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*Full Length Research Paper*

# Performance of 40 poinsettia cultivars grown under two different temperatures

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**This study evaluated forty poinsettia cultivars to determine which cultivars perform well under cool growing temperatures. Poinsettias were grown in separate greenhouses at temperatures of 20°C during the day and 17°C at night for cold production, or 25°C during the day and 22°C at night for warm production. Number of lateral shoots leading to inflorescences, number of bracts, canopy diameter, and stem diameter was determined. A significant (P= 0.03) cultivars by greenhouse temperature interaction existed for all parameters measured. Cultivars were then separated into classes based on greatest values for each trait. Poinsettia cultivars with the largest stem diameter in both warm and cold production systems included '39-02B', '7-07', 'Classic™ White', and 'Enduring™ Red'. Poinsettia cultivars 'HC-18B', 'Winter Blush', 'Cortez™ Burgundy, 'Winter Rose™ Early Red', '7-07', 'Silverstar™ Red', 'Topez'™, 'Classic™ Red', 'Enduring™ White', Novia™ Red', Advent™ Red', 'Silverstar™ Marble', and '1232' had high bract numbers in both warm and cold production. Only one cultivar, '1266', produced a large number of lateral inflorescences in both production systems. Poinsettia cultivars 'Classic™ White', 'Mira™ White', 'Novia™ Red', Early 'Orion™ Red', 'Mars'™ Pink', and 'Enduring™ Red' had larger canopy diameters when grown in cool temperatures than under warmer conditions.**

**Key words:** Greenhouse production, temperature, *Euphorbia pulcherrima*, plant physiology, plant architecture.

## INTRODUCTION

Poinsettias are greenhouse-grown using a precise schedule under specific horticultural conditions and practices to produce crops of uniform size and quality (Fisher et al., 1996). According to the most recent floricultural crop survey, poinsettias represent an industry valued at over $154 million (USDA 2009). The popularity of this traditional holiday plant has been sustained by releasing new poinsettia cultivars with improved post-harvest life, growth habits, color patterns, and varying maturity dates. Profit margins are small for poinsettia production due to the number of inputs required to produce a quality crop. The two most significant costs associated with poinsettia production are labor and energy (Williams, 2007).

Energy conservation is achieved by increasing facility insulation, starting production later, consolidating production, installing energy curtains, contracting fuel, or switching to alternative fuel sources; however, the strategies may require substantial investments in time, costs, and include certain risks. A simple solution would be to decrease the growing temperatures (Lopez, 2008). It is possible to grow quality poinsettias with less energy (cooler temperatures) using cultivars adapted to such conditions. Syngenta Flowers and Paul Ecke Ranch, both with poinsettia breeding programs, provide cold growing cultivar recommendations for cultivars that perform well under cool growing conditions (Ecke, 2008; Syngenta, 2009).

Benefits of growing cool temperature tolerant poinsettias include, cost savings on energy, less need for plant growth regulators and insecticides, more intense bract color, more compact plants that are more durable in shipping, and earlier developing cultivars may be sold later in the season along with longer developing varieties grown under normal warmer production (Lang, 2009). Lopez (2008) reported that growers in the north and on the east coast could potentially save between 24 and

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52% on energy costs by growing at 18/14°C (65/57°F) compared to 24/19°C (75/67°F) for daytime and nighttime temperatures, respectively; however, Faust et al. (2009) reported that due to increased production time associated with cooler growing, actual savings is cultivar and market date dependent.

Grower specific information, on plant growth using cooler temperatures throughout production, is not readily available. The present study was conducted to determine the effect of growing 40 different poinsettia cultivars under cold and warm production temperatures. The goal of this research was to determine cultivars that would lend themselves to a reduced energy production program, that would reduce costs associated with production and ultimately increase profitability.

