

Winter-hardy Mammoth™ Series Garden Chrysanthemums ‘Red Daisy’, ‘White Daisy’, and ‘Coral Daisy’ Sporting a Shrub Plant Habit

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Abstract. Three new *Chrysanthemum* × *hybrida*, garden chrysanthemum cultivars: Red Daisy, White Daisy, and Coral Daisy, are the first in the Mammoth™ series that are advanced interspecific hybrids derived from an open-pollinated cross between hexaploid *C. weyrichii* (Maxim.) Tzvelv. × *C. ×grandiflora* Tzvelv. These cultivars are backcross or inbred derivatives of the original interspecific F₁ hybrids. All three cultivars are U.S. Department of Agriculture Z3b (–34.4 °C to –37.2 °C) winter-hardy herbaceous perennials exhibiting a shrub habit with the cushion phenotype. Additional traits exhibited by these three cultivars are butterfly attractants, frost tolerance of the flowers, and genetic ‘self-pinching.’ These Mammoth™ cultivars are clonally propagated, virus indexed, protected by U.S. Plant Patents and Canadian Plant Breeder’s Rights, and are available from the North American exclusive licensee Ball Seed Company.

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Chrysanthemums (*Chrysanthemum* × *grandiflora* Ramat.; = *Dendranthema* × *grandiflora* Tzvelv.) are popular cut flowers, potted flowering plants, and perennial garden favorites worldwide with thousands of cultivars available (Anderson, 2006). Garden chrysanthemums are the number one herbaceous perennial in the United States, with a wholesale farmgate value of \$141.845 million in 2005 (U.S. Dept. Agr, 2006). Numerous factors contribute to the long-term popularity of garden chrysanthemums, including fall flowering (most cultivars are obligate short-day plants), a wide range of flower types and colors, distinct plant habits (upright, cushion, groundcover), and winter hardiness (particularly for northern gardeners; Anderson, 2004; Anderson and Gesick, 2003, 2004; Dole and Wilkins, 2005; Kim and Anderson, 2006). A small number of private and public sector

breeding programs across the globe have active chrysanthemum breeding programs (Anderson, 2006). The chrysanthemum breeding program at the University of Minnesota is now the oldest public sector chrysanthemum breeding program in the world and the only public sector chrysanthemum breeding program in the United States (Anderson, et al., 2001). The program’s trend-setting 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.

The cushion habit of mums, a genetic discovery of University of Minnesota Agricultural Experiment Station mum breeders, was the basis for the University of Minnesota’s first U.S. plant patent for ‘Minnogopher’ (U.S. Plant Patent, No. 4,327; Widmer, 1978). Plants are hemispherical in shape with flowers almost completely covering the outside surfaces of each plant, like a pincushion. Previous mums, like most other flowers, bloomed only at the top of long stems (upright plant habit; Anderson, 2006). Shortly thereafter, all U.S. breeding programs were producing garden chrysanthemums with this plant habit (Anderson, 2006). The cushion is now the primary plant phenotype in the market (Anderson, et al., 2001).

Origin

In 1989, when pursuing the University of Minnesota breeding objective of creating “wave” or groundcover plant habits, a natural pollination between hexaploid parents *C. weyrichii* (Maxim.) Tzvelv. ‘Pink Bomb’ (a groundcover species, nonpatented cultivar; White Flower Farms, Litchfield, CT; $2n = 6x = 54$) × *C. ×grandiflora* Tzvelv. ‘Crusador’ (PP No. 6,531; lavender daisy; $2n = 6x = 54$) or ‘Adorn’ (PP No. 6059; deep purple daisy; $2n = 6x = 54$) occurred in the garden of Betty Patsche (St. Paul, MN) (Anderson and Ascher, 2003a). The male parent cultivars (single daisies with pollen production) were planted adjacent to the female parent. There were no other garden chrysanthemums within proximity for pollinators (bees) to use for pollen transfer. These interspecific hybrid seeds were donated to the University of Minnesota breeding program (Anderson and Ascher, 2003a). The hybrid progeny ($N = 288$ plants; Cross No. 90-287) were grown out and compared with self-pollinated progeny from *C. weyrichii* ‘Pink Bomb’ to confirm hybridity. In the 1990 field breeder trials (St. Paul Campus, 45°N lat.), the 90-287 seedling phenotypes were neither groundcover nor normal-sized cushion plant habits. The new hybrids were distinctly different from the parents with interspecific heterosis for plant growth, reaching 1 to 1.25 m (height) × 1 to 2 m (width; N.O. Anderson and P.D. Ascher, unpublished data, 1990). The new plant size was recognized as having market potential; the 90-287 hybrids, which displayed this phenotype, flowered the first year from seed, were winter hardy, and were selected for

continued breeding and development. A new breeding objective was established to create shrub plant habits with the cushion phenotype for a new series of garden chrysanthemums. These hybrids have been taxonomically designated as *Chrysanthemum ×hybrida* (= *Dendranthema ×hybrida*) to distinguish these from *C. ×grandiflora* types (Anderson and Ascher, 2003a, 2003b, 2007). The first such hybrid released from the program was ‘Betty Lou’, MN Sel’n. No. 92-390-10, a first generation inbred derived from a self-pollinating primary interspecific hybrid, named in honor of Betty Patsche (in whose garden the cross originated; Ascher, et al., 1997a, 1997b).

