Mammoth™ ‘Yellow Quill’ Garden Chrysanthemum

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Mammoth™ ‘Yellow Quill’ (U.S. Plant Patent 15,027; Canadian Plant Breeders’ Rights Certificate No. 2951) is a new interspecific garden chrysanthemum cultivar, *Chrysanthemum ×hybridum* Anderson (= *Dendranthema ×hybrida* Anderson) with common names of

hardy mum, chrysanthemum, and garden mum. It is a new and distinct form of shrub-type garden mum in the Mammoth™ series with spoon-shaped ray florets, frost-tolerant flower petals, self-pinching growth, and

serves as a butterfly attractant in the garden. Mammoth™ ‘Yellow Quill’ is a winter-hardy herbaceous perennial in USDA Zones 4–9 with its cushion growth form displaying extreme hybrid vigor, increasing in plant height from 0.46 m in its first year to a shrub of 0.84–1.07 m in the second year, and thereafter with greater than 3000 leaves/plant. Flowering is prolific, covering the entire plant at full flowering and sporting as many as greater than 3500 flowers in Year 2.

Origin

Mammoth™ ‘Yellow Quill’ (Minnesota Sel’n. No. MN98-M91-1; U.S. Plant Patent 15,027; Canadian Plant Breeders’ Rights Certificate No. 2951) is a descendant of the 1989 open-pollinated interspecific cross No. 90-287 (Anderson et al., 2008) 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) (Fig. 1). To distinguish these unique interspecific hybrids, which exhibit shrub-like growth in Year 2 onward, from classic garden and/or greenhouse chrysanthemums [*Chrysanthemum ×grandiflorum* Tzvelv. (= *Dendranthema ×grandiflora* Tzvelv.)] that have smaller and consistent plant sizes regardless of plant age, all such selections have been taxonomically designated *Chrysanthemum ×hybridum* Anderson (= *Dendranthema ×hybrida* Anderson) (Anderson et al., 2004, 2008). Hybrid genotype Mn. Sel’n. 90-287-185 was crossed (as male) with Mn. Sel’n. No. 90-275-27 as female (PP 14,749) in 1994 to produce cross No. 95-332. Plant no. 3 (95-332-3) from that cross was hybridized (open-pollinated) with ‘Centerpiece’ (male; with spoon ray florets; Anderson et al., 2001; Widmer et al., 1981) in 1997 to produce Sel’n. No. MN98-M91-1. Stem tip cuttings of Mammoth™ ‘Yellow Quill’ were rooted in 1999 and thereafter with all vegetative generations having stable expression of selected traits. This genotype was selected in trials during 2000 at Morris, MN, Agric. Experiment Station field trials with the shrub-type habit

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

Fig. 1. Pedigree of *Chrysanthemum ×hybrida* Mammoth™ ‘Yellow Quill’.

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Chemical named used: ethanol (EtOH), indole-3-butyric acid (IBA)

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Fig. 2. Flowering, clonally propagated *Chrysanthemum xhybrida* Mammoth™ 'Yellow Quill' grown in liners from stem-tip cuttings displaying the yellow, spoon ray florets. Plants of this size are sold in the spring, typically for Mother's Day, for planting directly into the garden. Bar = 10 cm.

(Anderson et al., 2008) and yellow spoon ray florets (Fig. 2). It is now protected with a U.S. Plant Patent (PP 15,027; Anderson, et al., 2004) and Canadian Plant Breeder's Rights (Certificate No. 2951; Strauss, 2007) certificates.

Description

Morphological traits for characterization of Mammoth™ 'Yellow Quill' were based on plants produced from rooted, vegetative tip cuttings treated with 1000 ppm indole-3-butyric acid (IBA) in 50% ethanol (EtOH), placed in Oasis wedges (Smithers-Oasis, Kent, OH), and kept under intermittent mist at 21 °C day/night (soil). These rooted in 1 week, whereupon they were transplanted and grown under greenhouse conditions (lat. 45° N, St. Paul, MN) for 4 weeks vegetative growth (long days, 0800–1600 HR supplied by 400-W high-pressure sodium lamps + 2200–0200 HR night interruption; 18.5/22.0 °C day/night) followed by 6 weeks short days [8 h (0800–1600 HR) supplied by 400-W high-pressure sodium lamps; black cloth pulled closed at 1600 HR and opened at 0800 HR; 18.5/22.0 °C day/night]. Plants were grown in 15.2-cm (diameter) black plastic standard containers (Belden Plastics, St. Paul, MN) in Sunshine LC8 Professional Growing Mix (Sun Gro Horticulture, Seattle, WA); standard fertilization and fungicide drenches were followed (Langevin, 1992).

