

Plug Source and Growth Retardants Affect Finish Size of Bedding Plants

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Abstract. Eight bedding plant species were grown from plugs obtained from two sources. The plugs were transplanted into jumbo six packs and sprayed with a solution of chlormequat/daminozide with concentrations of 1000/800, 1250/1250, or 1500/5000 mg·L⁻¹ when new growth was ≈5 cm in height or width. Three different species were grown in the fall (*Dianthus chinensis* L., ‘Telstar Mix’, *Petunia ×hybrida* Hort. Vilm.-Andr., ‘Dreams Red’, and *Viola ×wittrockiana* Gams., ‘Bingo Blue’), winter [*Antirrhinum majus* L., ‘Tahiti Mix’, *Matthiola incana* (L.) R. Br., ‘Midget Red’, and *P. ×hybrida*, ‘Dreams Mix’], and spring [*Catharanthus roseus* (L.) G. Don, ‘Cooler Pink’, *Salvia splendens*, ‘Empire Red’, and *Begonia ×semperflorens-cultorum* Hort., ‘Cocktail Mix’]. The treatments significantly reduced finished plant size of all species for each season. There was a significant difference in finish size between sources for *Dianthus*, *Antirrhinum*, *Matthiola*, *Catharanthus*, *Salvia*, and *Begonia*. The efficacy of chlormequat/daminozide also differed for each source of *Dianthus*, *Matthiola*, and *Begonia*, but the treatments minimized the differences in finish size between sources for *Petunia* and *Viola*. Chemical names used: (2-chlorethyl) trimethylammonium chloride (chlormequat); (N-dimethylaminosuccinamic acid) (daminozide).

Plant growth retardants (PGRs) are of particular importance in the southern United States, where environmental control is more difficult and often not an effective method for regulating plant height (Kuehny et al., 1997). Use of PGRs reduces internode length (Barrett et al., 1994), resulting in smaller plants that are better for shipping and customer satisfaction.

Plug production has increased the finished product’s quality and uniformity, and legitimized bedding plants as profitable items (Armitage and Kaczperski, 1994). Various methods of height control are used in plug production. Some plug growers may control height by monitoring the difference between day and night temperatures (day – night = DIF) (Erwin et al., 1989), while others achieve better results with chemicals (Barrett et al., 1994). In certain situations, a combination of DIF and PGRs is used to control plant height

of plugs (Fisher and Heins, 1998). Factors such as time of application, environmental conditions, and mode of action determine extent and duration of effectiveness (Styer, 1997). The wide range of cultural practices used to grow plugs could also influence the efficacy of PGRs applied to the same crop in finishing. A bedding plant grower who purchases plugs from different sources should be aware that cultural practices may influence plug performance in transplant or later stages of production.

Extensive information is available concerning recommended PGRs and concentrations for specific bedding plants (Ball, 1998; Barrett et al., 1994; Barrett and Nell, 1992; Cox and Keever, 1988; Kuehny et al., 1997; Starman et al., 1994); however, these recommendations do not always account for different seasonal growing temperatures, irradiance, and photoperiods (and resulting changes in PGR application that must be used by some growers). In addition, no studies have been conducted on how differing cultural practices used in plug production influence final plant size and PGR efficacy during finishing. The objective of this research was to determine the effect of chlormequat + daminozide spray applications on development of bedding plant species from two plug sources.

Materials and Methods

Bedding plant plugs were planted in three experiments; three species were grown in the fall (Expt. 1, planted 3 Nov. 1997) (*Dianthus*

chinensis L., ‘Telstar Mix’, *Petunia ×hybrida* Hort. Vilm.-Andr., ‘Dreams Red’, and *Viola ×wittrockiana* Gams., ‘Bingo Blue’), winter (Expt. 2, planted 25 Feb. 1998) [*Antirrhinum majus* L., ‘Tahiti Mix’, *Matthiola incana* (L.) R. Br., ‘Midget Red’, and *P. ×hybrida*, ‘Dreams Mix’], and spring (Expt. 3, planted 24 Apr. 1998) [*Catharanthus roseus* (L.) G. Don, ‘Cooler Pink’, *Salvia splendens*, ‘Empire Red’, and *Begonia ×semperflorens-cultorum* Hort., ‘Cocktail Mix’]. The 288-cell plug trays (6.1 cm³ per cell) were obtained from two sources designated as source 1 and source 2. Differences between source 1 and source 2 production methods were PGR used, PGR rates, frequency of application, greenhouse temperatures and fertilization. These are not provided here, as the techniques used are proprietary. Each species was planted in jumbo six packs (180 cm³ per cell) in Metro Mix 250 (Scotts Co., Marysville, Ohio). Plants were fertilized at each irrigation with 20N–4.4P–16.6K (20–10–20 Peat-lite special; Scotts Co.) at 150 mg·L⁻¹ N until PGRs were applied, and with 250 mg·L⁻¹ N following the application of PGRs. Average maximum daytime/minimum nighttime greenhouse temperatures were 28/24 °C (fall), 31/21 °C (winter), and 34/28 °C (spring).