Mammoth™ ‘Red Daisy’, ‘Coral Daisy’, and ‘White Daisy’ are all advanced generation backcross or inbred derivatives of the original 1989 cross (90-287). Mammoth™ ‘Red Daisy’ is a first generation backcross hybrid (BC₁) derived from backcrossing a primary F₁ hybrid, MN Sel’n. 90-287-16 as the male parent with *C. ×grandiflora* MN Sel’n. 90-147-10 (Fig. 1). A resulting hybrid, MN Sel’n. 92-333-2 (U.S. Plant Patent No. 14,197; Canadian Plant Breeder’s Rights Application No. 2000/338; Anderson and Ascher, 2002a, 2003a) was first flowered during 1992 and submitted to breeder and grower trials for 10+ years before being named. This cultivar was first named and released in 2001 as My Favorite™ ‘Autumn Red’ and was sold on the market for a few years before the series and cultivar were renamed in 2006 (see discussion below). The cultivar is currently sold as Mammoth™ ‘Red Daisy’ (Monrovia, 2007).

Mammoth™ ‘White Daisy’ is a second-generation backcross hybrid (BC₂) derived from backcrossing a primary F₁ hybrid, MN Sel’n. 90-287-194 with two different *C. ×grandiflora* female parents, MN Sel’n. 77-AM3-3 (an inbred parent that created the BC₁) and ‘Baby Tears’ (a noninbred cultivar that resulted in the BC₂; Fig. 2). Mammoth™ ‘White Daisy’ was first flowered in 1995 and evaluated for ≈10 years before release (U.S. Plant Patent No. 17,786; Canadian Plant Breeder’s Rights Application No. 2000/339; Anderson and Ascher, 2002b, 2007). This cultivar was named and released in 2002 as My Favorite™ ‘White’ and was sold on the market for a few years before the series and cultivar were renamed in 2006 (see discussion below). The current cultivar name is Mammoth™ ‘White Daisy’ (Monrovia, 2007).

Mammoth™ ‘Coral Daisy’ is a second generation inbred derived from a BC₁ hybrid (Fig. 3). ‘Rose Blush’ × MN Sel’n. 90-287-158 resulted in the BC₁ hybrid, MN Sel’n. 91-204-2, which was self-pollinated for two generations, producing MN Sel’n. 95-105-6, which was later named Mammoth™ ‘Coral Daisy’ (Fig. 3; U.S. Plant Patent No. 14,129; Canadian Plant Breeder’s Rights Application No. 2000/340; Anderson and Ascher, 2002c, 2003b). This cultivar was first named and released in 2002 as My Favorite™ ‘Coral’ and was sold on the market for a few years

Chrysanthemum weyrichii ‘Pink Bomb’ × *C. ×grandiflora* ‘Crusador’ and/or ‘Adorn’

MN Sel’n. 90-147-10 × MN Sel’n. 90-287-16

MN Sel’n. 92-333-2
Mammoth™ ‘Red Daisy’

Fig. 1. Pedigree of *Chrysanthemum ×hybrida* Mammoth™ ‘Red Daisy’. The female (seed) parents are listed first, followed by the male (pollen) parent.

Chrysanthemum weyrichii ‘Pink Bomb’ × *C. ×grandiflora* ‘Crusador’ and/or ‘Adorn’

MN Sel’n. 77-AM3-3 × MN Sel’n. 90-287-194

‘Baby Tears’ × MN Sel’n. 92-279-2

MN Sel’n. 95-157-6
Mammoth™ ‘White Daisy’

Fig. 2. Pedigree of *Chrysanthemum ×hybrida* Mammoth™ ‘White Daisy’. The female (seed) parents are listed first, followed by the male (pollen) parent.

before the series and cultivar were renamed in 2006 (see discussion below). The current cultivar name is Mammoth™ ‘Coral Daisy’ (Monrovia, 2007).