## MATERIALS AND METHODS

Twenty-three trial poinsettia cultivars were received from Paul Ecke Ranch (Encinitas, CA, U.S.A.) on 8 August 2009. The 23 cultivars from Ecke Ranch consisted of eight reds (‘Prestige™ Red’, ‘Advent™ Red’, ‘Enduring™ Red’, ‘Prestige™ Early Red’, ‘Classic™ Red’, ‘Freedom™ Early Red’, ‘1232’); six whites (‘Polar Bear’, ‘Classic™ White’, ‘Enduring™ White’ and ‘Freedom™ Early White’, ‘1266’, ‘7-07’); three pinks (‘Classic™ Pink’ and ‘Polly’s Pink’™, ‘HC-18b’); one marble (‘Winter Blush’); six specialty cultivars (‘Winter Rose™ Early Red’, ‘Freedom™ Peppermint’, ‘Orange Spice’™ and ‘Ice Punch’, ‘146-06’, ’39-02b’), as well as six unnamed selections labeled: ‘HC-18b’, ‘146-06’, ‘1232’, ’39-02b’, ‘1266’’ and ‘7-07’. Seventeen different trial poinsettia cultivars were received from Syngenta Flowers Inc. (Boulder, CO, U.S.A) on 17 August, 2009. The poinsettias from Syngenta included: eight reds (‘Silverstar™ Red’, ‘Orion™ Red’, ‘Early Orion™ Red’, ‘Mira™ Red’, ‘Cortez™ Red’, ‘Sonora™ Red’, ‘Mars™ Red’ and ‘Novia™ Red’); three white cultivars (‘Sonora™ White’, ‘Mira™ White’ and ‘Mars™ White’); one pink (‘Mars™ Pink’); two marble (‘Silverstar™ Marble’ and ‘Mars™ Marble’); and three specialty cultivars (‘Cortez™ Burgundy’, ‘Topaz’™ and ‘Cinnamon Star™’). All cuttings were rooted in wedge-shaped foam plugs prior to shipping, and were placed under intermittent mist (16 s every 32 min) until transplanting on 19 August, 2009.

Cuttings were transplanted into 15.2 cm Elite Azalea Pots (ITML Horticultural Products, Middlefield OH) filled with Metro Mix 702 media (SunGro Horticulture Distribution Inc., Bellevue, WA). Each poinsettia cultivar was then divided into two equal groups. The first group was placed in a greenhouse with a night temperature of 17°C and a daytime temperature of 20°C [average daily temperature (ADT) of 18°C]; whereas, the second group was placed in a greenhouse with a night temperature of 22°C and daytime temperature of 25°C (ADT of 24°C). Poinsettias were grouped by cultivar and spaced 25.4 to 38.1 cm apart. Poinsettias were grown in the Oklahoma State University research greenhouses, which have fiberglass, semi-translucent walls and a clear polycarbonate roof, at Stillwater, Oklahoma.

No supplemental lighting was used during the 18 week study. Plants were fertigated as needed with non-pressure compensated 0.2 cm inside diameter on/off drip tube-weight emitters (Chapin Watermatics Inc. Watertown, NY) until media was saturated. One emitter with a flow rate ranging from 0.3 to 0.4 L per minute was placed in each pot. Plants were fertilized at each irrigation with 100 ppm 13N-2P-13K (Peter’s Excel® 13N-2 $P_2O_5$-13 $K_2O$, +6% Ca +3% Mg, Plug Special Basic Fertilizer, Scotts-Sierra Horticultural Products Co.; Marysville, OH).

On 16 September, 2009, all poinsettias were pinched to 5 nodes. The pH and EC were recorded weekly. The pH was high (average < 6.50) and EC was low (average 1.4 $dS \cdot m^{-1}$). So fertilizer was changed to apply 250 ppm 20N-10P-20K (Jack’s Professional® General Purpose 20N-10$P_2O_5$-20$K_2O$ acidic fertilizer, J.R. Peters Inc., Allentown, PA). On 22 September 2009, cultivars were treated once with 1 L magnesium sulfate, 0.1 L Soluble Trace Element Mix (J.R. Peters Inc., Allentown, PA) and ½ g molybdenum, mixed into 19 L of 250 ppm N 20N-20P-20K (Peter’s Excel® General Use 20N-20$P_2O_5$-20$K_2O$ fertilizer, J.R. Peters Inc., Allentown, PA). Two days later, all plants received a drench of 750 ppm B-9 (Fine Americas Incorporated, Walnut Creek, CA) and 750 ppm Cycocel (OHP industries, Mainland, PA). Insecticide treatments of either TriStar WPS 70 (Cleary Chemicals Company, Dayton, NJ) or a mixture of Enstar II (Wellmark International, Schaumburg, IL) and Mavrik (Wellmark International, Schaumburg, IL) were applied every 14 days starting 7 September 2009. Poinsettias were treated with a mixture of 2 g/L calcium chloride mixed with 30 mL of a Spread-It (Parkway Research Corp., Houston, TX) sticker spreader occurring weekly starting on 9 November, 2009.

Data collection consisted of the number of lateral shoots producing inflorescences, diameter (mm) of the tallest shoot at the median position of the main stem, the total number of bracts (that either started or had changed color) on the tallest shoot, and canopy diameter (cm) determined as the average of two measurements taken at the widest and narrowest diameter on 7 December, 2009.