Determination of phenotypic coloration of aboveground plant parts involved use of the Royal Horticultural Society (RHS) Color Chart (Royal Horticultural Society, 1995). Colors were determined on 18 Jan. 2001, between 1300 and 1500 HR, under 500 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ of light.

This cultivar displays a cushion plant shape (Table 1) after planting in fields and gardens; this is maintained for the life of the plant. Like with other cultivars in the Mammoth™ series (Anderson et al., 2008), Mammoth™ 'Yellow Quill' exhibits vigorous growth such that in Year 2 and thereafter,

Table 1. Comparative plant characteristics of *Chrysanthemum xhybrida* Mammoth™ 'Yellow Quill' grown with *C. xgrandiflora* 'Yellow Sandy' (Anderson et al., 2004) or *C. xgrandiflora* 'Golden Star' (Strauss, 2007).^z

Plant characteristic	Mammoth™ 'Yellow Quill'	'Yellow Sandy'	'Golden Star'
Plant shape	Cushion	Cushion	Upright
Plant height			
Year 1	0.46 m	0.46–0.61 m	0.26 m
Year 2	0.84–1.07 m	—	0.35 m
Flowering response group			
No. weeks short days	6.0	7.0	6.5
Flower type	Single, daisy spoon	Duplex–triplex daisy	Single, daisy spoon
Flower diameter	8.3 cm	7.0 cm	6.1 cm
Ray florets (mature), color			
Adaxial surface	RHS yellow group 3C	RHS yellow group 5A	RHS yellow group 6A
Abaxial surface	RHS yellow group 5C	RHS yellow group 5A	RHS yellow group 7D

^zQuantitative traits are mean values based on 10 replications.

^yPlants did not survive the winter in USDA Zones 3 to 4.

RHS = Royal Horticultural Society.

it attains the shrub plant habit of 0.84–1.07 m in height (Table 1) compared with Year 1 plant height of 0.46 m (Table 1). Lateral branches (one/node) initiate without removal of the apical meristem (pinching), reaching a mean length of ≈ 36.8 cm. Younger stems have coloration of RHS grayed purple 183B, whereas older ones classify as RHS yellow–green group 152A.

The number of leaves/lateral branch ranges from five to 19 with alternate phyllotaxy (one leaf/node). In Year 2, there are an average of greater than 3000 leaves/plant (based on actual counts) (Anderson et al., 2004). Fully expanded leaves average 7.4 cm $\times$ 4.4 cm (length $\times$ width) ending in a trimucronulate apex, possessing an auriculate leaf base with incised leaf margins (*Morus*-like shape) and a fairly glaucous surface. Mean petiole lengths are 3.1 cm. Young foliar coloration is RHS green group 137B (adaxial surface) and 137C (abaxial), changing to 137A (adaxial) and 147B (abaxial) on maturity. Leaf venation in mature leaves ranges from RHS yellow–green group 147C (adaxial) to 148B (abaxial), whereas the petiole is uniformly RHS yellow–green group 148B.

Phyllaries (involucral bracts) are crenulate with a glabrous texture, ranging from 0.2 to 0.4 cm in length and uniformly in the RHS green group 137A. The inflorescence is a composite (Asteraceae) of numerous disc and ray florets and is classed as a single daisy quill or spoon (one row of ray florets that are primarily quilled, but occasionally spooned, i.e., quill tubular florets with flattened tips). Mammoth™ 'Yellow Quill' flowering is classified with a 6-week short-day response group (Table 1) with ≈ 500 and greater than 3500 inflorescences (mean) in Years 1 and 2, respectively. Flower longevity of 2 to 4+ weeks in the field is temperature-dependent. Flower petals are frost-tolerant (Anderson et al., 2004).

Opening inflorescences have upright, twisted petals with a mean bud size of 2.5 $\times$ 1.4 cm (length $\times$ width) and RHS yellow group 5C coloration. When completely open, inflorescences are 8.3 cm (diameter) $\times$ 1.7 cm (depth), whereas the discs are 1.5 cm (diameter). Ray florets (mean of 36.6/inflorescence but ranging

as high as 60) have a tubular quill petal (rolled) often with a flattened end or "spoon" (glabrous; 3.9 $\times$ 0.4 cm) with biretuse apices, attenuate bases, rolled (entire) margins, and positioned at $\approx 45^\circ$ angle to the stem axis. Ray florets (gynocious) during elongation (opening) are RHS Yellow Group 3A and 4B, whereas those at anthesis or maturity are 3C and 5C for adaxial and abaxial surfaces (Table 1), respectively. There is 1 ovule each/ray and disc floret. Ray florets fade in color to RHS yellow group 3C.