Description and Performance

The Mammoth™ series garden chrysanthemum “shrub” phenotype offers unique attributes with market value (Anderson, 2006). A shrub plant habit denotes the large plant size each cultivar reaches in the second and successive years of growth, creating a new use for fall flowering garden mums: a flowering, nonwoody shrub. Additional traits that all cultivars of the Mammoth™ series possess are winter hardiness to United States Department of Agriculture Z3b (−34.4 °C to −37.2 °C), butterfly attractants, frost tolerance of the flowers (thereby increasing the duration of the flowering period; Anderson and Gesick, 2004; Kim and Anderson, 2006), and

genetic “self-pinching” (no need for disbudding in the spring—the cushion habit is created without shearing; Anderson and Ascher, 2003a, 2003b; 2007; Ascher, et al., 1997a, 1997b; Widmer, 1978). The Mammoth™ series occupies a distinct market niche in the garden mum market that has promoted new attention on these fall-flowering herbaceous perennials and the marketing of larger-sized products for retailers (Anonymous, 1994, 1996; Nelson, 2001; Poncavage, 1996).

When clones (rooted cuttings) of each cultivar are planted 0.3 to 0.6 m on center (O.C.), they will form a continuous hedge in the second and successive years of growth with a manicured appearance (Fig. 4). If individual plants are planted in the landscape, each flowering shrub can be used as a focal point (Anderson, 2006). The cushion shape, along with the shrub habit, produces thousands of flowers on each plant, completely covering all exposed surfaces of each plant (Table 1).

Chrysanthemum weyrichii 'Pink Bomb' × *C. ×grandiflora* 'Crusador' and/or 'Adorn'

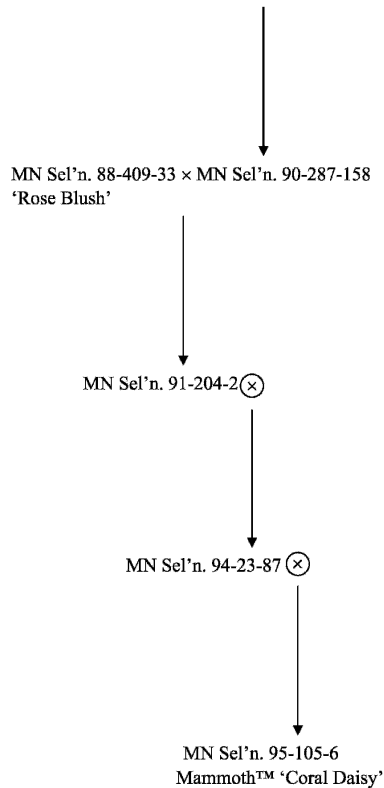


Fig. 3. Pedigree of *Chrysanthemum ×hybrida* Mammoth™ 'Coral Daisy'. The female (seed) parents are listed first, followed by the male (pollen) parent.

The flower type is a duplex-triplex daisy, 2 to 3 rows of ray petals, respectively (Table 3). As the first release in the Mammoth™ series, the deep maroon petals and a gold center (disc florets) reflect the official school colors of the University of Minnesota. The maroon color is from the combination of an adaxial red color and abaxial surface color of purple when the flowers are mature (Table 3). In growing conditions with high night temperatures, particularly in southern latitudes, the maroon may fade to pale orange. Although only 6 weeks of short days (Table 3) are required for flowering in the greenhouse under inductive conditions (Ball, 1985; Dole and Wilkins, 2005), the flowering date in the field (United States Department of Agriculture Z3b-4a) is September to October (Anderson and Ascher, 2003a). This difference may be indicative of heat delay. Such late flowering in the landscape means that fading rarely occurs in northern latitudes (data not shown).

Flower production is prolific, averaging ≈5000 flowers/plant (Table 3) in the second and subsequent years, creating a massive display of fall color. Stem strength and interlocking lateral branch growth result in lodging resistance during heavy rain/wind storms in peak flowering in the past 15 years of trials (data not shown). The flowers are extremely frost tolerant, with no visible signs of damage after a frost; plants continue flowering after frosts until a hard freeze occurs (Anderson and Ascher, 2003a).

Mammoth™ 'White Daisy'. The shrub plant habit of this cultivar reaches 0.55 to 0.7 m in height × 0.6 to 1.52 m in width (lateral branch length × 2) in the second year of growth (Table 1). More than 8000 leaves/plant provide the photosynthetic area to support the semidouble flowers with five rows of petals (pentaplex daisy). Upon maturity, flowers display an open center with yellow disc florets (Table 3). The white ray petals provide a contrast to the dark spinach green leaves (Table 1). In the landscape, Mammoth™ 'White Daisy' complements any dark flower color of taller herbaceous perennials, such as *Agastache* 'Blue Fortune' (Fig. 5).