Each poinsettia species was analyzed separately using a completely randomized design with six plants per cultivar as experimental units. All data were analyzed using PROC MIXED or PROC GLIMMIX of SAS (version 9.2; SAS Institute, Cary, NC). Fixed effects in the analyses were cultivar and growing temperature. The MIXED procedure was used for the continuous variables (and a normal distribution was appropriate), and the GLIMMIX procedure was used to model the discrete random variable responses using a Poisson distribution. Dunnett's multiple comparison method was used to determine a best treatment combination group, maximizing the response variables since a higher number was considered more favorable.

## RESULTS AND DISCUSSION

A significant ($P< 0.03$) interaction occurred between cultivars and greenhouse temperatures for all measured traits. ‘HC-18B’ had the greatest number of bracts in both warm and cold production (Table 1), though bract size was nearly a quarter to a third of the size of a traditional bract. Bracts are modified leaves that are the showy part of the plant, and vary in number, size, and color among cultivars (Ecke et al., 2004). Bract size is heavily influenced by growing temperature, especially during bract expansion (Tsujita and Craig, 1980; Albrecht and Ladd, 1984). Poinsettia cultivars ‘1232’, ‘7-07’, ‘Advent™ Red’, ‘Classic™ Red’, ‘Enduring™ White’, ‘Novia™ Red’, ‘Silverstar™ Marble’, ‘SilverStar™ Red’, ‘Topaz™’, ‘Winter Blush’, and ‘Winter Rose™ Early Red’ had a large number of bracts in both warm and cool production systems (Table 1). Within this same group, ten cultivars grown under cool production temperatures, had more bracts than the same cultivar grown under warmer temperature (Table 1). Sink and Carlson (1970) reported an increase in the number of bracts of poinsettia cultivar ‘Stoplight’ when grown at 16 or 18°C than at 21°C. Bract color was delayed by as many as nine days for ‘146-06’ under cool production, but the other cultivars displayed first color within two days in either warm or cool production (data not shown).

**Table 1.** Poinsettia cultivars grown under warm and cold production temperatures with the highest number of bracts on the tallest shoot.

| Variety | Company | Greenhouse* | Bract number** |
|---|---|---|---|
| HC-18B*** | Ecke | Warm | 40.7 |
| HC-18B*** | Ecke | Cool | 37.0 |
| Winter Blush**** | Ecke | Cool | 23.7 |
| Cortez™ Burgundy | Syngenta | Warm | 21.7 |
| Classic™ White | Ecke | Cool | 21.7 |
| Cortez™ Burgundy | Syngenta | Cool | 21.7 |
| Early Orion™ Red | Syngenta | Cool | 21.3 |
| Mira™ White | Syngenta | Warm | 21.0 |
| Winter Rose™ Early Red | Ecke | Warm | 20.8 |
| 7-07 | Ecke | Cool | 20.3 |
| 7-07 | Ecke | Warm | 20.3 |
| Mars™ Pink | Syngenta | Cool | 20.3 |
| Silverstar™ Red | Syngenta | Warm | 20.3 |
| Topez™ | Syngenta | Warm | 20.2 |
| Classic™ Red | Ecke | Warm | 19.8 |
| Enduring™ White | Ecke | Cool | 19.8 |
| Mars™ Marble | Syngenta | Warm | 19.8 |
| Sonora™ Red | Syngenta | Cool | 19.7 |
| Freedom™ Early White | Ecke | Cool | 19.2 |
| Novia™ Red | Syngenta | Warm | 19.2 |
| Advent™ Red | Ecke | Warm | 19.0 |
| Enduring™ Red | Ecke | Cool | 19.0 |
| Silverstar™ Marble | Syngenta | Warm | 19.0 |
| Silverstar™ Red | Syngenta | Cool | 19.0 |
| Winter Blush | Ecke | Warm | 18.8 |
| Winter Rose™ Early Red | Ecke | Cool | 18.8 |
| Mars™ Red | Syngenta | Warm | 18.8 |
| Enduring™ White | Ecke | Warm | 18.7 |
| Freedom™ Peppermint | Ecke | Warm | 18.7 |
| 1232 | Ecke | Cool | 18.3 |
| Classic™ Pink | Ecke | Warm | 18.3 |
| 146-06 | Ecke | Cool | 18.0 |
| 1232 | Ecke | Warm | 18.0 |
| Advent™ Red | Ecke | Cool | 17.8 |
| Classic™ Red | Ecke | Cool | 17.8 |
| Prestige™ Early Red | Ecke | Warm | 17.8 |
| Cortez™ Red | Syngenta | Cool | 17.8 |
| Polar Bear | Ecke | Cool | 17.5 |
| Topez™ | Syngenta | Cool | 17.3 |
| Sonora™ White | Syngenta | Warm | 17.2 |
| Novia™ Red | Syngenta | Cool | 17.0 |
| Mira™ Red | Syngenta | Warm | 17.0 |
| Prestige™ Red | Ecke | Warm | 16.8 |
| Silverstar™ Marble | Syngenta | Cool | 16.8 |
| Ice Punch | Ecke | Cool | 16.4 |