A chlormequat/daminozide tank mix was applied at 0, 1000/800, 1250/1250, and 1500/5000 mg·L⁻¹, respectively, as a one-time foliar spray to drip, when new plug growth was ≈5 cm in height or width. Control plants were sprayed with water only. Applications were made 10, 13, and 7 d after planting for the fall, winter and spring experiments, respectively.

Height and diameter (average of two measurements perpendicular to one another) of each plant were measured. Plant size (sum of average height plus average diameter) was determined at 50% bloom [32 and 33 d for *Petunia* (spring and winter experiments), 35 d for *Viola*, 39 d for *Dianthus*, 33 d for *Petunia*, 40 d for *Antirrhinum*, 42 d for *Matthiola*, 16 d for *Salvia*, 22 d for *Catharanthus*, and 28 d for *Begonia*].

Each experiment was arranged in a completely randomized design with four treatments, each of which was applied to a total of six jumbo six packs, with each six pack constituting an experimental unit. Analysis of variance (ANOVA) and orthogonal polynomial contrasts were used for data analysis (General linear model, SAS, 1987; SAS Institute, Cary, N.C.).

Results

Plant size decreased linearly as concentrations of chlormequat/daminozide increased in all species and experiments (Figs. 1–3). Source 2 *Dianthus* plants were significantly larger than source 1 plants (up to 21% larger for the fall experiment) (Fig. 1A and Table 1). The significant interaction of treatment and source of *Dianthus* indicates that the efficacy of chlormequat + daminozide varied with source. There was no effect of source on growth of *Petunia* and *Viola*, and no interaction of source with treatment (Fig. 1B and C;

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Table 1). Source 2 *Antirrhinum* and *Matthiola* plants were also significantly larger than source 1 plants (up to 20% and 24%, respectively) and the efficacy of chlormequat/daminozide differed with source of *Matthiola* in the winter experiment (Fig. 2 A and B; Table 1). There was no effect of source on growth of *Petunia* (Fig. 2C and Table 1), nor was source \times treatment interaction signifi-

cant. Source 2 *Catharanthus* and *Begonia* plants were significantly larger than source 1 plants in the spring experiment, and interaction between treatment and source was significant in *Begonia* (Fig. 3 A and C; Table 1). Source 1 *Salvia* plants were up to 13% larger than source 2 plants; this was the only species where this was the case (Fig. 3B and Table 1).

Discussion

Variations occurred in finished bedding plant size when grown from plugs obtained from two sources. Differences in cultural practices used to grow these plugs involved PGR use, PGR rates, frequency of application, greenhouse temperatures, and fertilization. These variations in cultural practices significantly influenced the size of the finished bedding plant and the efficacy of PGR concentration (Fig. 1A–C; Table 1). The plants from source 2 were significantly larger than those from source 1 in every experiment, except for *Salvia* in the spring experiment (Fig. 3B).

Plant growth retardants minimized the size variation among plants from different sources for certain species. The resulting sizes of *Petunia* (fall and winter experiment) and *Viola* (fall experiment) indicate that source differences in plant size can be reduced and a more uniform crop can be produced by using PGRs (Figs. 1 B and C; 2C).

Table 1. ANOVA of experiments to determine effects of chlormequat/daminozide and plug source on bedding plant size.

Experiment	Species	Chlormequat/ Daminozide	Plug source	Chlormequat + Daminozide \times Plug Source
Fall	<i>Dianthus chinensis</i>	***	***	**
Fall	<i>Petunia</i> \times <i>hybrida</i>	***	NS	NS
Fall	<i>Viola</i> \times <i>wittrockiana</i>	***	NS	NS
Winter	<i>Antirrhinum majus</i>	***	***	NS
Winter	<i>Matthiola incana</i>	***	***	**
Winter	<i>Petunia</i> \times <i>hybrida</i>	***	NS	NS
Spring	<i>Catharanthus roseus</i>	***	***	NS
Spring	<i>Salvia splendens</i>	***	***	NS
Spring	<i>Begonia</i> \times <i>semperflorens-cultorum</i>	***	***	*

ns, *, **, *** Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively.