Mammoth™ 'White Daisy' is an early-midseason garden chrysanthemum, flowering in mid-August to September in United States Department of Agriculture Z3b-4a trial sites (Anderson and Ascher, 2007). This cultivar produces an average of n = 63 emergent and n = 36 nonemergent rhizomes, less than Mammoth™ 'Red Daisy' (Anderson and Gesick, 2004), which is associated with winter hardiness.

As with Mammoth™ 'Red Daisy', emergent rhizome counts of Mammoth™ 'White Daisy' in the fall of the first year's growth were predictive of winter survival in U.S. Department of Agriculture Z4a using Fisher's linear discriminant function analysis for 1999 to 2001 field data (St. Paul, MN, 45° N lat.; minimum temperature of -34.5 °C; Anderson and Gesick, 2004). Winter survival in subsequent years at additional sites in



Fig. 4. A hedge of chrysanthemums (center of photograph; planted 0.6 m on center [O.C.]) are formed by Mammoth™ 'White Daisy' and all other cultivars in the series when individual plants are grown 0.3–0.6 m O.C. Bar = 0.76 m. Photo credit: Neil Anderson.

Mammoth™ 'Red Daisy'. This cultivar achieves the shrub habit in its second year of growth with dimensions as much as 1.15 m in height and a width of 1.8 m (lateral branch length × 2; Table 1). A large number of leaves and photosynthetic area support this growth (>3000 leaves/plant; Table 1), although Mammoth™ 'Red Daisy' has fewer leaves than 'Coral Daisy' or 'White Daisy'.

Because the large shrub habit in clonal ramets occurs in the second and successive years of growth, winter survival is a critical component. Anderson and Gesick (2004) studied key components in cold tolerance and found that Mammoth™ 'Red Daisy'

produced an average of n = 81 emergent and n = 75 nonemergent rhizomes per clonal ramet at the end of the first season of growth (year 1), with the five most basipetal rhizomes having a mean length of 20.8 cm. Mean winter survival for Mammoth™ 'Red Daisy' ranged from 37.5% to 100% across years and locations at six sites in Minnesota (Table 2). The predominant mean percentage of winter survival was ≥75%; in three winters, the scores were <75% (Table 2). These occurred when the respective sites had an open winter with minimal or no snow cover, below zero temperatures (°F) without snow cover, or low soil moisture conditions—any of which can cause winter kill. Mammoth™ 'Red Daisy' had a grand mean percentage of winter survival of 88.1%, pooled from 1996 to 2004 data at six sites in Minnesota, and yearly averages ranged from 42% to 100% (Table 2). In most years for Zone 3b test sites (Crookston, Grand Rapids, MN), winter survival was primarily 100% (Table 2). Thus, based on the winter survival data, Mammoth™ 'Red Daisy' is hardy in United States Department of Agriculture Zone 3b. Emergent rhizome counts of Mammoth™ 'Red Daisy' in the fall of the first year's growth were predictive of winter survival in U.S. Department of Agriculture Z4a using Fisher's linear discriminant function analysis with field trial data from 1999 to 2001 (St. Paul, MN, 45° N lat.; minimum temperature of -34.5 °C; Anderson and Gesick, 2004).

Table 1. Vegetative plant characteristics of garden chrysanthemum Mammoth™ ‘Red Daisy’ (U.S. PP No. 14,197; Canadian PBR Appl. No. 2000/338; Anderson and Ascher, 2002a, 2003a), Mammoth™ ‘Coral Daisy’ (U.S. PP No. 14,129; Canadian PBR Appl. No. 2000/340; Anderson and Ascher, 2002c, 2003b), and Mammoth™ ‘White Daisy’ (U.S. PP No. 17,786; Canadian PBR Appl. No. 2000/339; Anderson and Ascher, 2002b, 2007).