*Plants grown at either 65°F (18-19°C) during the day and 60°F (15-16°C) at night (cool); or plants grown at 75°F (23-24°C) during the day and 70°F (21-22°C) at night (warm).** Mean of six plants.*** In top class and was significantly greater (a =0.05) than all other cultivars.****Identifies the mean to which all cultivar with fewer bracts are compared using Dunnett's multiple comparison with this next "best" cultivar ($\alpha = 0.05$). Means listed below this in this table are not significantly different from this cultivar.

**Table 2**. Poinsettia cultivars grown under warm and cold production temperatures with the highest number of lateral shoots producing inflorescences.

| Variety | Company | Greenhouse* | Lateral shoots** |
|---|---|---|---|
| HC-18B*** | Ecke | Warm | 9.3 |
| Cortez™ Burgundy | Syngenta | Cool | 8.5 |
| 1266 | Ecke | Warm | 8.0 |
| Classic™ Pink | Ecke | Cool | 7.8 |
| 1266 | Ecke | Cool | 7.7 |
| Polar Bear | Ecke | Warm | 7.7 |
| Sonora™ White | Syngenta | Cool | 7.7 |
| Cortez™ Red | Syngenta | Warm | 7.5 |
| Mars™ Pink | Syngenta | Warm | 7.5 |

* Plants grown at either 65°F (18-19°C) during the day and 60°F (15-16°C) at night (cool); or plants grown at 75°F (23-24°C) during the day and 70°F (21-22°C) at night (warm).** Mean of six plants. *** Identifies the mean to which all varieties with smaller means are compared using Dunnett's multiple comparison with this "best" cultivar ($\alpha = 0.05$). Means listed in this table are not significantly different from this variety

**Table 3.** Poinsettia cultivars grown under warm and cold production temperatures with the largest stem diameter taken from the tallest shoot.

| Variety | Company | Greenhouse* | Mean (mm)** |
|---|---|---|---|
| 39-02B*** | Ecke | Warm | 6.9 |
| 7-07*** | Ecke | Warm | 6.9 |
| 39-02B | Ecke | Cool | 6.5 |
| 7-07 | Ecke | Cool | 6.4 |
| Enduring™ White | Ecke | Warm | 6.4 |
| Winter Rose™ Early Red | Ecke | Cool | 6.4 |
| Enduring™ Red | Ecke | Warm | 6.3 |
| Advent™ Red | Ecke | Warm | 6.2 |
| Classic™ White | Ecke | Cool | 6.0 |
| Enduring™ Red | Ecke | Cool | 6.0 |
| Classic™ White | Ecke | Warm | 5.9 |
| Silverstar™ Marble | Syngenta | Cool | 5.8 |
| Prestige™ Red | Ecke | Warm | 5.7 |
| Prestige™ Early Red | Ecke | Warm | 5.6 |
| Freedom™ Peppermint | Ecke | Warm | 5.5 |

* Plants grown at either 65°F (18-19 °C) during the day and 60°F (15-16 °C) at night (cool); or plants grown at 75°F (23-24°C) during the day and 70°F (21-22 °C) at night (warm).** Average of six plants.*** Identifies the mean to which all varieties with smaller means are compared using Dunnett's multiple comparison with this "best" cultivar ($\alpha = 0.05$). Means listed in this table are not significantly different from this cultivar.

Within the group for the most lateral shoots producing inflorescences, eight cultivars had mean inflorescence numbers ranging from 7.5 ('Cortez™ Red' and 'Mars™ Pink') to 9.3 ('HC-18B') (Table 2). Poinsettia cultivar '1266' produced several inflorescences under both production systems, whereas, three cultivars ('Classic™ Pink', 'Cortez™ Burgundy', and 'Sonora™ White') in this highest group produced more inflorescences during cool production than in warm production. Faust and Heins (1996) report that poinsettia cultivars differ in their capacity to branch after pinching, and growing temperature affects axillary bud development. Thus cool temperatures favored lateral shoot and inflorescence development in these three cultivars.