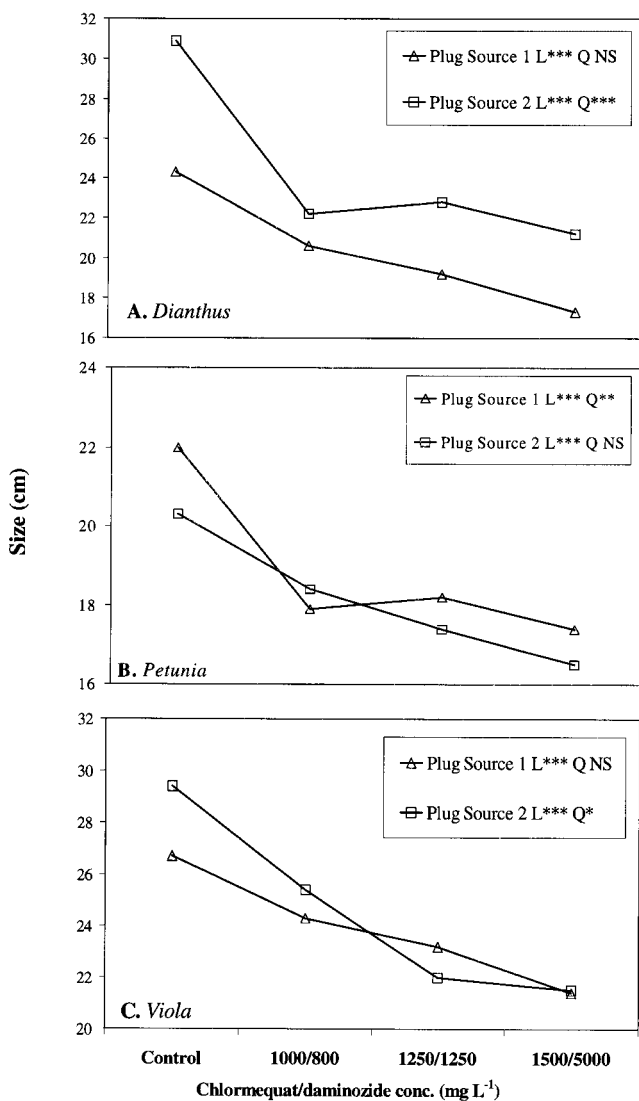


Fig. 1. Effects of chlormequat/daminozide concentration (mg L^{-1}) on size (cm) (sum of average height plus average diameter). ns, *, **, *** Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively. L = linear and Q = quadratic.