Disc florets (hermaphroditic) are tubular with a rounded tip, 0.5 $\times$ 0.1 cm (length $\times$ width) with a mean of 115/inflorescence. Immature disc florets are RHS yellow group 4C in color, changing to RHS yellow–orange group 15A on maturity (pollen dehiscence). Hirsute peduncles are RHS green group 131C in color, held stiffly at a 45° angle to the stem, with lengths of 3.3 cm (first) to 4.9 cm (fourth). Anthers and trinucleate pollen are both colored RHS yellow–orange group 16A, whereas the styles are RHS yellow group 11D.

The dry, indehiscent fruit is an achene with a single seed and lacks a pappus of awns for bristles. A half-inflated football, oval shape, and ridged texture characterizes the shape of each achene. Mature seeds are 0.2–0.5 cm $\times$ 0.1–0.2 cm (length $\times$ width) with RHS brown group 200D color.

Two comparative trials were conducted with Mammoth™ 'Yellow Quill' vs. 'Yellow Sandy' or 'Golden Star'. Colors were determined on 18 Jan. 2001 and 27 Sept. 2006 for comparison with 'Yellow Sandy' and 'Golden Star', respectively. When Mammoth™ 'Yellow Quill' is grown in comparison with 'Yellow Sandy' (PP 8,759), both have cushion plant shapes and similar plant height in Year 1 (Table 1). 'Yellow Sandy' did not survive into Year 2, whereas Mammoth™ 'Yellow Quill' developed a shrub habit (Table 1). Mammoth™ 'Yellow Quill' has a 1 week earlier short-day response group, larger flower diameters, and differing ray floret types. 'Yellow Sandy' had RHS yellow group 5A coloration on both adaxial and abaxial mature ray floret surfaces, whereas Mammoth™ 'Yellow Quill' was groups 3C and 5C, respectively (Table 1).

Table 2. Test sites, geographic locations, U.S. Department of Agriculture (USDA) plant hardiness zones, and mean percent winter survival of Mammoth™ ‘Yellow Quill’ over multiple trial locations in Minnesota, Wisconsin, and West Virginia.^z

Test sites	Latitude	Longitude	USDA plant 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		80.0			100.0		0.0		25.0
Lamberton, MN	44.23111° N	95.26389° W	4b		70.0		100.0	100.0				
Morris, MN	45.62820° N	95.88908° W	3b/4a		100.0		100.0	10.0	80.0	100.0	77.8	
St. Paul, MN	44.98776° N	93.13700° W	4a	66.7		33.3		0.0	100.0			66.7
Waseca, MN	43.90669° N	93.43338° W	4b		80.0	90.0		40.0		100.0	40.0	
Verona, WI	43.06048° N	89.52742° W	5a		55.6		50.0					
Institute, WV	38.41981° N	81.8339° W	6a						30.0	37.5		
Grand mean				66.7	77.1	61.6	83.3	50.0	70.0	59.4	58.9	45.8

^zData were collected in the spring (April to May) of each listed year. Years with adequate snow cover are noted in **bold**. There were 10 replications (clones) per site per year; blanks indicate the genotype was not planted at a particular location during that year.

^yLow air temperature ranges: Zone 3b (−34.4 °C to −37.2 °C), 4a (−31.7 °C to −34.4 °C), 4b (−28.9 °C to −31.7 °C), 5a (−26.2 °C to −28.8 °C), and 6a (−20.6 °C to −23.3 °C) (<<http://www.usna.usda.gov/Hardzone/hzm-ne1.html>>).

Comparative growth of Mammoth™ ‘Yellow Quill’ with ‘Golden Star’ (an earlier University of Minnesota release)—both of which are single, daisy spoons with rolled quill tubular florets—show that the two cultivars differ in plant habit (cushion vs. upright, respectively; Table 1). Plant height of ‘Golden Star’ is significantly shorter than Mammoth™ ‘Yellow Quill’ in Years 1 to 2 (Table 1), whereas the short-day flowering response groups are similar (6.5 vs. 6.0, respectively). Mammoth™ ‘Yellow Quill’ has wider leaves, less ray florets, with a lighter yellow color and deeper lower lobe sinuses than ‘Golden Star’ (Strauss, 2007).

