces. The leaf attachment is sessile; its leaf venation has coloration of RHS 138B (adaxial surface) and RHS 138C (abaxial), whereas the young foliage has coloration of RHS 138A and RHS 138B on

the adaxial and abaxial surfaces, respectively (Anderson and Ascher, 2008). Only the adaxial leaf surface changes coloration to RHS 137B when mature.

Flower Description

Mammoth™ 'Dark Bronze Daisy' has composite inflorescences, since it is a member of the Asteraceae (=Compositae), with ray petal (gynoeceous) and disk (hermaphroditic; perfect) florets. On average, a second year plant produces as many as 3000–4000 flowers (Anderson and Ascher, 2008). Flower buds of the inflorescence are inverted funnel shaped with an average depth of 8.0 × 1.1 cm diameter with a color of RHS 23D. Involucral bracts or phyllaries have a glabrous texture, are crenulate in shape with a color of RHS 138A ranging in size from 2 to 5 mm (length) × <1 mm (width). At anthesis, mature flowers have a depth of 1.5 cm and a total diameter of 5.0 cm that includes the 1-cm disk diameter. Mammoth™ 'Dark Bronze Daisy' peduncles are stiffly held at an angle of 45° to the stem with a slightly hirsute texture. The first peduncle has a mean length of 1.9 cm, whereas the fourth extends to 3.5 cm in length; all have coloration of RHS 138B (Anderson and Ascher, 2008).

Each flower (inflorescence) has a mean of 48 capitulate ray florets (petals), arranged in four rows to create a duplex daisy. The flower petals are linear lanceolate in shape: the outer ones are reflexed whereas the inner are upright. On average, Mammoth™ 'Dark Bronze Daisy' flower petals are 2.4 × 6 mm (length × width) in size and frost tolerant. Petal apices and bases are rounded and equilateral, respectively, with entire margins (Fig. 3). All petals are glabrous and silky on the adaxial and abaxial surfaces, respectively (Fig. 3; Anderson and Ascher, 2008). As the petals unfurl and show color, the adaxial surfaces are RHS 60A whereas the abaxial is RHS 184B. At maturity, flower petals are RHS 181A on the adaxial and RHS 173D on the abaxial surfaces (Table 1). As the flower petals fade, both the adaxial and abaxial surfaces change in color to RHS 182A.

Mammoth™ 'Dark Bronze Daisy' inflorescences have an average of 150 ovules/inflorescence (Anderson and Ascher, 2008). Each floret in Asteraceae flowers has only one ovule. Anther coloration and the fairly abundant trinucleate pollen are both RHS 21A. At mature seed stage, each achene (an indehiscent fruit) lacks a pappus (awn or bristle), is a compressed oval shape with pointed ends, ≈2–5 × 1–2 mm (length × width). The outer surfaces have a ridged texture and are RHS 200D in color.

Performance

When grown in the field, containers, or the landscape, Mammoth™ 'Dark Bronze Daisy' plants possess a cushion habit in Year 1 with plant dimensions of 45–53 cm (height) and, thereafter, maintains a tight cushion plant habit in all subsequent years (Year 2

Fig. 3. Adaxial (left) and abaxial (right) leaf trait profiles of Mammoth™ 'Dark Bronze Daisy'. Bar = 0.46 cm. Photo credit: Neil Anderson.

Table 1. Comparative plant traits of *Chrysanthemum ×hybridum* Mammoth™ 'Dark Bronze Daisy' (PP 19,043) grown with *C. ×grandiflorum* 'Dark Grenadine' (PP 7632) (Anderson and Ascher, 2008). Quantitative traits are mean values, based on 10 replications.

Plant trait	Mammoth™ Dark Bronze Daisy	Dark Grenadine
Plant shape	Cushion (mounded, spherical)	Cushion
Plant height, Year 1	45.7 cm	45.7 cm
Plant height, Year 2	76.2–106.7 cm	— ^z
Flowering response group		
No. weeks required		
For flowering (short days)	6	7
Flower type	Quadriplex daisy	Decorative
Flower diameter	5.0 cm	4.5–5.0 cm
Ray florets (mature), color		
Adaxial surface	RHS Greyed Red Group 181A	RHS Greyed Red Group 181D
Abaxial surface	RHS Greyed Orange Group 173D	RHS Greyed Red Group 181D

RHS = Royal Horticultural Society.

^zPlants did not survive the winter in USDA Z3b–4b.

and onwards, Fig. 2). In Year 2 and onwards, as is characteristic of the Mammoth™ series (Anderson et al., 2004, 2008, 2012a, 2012b), Mammoth™ 'Dark Bronze Daisy' also produces a shrub habit, growing to 76–106 × 83–152 cm (height × width; Anderson and Ascher, 2008).