Trait	Cultivars		
	Mammoth™ ‘Red Daisy’	Mammoth™ ‘Coral Daisy’	Mammoth™ ‘White Daisy’
Appearance, shape	Spherical mound	Spherical mound	Spherical mound
Plant height (m)			
First year	≈0.55–0.60	≈0.35–0.50	≈0.45–0.48
Second year	≈0.9–1.15	≈0.58–0.73	≈0.55–0.70
Lateral branch length (m)	≈0.15–0.90	0.30–0.90	0.30–0.76
Stem color (RHS) ^z	Green 138B	Green 139B	Paris Green 58/1
Leaves			
No. leaves/plant	>≈3,000	>10,000	>8,000
No. leaves/lateral branch	3–25	5–25	5–20
Leaf size, length × width (cm)	5.0 × 4.0	9.7 × 4.6	7.8 × 4.8
Leaf apex	Acute	Obtuse to mucronate	Mucronulate
Leaf base	Truncate to auriculate	Cuneate to oblique	Cuneate
Leaf margin	Incised	Incised	Incised
Leaf texture	Glaucous/hirsute	Glabrous	Mildly hirsute
Mean petiole length (cm)	4.0	3.8	2.2
Leaf color (fully expanded):			
Adaxial surface (RHS) ^y	Green 138B	Green 138A	Spinach Green o960
Abaxial surface (RHS) ^y	Green 141B	Green 138C	Spinach Green o960/1 to o960/3
Venation color			
Adaxial surface (RHS) ^y	Green 138B	Green 128D	Spinach Green o960/2
Abaxial surface (RHS) ^y	Green 138C	Green 128D	Spinach Green o960/3
Phyllaries (involucral bracts):			
Appearance	Crenulate	Crenulate	~Crenulate
Color (RHS) ^z	Green 138C	Green 139C	Green 138C
Texture	Glabrous	Glabrous	Glabrous
Length (cm)	≈0.2–0.4	≈0.2–0.4	≈0.2–0.3

^zRoyal Horticultural Society (RHS) Color Group Codes: Mammoth™ ‘Red Daisy’, Mammoth™ ‘Coral Daisy’ (Royal Horticultural Society, 1995); Mammoth™ ‘White Daisy’ (Royal Horticultural Society, 1986).

northern latitudes is comparable to the 1999 to 2001 data (Table 2). The grand mean percentage of winter survival was 89.2%, with the average percentage of survival pooled across years ranging from 55.25% to 100% (Table 2). Only one mean percentage of winter survival value was <50% from 1999 to 2004 (0% for St. Paul, MN in 2003) because of an open winter with little snowfall, low temperatures, and low soil moisture levels (Table 2). All winter-hardy comparisons that year also had 0% winter survival because of the harsh winter conditions. Additionally, in that same year, Mammoth™ ‘White Daisy’ had 100% survival in Waseca, MN (U.S. Department of Agriculture Z4b; Table 2). Thus, the 2003 data from the St. Paul site was considered and ignored. These data, coupled with the high emergent rhizome counts, warrants classification of Mammoth™ ‘White Daisy’ as an United States Department of Agriculture Z3b herbaceous perennial.

Mammoth™ ‘Coral Daisy’. The plant height of second-year Mammoth™ ‘Coral Daisy’ is intermediate to Mammoth™ ‘Red Daisy’ and Mammoth™ ‘White Daisy’, with a range of 0.58 to 0.73 m in height (Table 1). Its appearance is more of a flattened, wider spherical mound than the other two cultivars (Fig. 6); lateral branch width is 0.6 to 1.8 m (lateral branch length × 2; Table 1). The growth habit does not change from year to year, as two-year-old and five-year-old plantings display identical plant habits (data not shown). The highest number of leaves/plant

Table 2. Geographic locations, United States Department of Agriculture (USDA) plant hardiness zones, and mean percentage of winter survival of Mammoth™ ‘Red Daisy’, Mammoth™ ‘Coral Daisy’, and Mammoth™ ‘White Daisy’ over multiple trial locations in Minnesota. There were n = 10 replications (clones) per site per year with the exception of St. Paul, Minnesota, which had n = 24/yr.

Test site	Latitude	Longitude	USDA plant hardiness zone ^z	Years						
				1996	1999	2000	2001	2002	2003	2004
Mammoth™ ‘Red Daisy’										
Crookston, MN	47.78232°N	96.60461°W	3b	100.0%	37.5% ^y	100.0%				
Grand Rapids, MN	47.24739°N	93.54444°W	3b	85.5		100.0	100.0%			100.0%
Lamberton, MN	44.23111°N	95.26389°W	4b	83.0		30.0 ^y				
Morris, MN	45.62820°N	95.88908°W	3b/4a	94.3	100.0	100.0	100.0			
Saint Paul, MN	44.98776°N	93.13700°W	4a		100.0	80.0		100.0	42.0 ^y	75.0
Waseca, MN	43.90669°N	93.43338°W	4b	100.0	100.0	100.0	100.0			100.0
Pooled				92.6	84.4	85.0	100.0	100.0	42.0	91.7
Grand mean										88.1
Mammoth™ ‘Coral Daisy’										
Crookston, MN	47.78232°N	96.60461°W	3b		66.6%	100.0%				
Grand Rapids, MN	47.24739°N	93.54444°W	3b			100.0	100.0%			100.0%
Lamberton, MN	44.23111°N	95.26389°W	4b			100.0				
Morris, MN	45.62820°N	95.88908°W	3b/4a		100.0	100.0	100.0			
Saint Paul, MN	44.98776°N	93.13700°W	4a		100.0	83.0	50.0 ^y	100.0%	10.5 ^y	83.3
Waseca, MN	43.90669°N	93.43338°W	4b		100.0	100.0	90.0		100.0	100.0
Pooled					91.6	97.2	85.0	100.0	55.25	94.4
Grand mean										89.2
Mammoth™ ‘White Daisy’										
Crookston, MN	47.78232°N	96.60461°W	3b		60.0%	100.0%				
Grand Rapids, MN	47.24739°N	93.54444°W	3b			100.0	97.5%			58.3%
Lamberton, MN	44.23111°N	95.26389°W	4b			100.0				
Morris, MN	45.62820°N	95.88908°W	3b/4a		50.0 ^y	100.0	100.0		100.0%	
Saint Paul, MN	44.98776°N	93.13700°W	4a		100.0	83.3	85.7	100.0%	0.0 ^y	83.3
Waseca, MN	43.90669°N	93.43338°W	4b		100.0	100.0	80.0		90.0	90.0
Pooled					77.5	96.7	92.6	100.0	67.5	77.2
Grand mean										84.7