Winterhardiness of Mammoth™ ‘Yellow Quill’ is classified for USDA Zones 4 to 9 with marginal survival in USDA Zone 3 (Anderson et al., 2004). Snow cover throughout the winter period is required for adequate survival of Mammoth™ ‘Yellow Quill’ (Table 2). We evaluated garden performance and winter survivorship during 2000 to 2008 at seven sites in USDA Zones 3b (Grand Rapids, MN), 3b/4a (Morris, MN), 4a (St. Paul, MN), 4b (Lamberton, MN; Waseca, MN), 5a (Verona, WI), and 6a (Institute, WV), although not all sites had Mammoth™ ‘Yellow Quill’ planted each year (Table 2). All trials were conducted in open field or garden plots without protective mulch or covering. In years with adequate snow cover (2000–01, 2003, 2005–07, Table 2), winter survival was higher, ranging from 30% (2005, Institute, WV) to 100% (2001, Morris MN; 2003, Lamberton and Morris, MN; 2005, St. Paul, MN; 2006, Morris and Waseca, MN). Grand means for each year ranged from 45.8% (2008) to 83.3% (2003) (Table 2).

Propagation and Production

Asexual propagation is necessary to ensure the morphological traits are firmly fixed. Mammoth™ ‘Yellow Quill’ is vegetatively propagated through herbaceous stem tip cuttings, which root in 1 week under mist or fog propagation after treatment with 1000 ppm IBA in 50% EtOH (Anderson et al., 2008). Plants can then be programmed to flower by potting in a high-porosity soilless medium,

3- to 4-week long days for vegetative growth (0800 to 1600 HR + 2200 to 0200 HR night interruption lighting) at 18.5/22.0 °C day/night followed by 6 weeks short days [8 h (0800–1600 HR); black cloth pulled closed at 1600 HR and opened at 0800 HR], 18.5/22.0 °C day/night, and standard fertilization, e.g., 300 ppm N 20–10–20 weekly liquid feed based on weekly soil tests, and monthly fungicide drench rotations (Langevin, 1992).

Mammoth™ ‘Yellow Quill’ is a facultative short-day plant (Anderson et al., 2004). This cultivar may be grown for spring bedding plant sales (Mother’s Day) in liners (Fig. 2). After consumers enjoy the flowers in May, the liners are planted in the garden or containers for subsequent regrowth and fall flowering (Fig. 3; Anderson et al., 2008; Langevin, 1992). Mammoth™ ‘Yellow Quill’ may also be grown outdoors in “mum pans” to form flowers under naturally shorter day-lengths for sale as larger plants in the fall. If either type is overwintered, the plants will display the shrub habit in Year 2 and onward (Fig. 4).

To maximize summer growth potential, both in containers and direct-planted, full sun is required along with intensive fertilization and irrigation (Anderson, 2006; Anderson et al., 2008). Mammoth™ ‘Yellow Quill’ is classified as a “heavy” feeder requiring as much as 1361 g/30.48 m² of 5–20–20 pre-plant fertilizer or weekly 300 ppm N 20–10–20 postplant soluble fertilization (Anderson et al., 2008).

Use

All Mammoth™ garden chrysanthemums are notably winter-hardy herbaceous perennials that are butterfly attractants and frost-tolerant. Mammoth™ cultivars have standard plant dimensions in the first year (Anderson et al., 2001) but achieve shrub status in Year 2 (Anderson et al., 2004, 2008). The Mammoth™ series is a collection of low-maintenance perennials resulting from their genetic “self-pinching,” removing the necessity to hand or mechanically pinch terminal shoots in mid-summer to form the cushion habit (Anderson et al., 2008). Mammoth™ ‘Yellow Quill’ may be grown as a specimen shrub within the

Fig. 3. Natural flowering of *Chrysanthemum × hybrida* Mammoth™ ‘Yellow Quill’ under naturally occurring short days in Year 1. Bar = 10 cm.

Fig. 4. Year 2 flowering plant size of overwintered *Chrysanthemum × hybrida* Mammoth™ ‘Yellow Quill’ demonstrating the shrub habit. Bar = 1 m.

garden in Year 2 (Anderson, 2006) but should be spaced as much as 1 m away from adjacent plants. This cultivar may also be grown as a flowering hedge, spacing the plants 0.3–0.6 m on center. Likewise, Mammoth™ ‘Yellow Quill’ is well-suited for large container plantings in landscapes, providing fall color at eye level.

Availability

Mammoth™ ‘Yellow Quill’ (U.S. Plant Patent 15,027; Canadian Plant Breeders’ rights Certificate No. 2951) 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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