Plant Growth Retardants Affect Growth and Flowering of *Coreopsis verticillata* 'Moonbeam'[1]

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Abstract

This investigation was conducted to determine the plant growth retardant type, application method, and rate required to produce a marketable greenhouse pot plant of *Coreopsis verticillata* L. 'Moonbeam'. Pruned plants in 10 cm (4 in) pots received growth retardant treatments in two experiments consisting of one application of ancymidol or paclobutrazol medium drenches at 0, 2, 4, or 6 ppm; daminozide spray at 0, 2550, 5100, or 7650 ppm; paclobutrazol spray at 0, 12, 24, 36, 48, or 60 ppm; flurprimidol spray at 0, 25, 50, 75, 100, 150, or 200 ppm; or maleic hydrazide at 0, 360, 720, 1080, 1440, or 1800 ppm in the first experiment and sprays of daminozide at 0, 2550, 5100, or 7650 ppm; paclobutrazol at 0, 60, or 120 ppm; daminozide/paclobutrazol combinations at 0, 2550/16, 2550/32, 2550/48, or 2550/64 ppm, chloromequat at 0, 767, 1534, or 2301 ppm; or daminozide/chloromequat combinations at 0, 1275/1534, 2550/1534, 3825/1534, or 5100/1534 ppm in the second experiment. In the first experiment, there was a linear decrease in shoot height, growth index, and lateral shoot length with increasing rates of ancymidol and paclobutrazol drenches and flurprimidol sprays while daminozide decreased growth quadratically. There was a linear increase in shoot height and lateral shoot length with increasing rates of maleic hydrazide but no effect on growth index. Only daminozide and maleic hydrazide increased the number of days from treatment to flower with increasing rates. Quality ratings increased with increasing rates of ancymidol, daminozide, and flurprimidol with the highest ratings found at the two highest rates of daminozide and flurprimidol. Paclobutrazol spray did not affect the parameters measured. In the second experiment, chloromequat spray did not affect the parameters measured but when combined with increasing rates of daminozide, linearly decreased shoot height, growth index, and lateral shoot length while increasing the number of days to flower. Daminozide alone resulted in a quadratic change in growth index and lateral shoot length while linearly increasing the number of days to flower but with no effect on quality rating. The higher rates of paclobutrazol than were used in the first experiment decreased shoot height and lateral shoot length with no effect on growth index, the number of days to flower, or quality rating. Overall, the best quality ratings and the most compact plants resulted from spray applications of daminozide at 5100 ppm or 7650 ppm and flurprimidol at 150 ppm or 200 ppm, however flurprimidol is not currently registered for application to greenhouse crops but a newer product, Topflor, has the same active ingredient and greenhouse crop labeling.

Index words: plant growth regulator, herbaceous perennial.

Growth regulators used in this study: Ancymidol (A-Rest) [α-cyclopropyl-α-(4-methoxyphenyl)-5-pyrimidinemethanol], daminozide (B-Nine) [butanedioic acid mono(2,2-dimethylhydrazide)], paclobutrazol (Bonzi) [(αR,βR)-rel-β-[(4-chlorophenyl)methyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol], flurprimidol (Cutless) [α-(1-methylethyl)-α-[4-(trifluoromethyoxy)phenyl]-5-pyrimidinemethanol], chloromequat (Cycocel) [(2-chloroethyl)trimethylammonium chloride], and maleic hydrazide (Royal Slo-Gro) [1,2-Dihydro-3,6-pyridazinedione].

Species used in this study: coreopsis, tickseed, threadleaf coreopsis, or whorled tickseed (*Coreopsis verticillata* L. 'Moonbeam').