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

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

Table 3. Reproductive plant characteristics of garden chrysanthemum Mammoth™ ‘Red Daisy’ (U.S. PP No. 14,197; Canadian PBR Appl. No. 2000/338; Anderson and Ascher, 2002a, 2003a), Mammoth™ ‘Coral Daisy’ (U.S. PP No. 14,129; Canadian PBR Appl. No. 2000/340; Anderson and Ascher, 2002c, 2003b), and Mammoth™ ‘White Daisy’ (U.S. PP No. 17,786; Canadian PBR Appl. No. 2000/339; Anderson and Ascher, 2002b, 2007).

Trait	Cultivars		
	Mammoth™ ‘Red Daisy’	Mammoth™ ‘Coral Daisy’	Mammoth™ ‘White Daisy’
Inflorescence			
Flower form	Duplex/triplex daisy	Triplex-quadruplex daisy	Pentaplex daisy
Flowering response (wks.) ^y	6.0	≈5.5	≈6.0
No. of flowers (second year)	≈5,000	≈6,000	≈3,000
Mean diameter (cm)	7.5	6.3	7.1
Mean depth or height (cm)	2.5	2.3	3.4
Mean disc diameter (cm)	1.9	1.5	1.0
Bud shape	Upright, tubular	Flattened hemisphere to widened upright tubular dome	Upright tubular
Bud size, length (cm)	1.8–2.0	0.70	0.60
Bud size, width (cm)	1.2–1.8	0.90	0.70
Bud color (RHS) ^z	Red Purple 60D	Red Purple 74A	Creamy White
Ray floret length (cm)	2.1–3.0	3.0	2.7
Ray floret width (cm)	0.8–0.9	0.7	0.6
Ray floret apex	Obtuse	Multi-notched mucronulate	Retuse
Ray floret base	Cuneate	Attenuate	Attenuate
No. ray florets/inflorescence	≈68	≈60	≈119
Ray floret color (when opening):			
Adaxial surface (RHS) ^z	Red Purple 60	Red Purple 74B	Sap Green 62/3
Abaxial surface (RHS) ^z	Red Purple 74	Red Purple 43C	Uranium Green 63/3
Ray floret color (mature)			
Adaxial surface (RHS) ^z	Red 53C	Orange Red 35C	White
Abaxial surface (RHS) ^z	Purple 78D	Orange Red 35D	White
Disc florets, shape	Tubular, rounded at tip	Tubular, rounded at tip	Tubular, rounded
Disc florets, length (cm)	0.4	0.6	0.7
Disc florets width (cm)	0.2	0.4	0.2
No. disc florets/inflorescence	≈120	≈191	≈100
Disc floret color			
Immature (RHS) ^z	Yellow Orange 16A	Yellow Orange 16A	Yellow 604
Mature (RHS) ^z	Yellow Orange 15B	Yellow Orange 15A(eye–Red 46B)	Chinese Yellow 606
Peduncle			
Angle to stem (degree)	45°	30°	45°
Length of first (cm)	3.2	4.2	3.0
Length of fourth (cm)	8.4	7.0	4.6
Texture	Ribbed, mildly hirsute	Slightly hirsute	Mildly hirsute
Color (RHS) ^z	Green 138A	Green 138B	Viridian Green 55/3
Reproductive organs (androecium–disc florets):			
Anther color (RHS) ^z	Yellow Orange 21B	Yellow Orange 21B	Canary Yellow 2/1
Pollen quantity	Abundant	Abundant	Abundant
Pollen color (RHS) ^z	Yellow Orange 21A	Yellow Orange 21B	Buttercup Yellow 5
Reproductive organs (gynoecium–ray florets):			
Style color (RHS) ^z	Yellow Orange 7A	Yellow Orange 7B	Buttercup Yellow 5/2
No. ovules/flower	≈192	≈251	≈152
Seed size, length (cm)	≈0.2–0.5	≈0.2–0.5	≈0.2–0.5
Seed size, width (cm)	≈0.1–0.2	≈0.1–0.2	≈0.1–0.2