Side-by-side growth of Mammoth™ 'Dark Bronze Daisy' and its comparison, 'Dark Grenadine' (Plant Patent no. 7632), demonstrated no difference in plant shape for Year 1: both had a cushion habit (Table 1). The plant height of 'Dark Grenadine' is 45.7 cm in Year 1, exactly the same as Mammoth™ 'Dark Bronze Daisy'. However, in Year 2—when 'Dark Grenadine' does not survive in northern latitudes due to a lack of winterhardiness—Mammoth™ 'Dark Bronze Daisy' attains a height of 76.2–106.7 cm (Table 1). Although Mammoth™ 'Dark Bronze Daisy' is a quadriplex daisy, 'Dark Grenadine' is a decorative flower type (Table 1). Mature ray floret colors on mature ray floret adaxial surfaces are RHS 181A for Mammoth™ 'Dark Bronze Daisy' compared with RHS 181D for 'Dark Grenadine'; abaxial surfaces change to RHS 173D for Mammoth™ 'Dark Bronze Daisy' but stay the same for 'Dark Grenadine' (Table 1).

Mammoth™ 'Dark Bronze Daisy' is 1 week earlier in flowering (6-week short day response group) than 'Dark Grenadine' (7-week short day response group) under

short day conditions (Table 1). Flowering for Mammoth™ 'Dark Bronze Daisy' starts in about week 34. Due to flower petal frost tolerance, Mammoth™ 'Dark Bronze Daisy' may continue to flower for another 8–10 weeks in USDA Z4b, dependent on the first freeze date.

Winter survival of Mammoth™ 'Dark Bronze Daisy' is enhanced with snow cover throughout the season in northern latitudes, as reported for all other winter-hardy Mammoth™ cultivars (Anderson et al., 2012a, 2012b; 2014a, 2014b). Since snow cover is unpredictable, winter survival increases with the use of a soil surface mulch (Anderson et al., 2012b). Winter survivorship was determined at multiple locations [7 sites in USDA Z3b (Grand Rapids, MN), 4a (Morris, MN), 4a (St. Paul, MN), 4b (Lamberton, MN; Waseca, MN), 5a (Verona, WI), and 6b (Institute, WV)], 10 plants/site and years (2003–08) (Table 2), although Mammoth™ 'Dark Bronze Daisy' was not planted at each site every year. All field trials were conducted in open fields or garden plots without protective mulch. Mean percent winter survival ranged from 0.0% (2008, St. Paul, MN) to 100% in one or more years at all sites with the exception of Institute, WV (Table 2). The overall grand arithmetic mean winter survival was 72% for the tested years and locations (Table 2), whereas the lowest annual arithmetic mean of 43.3% was in 2006;

the highest was 100.0% in 2003 (Table 2). Geometric means, first used by Anderson et al. (2012b) to express garden chrysanthemum winterhardiness as a more accurate calculation of winter survival, for years and locations ranged from 31.8% (2006) to 100.0% (2003) (Table 2); most geometric means were lower than the corresponding arithmetic means. Geometric means include only positive numbers greater than zero (Ouellet, 1976). Therefore, geometric means could not be calculated in 2005 and 2008 as they contained 0.0% winter survival at one site or more (Table 2). In 2007, neither arithmetic nor geometric means were determined since there was only one average at one location (Table 2). The grand geometric mean for all years and locations could not be calculated for Mammoth™ 'Dark Bronze Daisy' as the data included zeroes. Winter survival in lower latitudes (data not shown) demonstrated that Mammoth™ 'Dark Bronze Daisy' also survives to USDA Z9 (Southeast)/Z10 (West). Thus, the complete winterhardiness range of Mammoth™ 'Dark Bronze Daisy' is USDA Z3b–Z9 (southeast)/Zone 10 (West) (Anderson and Ascher, 2008; Table 2).