Stem diameter varies among cultivars (Goreta et al., 2008). In this study, stem diameter ranged from 2.7 mm ('Polar Bear') to 8.3 mm ('Advent™ Red') for warm production, and 3.5 mm ('HC-18B', '1266', and 'Freedom™ Peppermint') to 7.4 mm ('Enduring™ Red') for the cool production system. Poinsettia cultivars '39-02B', '7-07', 'Classic™ White', and 'Enduring™ Red' had the largest stem diameter in warm and cold production systems (Table 3). Two cultivars ('Silverstar™ Marble' and 'Winter Rose™ Early Red') had larger stem diameters in cold production than warm production (Table 3). Lang (2009) reported that poinsettias grown under cooler temperature resulted in thicker more compact stems, allowing plants to avoid stem breakage associated with handling and shipping.

No cultivar had the largest canopy diameter in both

**Table 4.** Poinsettia cultivars grown under warm and cold production temperatures with the largest canopy diameter.

| Variety | Company | Greenhouse* | Mean (cm)** |
|---|---|---|---|
| Classic™ White*** | Ecke | Cool | 42.1 |
| Classic™ Red | Ecke | Warm | 41.4 |
| Enduring™ White | Ecke | Warm | 40.3 |
| Mars™ Red | Syngenta | Warm | 39.8 |
| Mira™ White | Syngenta | Cool | 39.6 |
| Novia™ Red | Syngenta | Cool | 39.3 |
| Polly's Pink | Ecke | Warm | 38.6 |
| Orion™ Red | Syngenta | Warm | 38.2 |
| Early Orion™ Red | Syngenta | Cool | 37.9 |
| Mars™ Pink | Syngenta | Cool | 37.8 |
| Cortez™ Burgundy | Syngenta | Warm | 37.8 |
| Mars™ Marble | Syngenta | Warm | 37.7 |
| Enduring™ Red | Ecke | Cool | 37.5 |
| Prestige™ Early Red | Ecke | Warm | 37.5 |

* Plants grown at either 65°F (18-19°C) during the day and 60°F (15-16°C) at night (cool); or plants grown at 75°F (23-24°C) during the day and 70°F (21-22°C) at night (warm).** Average of six plants with measurements taken at the widest and shortest diameter.
*** Identifies the mean to which all varieties with smaller means are compared using Dunnett's multiple comparison with this "best" or "top" variety ($\alpha = 0.05$). Means listed in this table are not significantly different from this variety.

warm and cold production. Six cultivars ('Classic™ White', 'Enduring™ Red', 'Mars™ Pink', 'Mira™ White', 'Novia™ Red', and 'Early Orion™ Red') grown under cold production had the largest canopy diameter class (Table 4). These cultivars show promise for cool production since poinsettias grown under cooler conditions often have smaller growth habits (Gislerod and Litlere, 1976; Runkle and Faust, 2008). Lang (2009) also reported 'Early Orion™ Red' had sufficient height and bract development when finished at 17°C or 18°C. Although the majority of plants grown under cool temperatures were smaller, they can serve a market for a medium-sized plant desired for travel or table space limitations.

Temperature clearly affects poinsettia growth and morphology; however, this study indicates that certain Syngenta Flowers and Paul Ecke Ranch poinsettia cultivars are less affected than other cultivars for measured traits when grown continuously cooler temperatures (Tables 1, 2, 3, 4). No cultivar, grown under cooler conditions, were placed in the top class for all measured traits; however several cultivars outperformed similar plants grown under warmer conditions for one trait or another (Tables 1, 2, 3 and 4). There are a number of environmental and production factors that influenced these results. Growing poinsettia cultivars under cooler average daily temperatures did not improve growth or quality enough to compensate for reduced fuel usage; however, growers who market them as environmentally friendly due to reduced fuel and chemical usage may get a premium price for the product.

Cooler temperatures delay flowering, so cultivars with long response times are recommended (Lang, 2009). Faust and Kehoe (2008) and Faust et al. (2008) suggest choosing cultivars that naturally flower in November due to delayed development, have medium to high growth rates to compensate for slower growth, and select cultivars with large bracts to overcome any effects on bract size. Nutrient and water uptake as well as shoot and root growth are reduced by the cooler temperatures, therefore, plant growth regulator application will likely need to be reduced.

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