

# Response of Potted Sunflower Cultivars to Daminozide Foliar Sprays and Paclobutrazol Drenches

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**SUMMARY.** Plant growth retardant (PGR) foliar sprays of daminozide at 4,000 or 8,000 mg·L<sup>-1</sup> (ppm) and paclobutrazol drenches of 2 or 4 mg a.i. per pot were applied to 'Big Smile', 'Pacino', 'Sundance Kid', 'Sunspot', and 'Teddy Bear' pot sunflowers (*Helianthus annuus* L.) to compare their chemical height control. Plant height varied among the cultivars due to genetic variation. The percentage reduction in plant height from the untreated control only was significant at the PGR level, indicating similar responses of all five cultivars to each PGR rate. Paclobutrazol drenches at 2 mg and daminozide foliar sprays at 4,000 or 8,000 mg·L<sup>-1</sup> reduced plant height by about 24% when compared to the control. Paclobutrazol drenches at 4 mg produced plants that were 33% shorter than the control. Plant diameter of 'Big Smile', 'Pacino', or 'Sundance Kid' was unaffected by daminozide, whereas 'Sunspot' plants were smaller than the controls. Paclobutrazol drenches at 2 or 4 mg decreased plant diameter for all cultivars except 'Teddy Bear', with the reduction being greater as paclobutrazol drench rates increased.

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The number of inflorescence buds increased by ≥18% with the use of daminozide sprays, while paclobutrazol drenches at 2 or 4 mg had no effect when compared to the untreated control. Paclobutrazol drenches of 2 or 4 mg offer the economic advantage to growers of increased plant density on greenhouse benches, while plants treated with daminozide had an increased bud count but would require a greater amount of bench space.

Plant growth retardants (PGRs) are commonly applied to container-grown plants to control stem elongation and produce compact plants (Tayama et al., 1992). Marketable sized 'Pacino' potted sunflower plants were produced with daminozide (2,2-dimethylhydrazide) (B-Nine, Uniroyal Chemical, Middlebury, Conn.) foliar sprays of 4000 to 8000 mg·L<sup>-1</sup> (ppm) (Whipker and Dasoju, 1998) or with paclobutrazol ((2R, 3R+2S, 3S)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)pentan-3-ol) (Bonzi, Uniroyal Chemical, Middlebury, Conn.) drench doses of 2 to 4 mg per pot (Dasoju et al., 1998). However, 'Pacino' was the only cultivar used in establishing the recommended PGR rates for potted sunflowers. Growth of other commercially available sunflower cultivars varies greatly from 'Pacino'. Therefore, this study was conducted to determine if PGR rates recommended for height control of 'Pacino' were appropriate for 'Big Smile', 'Sundance Kid', 'Sunspot', and 'Teddy Bear' pot sunflowers.

## Materials and methods

Sunflower seeds of 'Big Smile', 'Pacino', 'Sundance Kid', 'Sunspot', and 'Teddy Bear' were sown into cell packs [8 × 4 × 5.5 cm cells (3.1 × 1.6 × 2.2 inch)] on 14 Jan. 1998. On 28 Jan., seedlings were transplanted into 1.2-L (0.3-gal) [15-cm (6-inch) diameter] round plastic pots, except 750-mL (0.2-gal) [12 cm diameter (5 inch)] containers were used for 'Big Smile'. The root substrate was Fafard 4P (Fafard, Anderson, S.C.). Plants were fertilized at each watering with 150 mg·L<sup>-1</sup> N from Excel 15-5-15 Cal-Mag (Scotts, Marysville, Ohio) (15N-2.1P-12.5K). Greenhouse day/night set points were 24/18 °C (75/65 °F). The plants were grown under natural daylength. The PGRs were applied 20 d after potting: daminozide foliar sprays at 4,000 or 8,000 mg·L<sup>-1</sup> using a volume of 204

mL·m<sup>-2</sup> (0.5 gal/100 ft<sup>2</sup>); paclobutrazol drenches at 2 or 4 mg a.i./pot using 133 mL (4.5 fl oz) of solution per pot; or an untreated control. The experiment was a completely randomized design with eight single-plant replications of the five treatments. At anthesis, the number of days from seeding until anthesis, total plant height (measured from the pot rim to the uppermost part of the inflorescence), inflorescence and plant diameter (measured at the widest dimension and turned 90°, and averaged), and the number of inflorescence buds in addition to the primary inflorescence were recorded. Data were tested by analysis of variance by general linear model (SAS Institute, Cary, N.C.) and means were separated by least significant differences at  $P \leq 0.05$ .