^zRoyal Horticultural Society (RHS) Color Group Codes: Mammoth™ ‘Red Daisy’, Mammoth™ ‘Coral Daisy’ (Royal Horticultural Society, 1995); Mammoth™ ‘White Daisy’ (Royal Horticultural Society, 1986).

^yNumber of weeks of short days (SD) required for complete flower bud development.



Fig. 5. Second year growth of Mammoth™ ‘White Daisy’ plants (0.6 m O.C.) provides a bright contrast with dark-flowered herbaceous perennials such as *Agastache* ‘Blue Fortune’. Bar = 1.0 m. Photo credit: Neil Anderson.

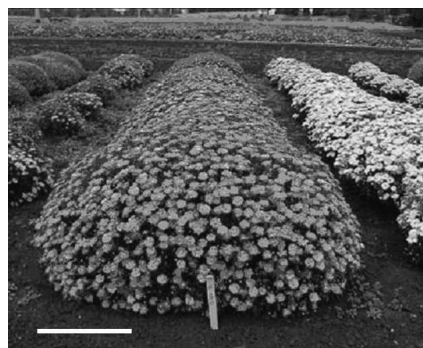


Fig. 6. Fourth year growth of Mammoth™ ‘Coral Daisy’ plants at flowering, planted 1.3 m O.C. Bar = 0.6 m. Photo credit: Neil Anderson.

(>10,000; Table 1) among these three cultivars attests to the immense plant growth exhibited by Mammoth™ ‘Coral Daisy’. Interestingly, the leaf length is also the longest of all three cultivars (Table 1).

Winter survival of Mammoth™ ‘Coral Daisy’ in open fields is similar to the other Mammoth™ cultivars with a grand mean percentage of winter survival of 84.7%, pooled mean values ranging from 67.5% (2003) to 100% (2002; Table 2). A high number of mean emergent rhizomes in first-year crowns ($n = 80.7$; Anderson and Gesick, 2004)—nearly identical to Mammoth™ ‘Red Daisy’. Mammoth™ ‘White Daisy’—was also predictive of winter survival. Mammoth™ ‘Coral Daisy’ had the highest mean fresh weight of crowns (345.5 g; Anderson

and Gesick, 2004) of all three Mammoth™ cultivars. These data have led to the classification of Mammoth™ ‘Coral Daisy’ as a U.S. Department of Agriculture Z3b herbaceous perennial.

Mean flowering response group for Mammoth™ ‘Coral Daisy’ is 5.5 weeks of short days (Table 3); field flowering normally occurs in early September, classifying this cultivar as midseason. As its name suggests, Mammoth™ ‘Coral Daisy’ flowers have a coral color (orange red 35C-D ray floret colors at maturity on both sides of the petals; Table 3). The triplex-quadruplex daisy flowers have ≈60 ray florets/inflorescence and the highest number of disc florets/inflorescence (≈191) of any cultivar (Table 3). The quantity of flowers/plant is the highest (≈6000; Table 3) of all three cultivars, most likely because of the immense plant size.

Culture

All three Mammoth™ cultivars are vegetatively propagated clones (using stem tip cuttings) and can be produced commercially for spring (Mother’s Day) or fall sales using standard protocols (Ball, 1985; Langevin, 1992; Widmer, 1980). Stem tip cuttings root in 1.5 weeks under mist propagation after a treatment with 1000 ppm indole butyric acid in 70% EtOH (N.O. Anderson, unpublished data). In addition to standard container sizes, Mammoth™ cultivars may be grown from overwintered, field-grown crowns or containerized stock plants and then transplanted into large containers (≥1.33 ft³) or balled and burlaped (Fig. 7) to demonstrate the shrub habit in point of purchase or end-cap sales promotions. Likewise, large containerized or balled and burlaped plants can be planted directly into landscape for an “instant” mature plant form.