Propagation and Production

As an asexual or clonal crop, Mammoth™ 'Dark Bronze Daisy' propagation requires certified, virus-free stock plants for the production of stem tip cuttings. Tests of clonal material assure that morphological traits in clonal ramets are firmly fixed. Mammoth™ 'Dark Bronze Daisy' cuttings root in ≈1 week under intermittent mist or fog, after the basipetal ends are dipped into 1000 ppm IBA in 50% EtOH (Anderson et al., 2008, 2012a, 2012b, 2014a, 2014b). Rooted cuttings can be programmed for flowering with 3–4 weeks of a long day photoperiod (0800–1600 HR + 2200–0200 HR night interruption lighting) at 18.5/22.0 °C day/night to produce vegetative growth (Dole and Wilkins, 2005). Subsequently, 6 weeks of short day photoperiods [8 h (0800–1600 HR) with black cloth pulled closed at 1600 HR and opened at 0800 HR] at 18.5/22.0 °C day/night will cause flower bud initiation and development. Standard chrysanthemum fertilization of 1361 g/30.48 m² of N using 5N–8.7P–16.6K (5–20–20; Peter's Professional, Everris Na Inc., Marysville, OH) preplant fertilizer or 300 ppm N using 20N–4.4P–16.6K (20–10–20, Peat-Lite Special; The Scotts Co., Marysville, OH) weekly liquid feed and monthly fungicide drenches—are required (Langevin, 1992). For containers or direct transplant into gardens or fields, full sun is required along with high fertilization and irrigation (Anderson, 2006; Anderson et al., 2004, 2008, 2012a, 2012b; Langevin, 1992; Widmer, 1980). Plants will display the shrub habit in Year 2 onwards (Fig. 2).

Mammoth™ 'Dark Bronze Daisy' is a facultative short day plant (Anderson and Ascher, 2008) that can be grown for Mother's Day spring bedding plant sales in packs or liners

Table 2. Test sites, geographic locations, U.S. Department of Agriculture (USDA) plant hardiness zones, and mean % winter survival of Mammoth™ ‘Dark Bronze Daisy’ (MN. Sel’n. no. 95-169-8) over seven trial locations in Minnesota, Wisconsin, and West Virginia.^z

Test sites	Latitude	Longitude	USDA hardiness zone ^y	Percent winter survival over years								
				2000	2001	2002	2003	2004	2005	2006	2007	2008
Grand Rapids, MN	47.24739°N	93.54444°W	3b	90.0	100.0			100.0		10.0		
Lamberton, MN	44.23111°N	95.26389°W	4b	90.0		100.0						
Morris, MN	45.62820°N	95.88908°W	4a	100.0	100.0		100.0		100.0	80.0		
St. Paul, MN	44.98776°N	93.13700°W	4a	50.0	64.3	36.0 ^x	100.0	5.0 ^x				0.0 ^x
Waseca, MN	43.90669°N	93.43338°W	4b	100.0	100.0		100.0	77.8			100.0	100.0
Verona, WI	43.06048°N	89.52742°W	5a		77.8		100.0					
Institute, WV	38.41981°N	81.8339°W	6a						0.00	40.0		
Annual geometric means (grand mean = — ^w)	—	—	—	83.5	87.1	60.0	100.0	33.9 ^x	— ^w	31.8	N/A ^v	— ^w
Annual arithmetic means (grand mean = 72.0)	—	—	—	86.0	88.4	68.0	100.0	60.9	50.0	43.3	N/A ^v	50.0

^aData 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 = 9–10 replications (clonal ramets) in each site each year; blanks denote the genotype was not planted at this location during that specific year.

^bLow 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>).

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

^dGeometric mean could not be calculated as data includes a nonpositive number, i.e., zero (0).

^eN/A = means are irrelevant since there is only one average at one location for this year.

Use

Mammoth™ ‘Dark Bronze Daisy’ is a winter-hardy, herbaceous perennial, garden chrysanthemum shrub that is a butterfly attractant. Each Mammoth™ cultivar has flower petal frost tolerance and standard garden chrysanthemum plant dimensions with a cushion habit in the first year (Anderson et al., 2008; Langevin, 1992), but achieve a shrub habit overlaid onto the cushion habit in Year 2 onwards (Anderson et al., 2004, 2008, 2012a, 2012b, 2014a, 2014b). Mammoth™ ‘Dark Bronze Daisy’ is low in landscape maintenance, not needing pinching before July 4 to induce lateral branching and enhanced plant dimensions (Langevin, 1992; Widmer, 1980). When growing individual specimens of Mammoth™ ‘Dark Bronze Daisy’, plants should be spaced ≥ 1 m on center (OC). If plants are spaced at 0.3–0.6 m OC, a flowering hedge will result.

Availability

Chrysanthemum ×hybridum Mammoth™ ‘Dark Bronze Daisy’ (U.S. Plant Patent 19,043) is available as certified, unrooted, or rooted cuttings. Ball Seed Company (622 Town Road, West Chicago, IL, 60185; www.ballseed.com) is the exclusive owner of the Mammoth™ brand cultivars.

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