## Results and discussion

Total plant height was significant for the PGR × cultivar interaction (Table 1). Plant height varied by cultivar, with the height of the untreated control plants increasing (shortest to tallest) from 'Big Smile', 'Sunspot', 'Teddy Bear', 'Sundance Kid', to 'Pacino'. Differences in plant height among the cultivars was expected due to genetic variation. However, the percentage reduction in plant height from the untreated control was only significant at the PGR level, indicating similar responses of the five cultivars to each PGR rate (Table 2). Paclobutrazol drenches at 2 mg and daminozide foliar sprays at 4,000 or 8,000 mg·L<sup>-1</sup> reduced plant height by about 24%, whereas paclobutrazol drenches at 4 mg reduced plant height by 33% compared to the control. The percentage height reduction with the 4 mg paclobutrazol drench for 'Pacino', 'Sundance Kid', 'Sunspot', and 'Teddy Bear' resulted in plants that were proportional to the pot size, but this rate was excessive for 'Big Smile'. Even though 'Big Smile' was the shortest cultivar utilized, the use of daminozide foliar sprays at 4,000 or 8,000 mg·L<sup>-1</sup> or paclobutrazol drenches at 2 mg reduced the degree of internode elongation compared to the untreated plants. These results suggest that the optimal PGR rates recommended for height control of 'Pacino' (Dasoju et al., 1998; Whipker and Dasoju, 1998) were applicable to other pot sunflower cultivars.

Plant diameter of untreated control plants of 'Pacino', 'Sundance Kid', 'Teddy Bear', and 'Sunspot' were similar, but 'Big Smile' was the smallest

**Table 1. Effect of daminozide foliar spray or paclobutrazol drench applications on subsequent growth and flowering of five cultivars of potted sunflowers (1 mg·L<sup>-1</sup> = 1 ppm, 28,350 mg = 1.0 oz, 2.54 cm = 1.0 inch).**

Cultivar and plant growth regulator treatment	Plant ht (cm)	Plant diam		Days until anthesis	
		cm	% of control	days	% of control
<b>Big Smile</b>					
Control	19.8	37.1	100	52.1	100
4,000 mg·L <sup>-1</sup> Daminozide	14.2	36.8	99	56.1	108
8,000 mg·L <sup>-1</sup> Daminozide	15.0	38.0	102	56.0	108
2 mg Paclobutrazol	14.6	33.2	90	53.0	102
4 mg Paclobutrazol	12.7	30.7	83	53.4	103
<b>Pacino</b>					
Control	59.7	45.0	100	76.6	100
4,000 mg·L <sup>-1</sup> Daminozide	53.9	43.8	97	77.9	102
8,000 mg·L <sup>-1</sup> Daminozide	54.3	44.5	99	78.9	103
2 mg Paclobutrazol	50.2	39.2	87	79.1	103
4 mg Paclobutrazol	44.4	35.8	80	78.1	102
<b>Sundance Kid</b>					
Control	49.8	43.1	100	59.8	100
4,000 mg·L <sup>-1</sup> Daminozide	38.4	41.6	97	62.9	105
8,000 mg·L <sup>-1</sup> Daminozide	38.5	43.5	101	63.6	106
2 mg Paclobutrazol	41.7	38.6	90	62.3	104
4 mg Paclobutrazol	31.2	34.3	80	61.9	104
<b>Sunspot</b>					
Control	36.3	41.1	100	60.9	100
4,000 mg·L <sup>-1</sup> Daminozide	26.5	36.5	89	63.4	104
8,000 mg·L <sup>-1</sup> Daminozide	27.5	34.7	84	66.6	109
2 mg Paclobutrazol	25.2	34.4	82	61.1	100
4 mg Paclobutrazol	25.2	33.1	80	60.8	100
<b>Teddy Bear</b>					
Control	40.1	43.1	100	67.4	100
4,000 mg·L <sup>-1</sup> Daminozide	26.9	44.7	104	70.4	104
8,000 mg·L <sup>-1</sup> Daminozide	25.0	49.0	114	70.6	105
2 mg Paclobutrazol	28.6	40.9	95	71.3	106
4 mg Paclobutrazol	24.8	40.9	95	71.8	107
Significance	**	***	**	**	**
LSD ( $\alpha \leq 0.05$ )	4.5	3.1	7.4	2.2	3.6

\*\*\*\*Significant at  $P \leq 0.01$  or  $0.001$ , respectively, for the plant growth regulator × cultivar interaction.