Full sun exposure is the optimum growing condition for the Mammoth™ cultivars. When grown in partial sun conditions, weak stems may lodge easily in wind/rain storms, stems will be taller, and flowering may be delayed or eliminated altogether (Ascher, et al., 1997a; Langevin, 1992; Widmer, 1980). Mammoth™ cultivars respond favor-



Fig. 7. A balled and burlaped 2-year-old Mammoth™ ‘Red Daisy’ plant ready for use in instant landscaping or sales promotions to demonstrate the large “shrub” habit. Bar = 1 m. Photo credit: Neil Anderson.

ably to fertilizer applications, which should commence as soon as emergent rhizomes begin elongation in the spring and should continue throughout the growing season. These cultivars are heavy feeders and it is recommended that growers, landscapers, and home gardeners apply N at the high end of the recommended rates to maximize plant growth to create large shrub plants (1361g/30.48m² 5–20–20 preplant or 300 ppm N 20–10–20 weekly postplant soluble fertilizer applications; Meyer, et al., 2007).

Because of the presence of daisy flowers with numerous disc florets containing pollen, all Mammoth™ cultivars attract butterflies. The Mammoth™ cultivars are low-maintenance herbaceous perennials and landscape plantings and do not require pinching in the spring or shearing to achieve the cushion plant habit (Anderson, 2006; Ascher, et al., 1997). The cushion plant habit will be created by genetic “self-pinching,” which causes branching, similar to the “Minn” series of garden chrysanthemums (Anderson and Ascher, 2001).

Because all three Mammoth™ cultivars are winter-hardy herbaceous perennials and achieve their full plant size only in the second and subsequent years, commercial and home gardener consumers will have an added benefit from planting these into the ground. This differs from many nonwinter-hardy garden mum cultivars, which are treated as annuals and are destroyed at the end of the growing season (Anderson, 2006). Spring planting is recommended for these cultivars to maximize plant growth, crown establishment, and emergent and nonemergent rhizome production for the second year when the plants attain their shrub stature. Although these may be planted in the fall season, they will not establish as well as spring-planted genotypes for maximum second-year performance. Fall plantings are recommended to occur no later than in the month of September in northern latitudes; all crowns should be mulched to minimize frost heaving during winter months. In an experiment (1998–1999 winters), all three cultivars overwintered (100% survival) when planted in late October in U.S. Department of Agriculture Z5 (N.O. Anderson, unpublished data); survival in more northerly latitudes may be less likely, although this has not been tested.

Although the winter-hardiness performance data reported herein (Table 2) reflects the “toughest” outdoor growing conditions, i.e., bare, unmulched, and open ground, we recommend that landscapers and home gardeners use mulch to protect the crowns to maximize winter survival (Anderson, 1999, 2006; Ascher, et al., 1997a; Marcinkowski and Robak, 1981; Widmer, 1980). In years where less than adequate snowfall in northern latitudes occurs, it is recommended that the dead, aboveground plant material not be removed after a killing freeze in the fall. Instead, it is better for the material to be left in place during the winter months, thereby acting as a “snow fence: to hold additional snow cover around the crown of each plant



Fig. 8. A “snow fence” creating drifts of snow over the crown of Mammoth™ ‘White Daisy’ (lower portion of photo). The previous years’ stems are not removed until spring and, thus, aid in creating additional insulation to promote winter survival in northern latitudes with less than adequate snowfall.

(Fig. 8; Kim and Anderson, 2006). The remaining aboveground plant material should be removed in the spring before shoot emergence of the next year’s growth.

In southern latitudes with warmer winter climates, Mammoth™ cultivars will overwinter as nondormant, green plants. In Florida, Texas, and California, the Mammoth™ cultivars have flowered two times a year—once in the early spring (May–June) and, after cutback to the ground, again later in the fall growing season (September to November; data not shown). Because winter survival data (Table 2) are based on minimum cold temperatures, overwintering in southern latitudes may be confounded with other biotic and abiotic factors, e.g., moist and heavy soil conditions, adequate hardening off periods before low temperature exposures, premature foliage losses, secondary invasion by disease organisms, and frost heaving (Anderson and Gesick, 2004; Widmer, 1958).

Availability

All three cultivars were originally released in the My Favorite™ chrysanthemum series branded trademark under the auspices of an exclusive worldwide license agreement with Ball Horticulture Co. (622 Town Road, W. Chicago, IL, 60185; www.ballseed.com). The My Favorite™ series was first marketed by the My Favorite Company, LLC, under a Joint Venture Agreement between Ball Horticultural Company and Anthony Tesselaar International Pty. Ltd. (A.B.N. 90 105 245 494, 327 Monbulk Road, Silvan, Victoria 3795 Australia; www.tesselaar.com). Later, Anthony Tesselaar International exclusively marketed the My Favorite™ chrysanthemums as part of the Tesselaar line.

Currently, rooted or unrooted certified (virus indexed) cuttings of all Mammoth™ cultivars are available in North America from Ball Seed Company. Ball Seed Company has an exclusive license with the University of Minnesota to propagate and distribute

certified, disease-free propagules of these cultivars.

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