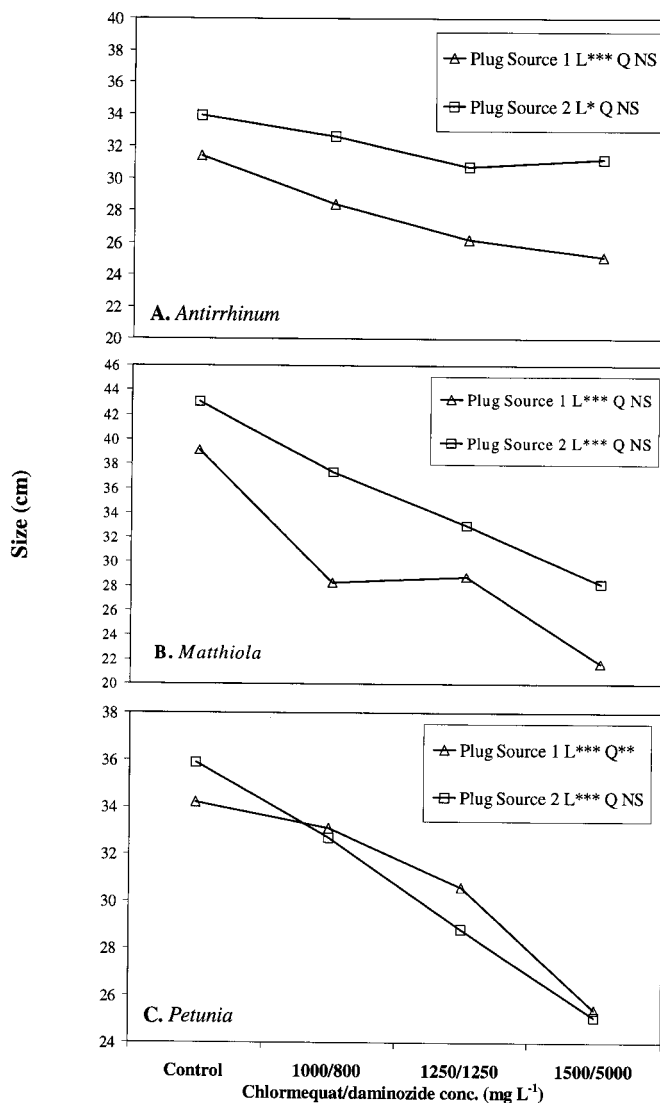


Fig. 2. Effects of chlormequat/daminozide concentration (mg L^{-1}) on size (cm) (sum of average height plus average diameter). ns, *, **, *** Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively. L = linear and Q = quadratic.

The efficacy of a PGR used to control finished bedding plant size can be affected by many factors. These include greenhouse temperatures (Fisher and Heins, 1998), time of day applied (Kuehny et al., 1997), size of plant at application (Gilbertz, 1992), number of applications (Miranda and Carlson, 1980),

volume of application (Barrett et al., 1994), improper application of PGR (Styer, 1997), and the rate of PGR applied (Barret and Erwin, 1994). These factors can be controlled by the producer of both the bedding plant plugs and finished bedding plants.

Effect of source (plugs grown at different

locations and with different cultural practices) has been suggested as being responsible for some of the differences found in finished plant size. This research confirms that hypothesis and indicates that further research should be conducted to determine the effect of the different cultural practices and environmental conditions on bedding plant plug production and the resultant effect on finished bedding plants.

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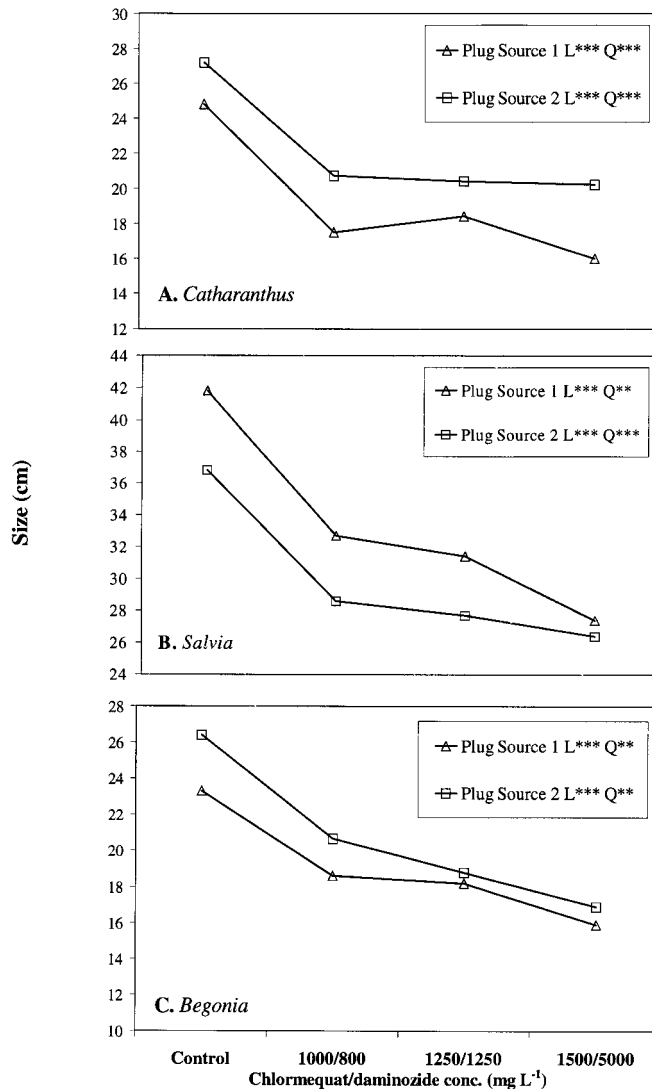


Fig. 3. Effects of chlormequat/daminozide concentration (mg·L⁻¹) on size (cm) (sum of average height plus average diameter). ^{ns}, ^{*}, ^{**}, ^{***} Nonsignificant or significant at $P \leq 0.05$, 0.01, or 0.001, respectively. L = linear and Q = quadratic.