(Table 1). Plant diameter was unaffected by daminozide sprays at 4,000 or 8,000 mg·L<sup>-1</sup> for ‘Big Smile’, ‘Pacino’, or ‘Sundance Kid’ relative to the untreated controls. ‘Sunspot’ plants treated with daminozide were smaller than the control. ‘Teddy Bear’ plants sprayed with 8,000 mg·L<sup>-1</sup> of daminozide had a significantly larger plant diameter than the control. Paclobutrazol drenches at 2 or 4 mg decreased plant diameter for all cultivars except ‘Teddy Bear’, with the reduction being greatest at 4 mg. At the rates used, paclobutrazol drenches offer an economic advantage over daminozide sprays for commercial greenhouse operations in producing smaller diameter plants which can be spaced closer. This spreads out the cost-per-square-foot-per-week of the greenhouse operation over a larger number of plants and results in lower per-pot production costs.

The percentage of buds when compared to the untreated control was only significant at the PGR level. Daminozide

increased the number of buds by ≥18%, while paclobutrazol drenches had no effect (Table 2). More floriferous plants would be a valuable characteristic for growers producing plants for retail sales where a wider plant spacing required with the use of daminozide could be economically justified.

The number of days until anthesis

was significant for the cultivar × PGR interaction (Table 1). For ‘Big Smile’ and ‘Sunspot’, daminozide sprays delayed flowering, but paclobutrazol drenches had no effect, when compared to the untreated control. All the PGRs delayed flowering of ‘Teddy Bear’. Even though the delay in flowering caused by the use of PGRs was statistically signifi-

**Table 2. Effect of daminozide foliar spray or paclobutrazol drench applications on the percentage height reduction and percentage bud count of potted sunflowers (1 mg·L<sup>-1</sup> = 1 ppm, 28,350 mg = 1.0 oz).**

Plant growth regulator treatment	Plant ht (% of control)	Inflorescence bud count (% of control)
Control	100	100
4,000 mg·L <sup>-1</sup> Daminozide	76	119
8,000 mg·L <sup>-1</sup> Daminozide	76	118
2 mg Paclobutrazol	76	103
4 mg Paclobutrazol	67	95
Significance	***	*
LSD ( $\alpha \leq 0.05$ )	5.2	16.4

\*\*\*\*Significant at  $P \leq 0.05$  or  $0.001$ , respectively, (n = 40).

cant, the differences would not be detrimental to commercial greenhouse operations.

Inflorescence diameter varied only by cultivar, with the mean sizes ranging from (in cm): 'Teddy Bear' (10.2), 'Big Smile' (10.3), 'Sundance Kid' (10.5), 'Sunspot' (13.0), to 'Pacino' (14.0). This varied only slightly from earlier reports in which daminozide foliar sprays at 4,000 or 8,000 mg·L<sup>-1</sup> (Whipker and Dasoju, 1998) or paclobutrazol drenches at 4 mg (Dasoju et al., 1998) resulted in a statistically smaller inflorescence (5% to 12%). Although inflorescence diameter was statistically smaller, the differences would not be a detrimental reduction to commercial growers.

## Conclusions

The recommended PGR rates derived from research with 'Pacino' are suitable for other commercially grown pot sunflower cultivars. Based on the cost of \$70/lb (\$154/kg), daminozide foliar sprays between 4,000 or 8,000 mg·L<sup>-1</sup> would cost <\$0.01 per 1.2-L pot. Based on the cost of \$110/qt (\$116/L), a 2 mg paclobutrazol drench would cost \$0.06 per 1.2-L pot, which was six times more expensive than the daminozide foliar sprays. Height control was similar with either daminozide foliar sprays at 4,000 or 8,000 mg·L<sup>-1</sup> or with paclobutrazol drenches of 2 mg. Paclobutrazol drenches of 2 or 4 mg offer the economic advantage to growers of increased plant density on greenhouse benches, while plants treated with daminozide had an increased bud count, but would require a greater amount of bench space. Growers should evaluate the trade-offs between the added costs of a paclobutrazol drench and labor costs of applying a drench versus the higher cost-per-square-foot-week of production space required for a daminozide foliar spray.

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