Significance to the Nursery Industry

'Moonbeam' coreopsis is a fast growing, durable herbaceous perennial well adapted to bright, warm areas of the United States, especially where periodic summer drought may occur (1). Under greenhouse conditions, rapid growth in small containers may result in excessively tall, leggy plants that are poor in quality or unmarketable. Application of a plant growth retardant is often the best method used by growers to keep perennial plants compact and of high quality (7). In this study, application of Bonzi as a spray or drench to 'Moonbeam' coreopsis was either not effective or not as effective as other growth retardants tested, even at rates up to 120 ppm. When used in a tank mix with B-Nine, Bonzi was not as effective as B-Nine alone. Royal Slo-Gro increased plant size and delayed flowering resulting in poor quality. A-Rest applied as a drench was effective in reducing plant size and quality but not as effective as B-Nine or Cutless at the rates used. Cycocel was not effective at the rates used but when combined with increasing rates of B-Nine did result in improved plant quality but was not as effective as other growth retardants tested. When applied as a foliar spray, both B-Nine and Cutless resulted in the highest quality plants of all treatments to 'Moonbeam' coreopsis when grown in 4-inch pots in the greenhouse. However, Cutless is not labeled for application to greenhouse-grown ornamentals. B-Nine was equally effective when applied at 5100 or 7650 ppm.

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Introduction

Coreopsis verticillata is a herbaceous perennial native to the Eastern United States from Florida to New York (16). Cultivars of threadleaf coreopsis are widely produced by growers for use in gardens and landscapes (9). They are well known for their upright, spreading growth habit and adaptability to tolerate full sun and warm, dry locations in well-drained soil (1). 'Moonbeam' coreopsis was a 1992 Perennial Plant of the Year winner (10) that grows 45.7–61.0 cm (18–24 in) in the garden and bears single, light yellow flowers repeatedly from June through August.

Threadleaf coreopsis cultivars can be propagated from cuttings or divisions, though tip cuttings are more widely used (9). Tip cuttings are commonly harvested from stock plants from fall through spring or any time flowers are not present. Cuttings are stuck in 72-cell flats, rooted under intermittent mist in about 2 weeks, and may be transplanted 5–7 weeks after sticking into 10 cm (4 in) pots, quarts, or larger containers for growing on during the summer.

'Moonbeam' coreopsis has no vernalization requirement, but has an obligate requirement for long photoperiods (>14 hours or night-break lighting) to flower (6). Because vegetative growth and flowering can be controlled using photoperiod, researchers have investigated it as a possible greenhouse pot crop (9). However, 'Moonbeam' coreopsis may grow too tall in small containers under greenhouse conditions for market acceptance, and therefore may benefit from plant growth retardants. Amlying et al. (2) found that daminozide was more effective in reducing height of 'Moonbeam' coreopsis than alone or daminozide/chloromequat combinations. Flower diameter was not affected by daminozide, but the number of days to flower increased with increasing rates from 0 to 7500 ppm. Two investigations were conducted to determine the plant growth retardant type, application method, and rate required to produce a marketable greenhouse pot plant of 'Moonbeam' coreopsis in 10 cm (4 in) pots.

Materials and Methods

Terminal cuttings about 6.4 cm (2.5 in) long of *Coreopsis verticillata* 'Moonbeam' ('Moonbeam' coreopsis) were removed just below a node from greenhouse maintained, vegetative plants on December 12, 1996, in the first experiment and on February 15, 1997, in the second experiment. The lower leaf set was removed from each cutting and they were stuck in 72-cell flats (6.0 cm deep, 48 cm^3 per cell) containing Fafard Germinating Mix (Conrad Fafard, Inc., Anderson, SC). The cuttings were rooted under intermittent mist set initially to 5 sec on every 5 min from 8:00 am to 5:00 pm in a shaded, glass covered greenhouse under natural photoperiods. Adjustments for changing environmental conditions were made to the mist intervals as needed to maintain turgid foliage. Bottom heat was provided at 29.4C (85F) during propagation using electric heating mats. Rooted cuttings were removed from mist on January 8, 1997, in the first experiment and March 12, 1997, in the second experiment and placed in an unshaded glass greenhouse with a heat set point of 18.3C (65F) and a ventilation set point at 25.6C (78F).

All cutting received a soft terminal pinch on January 10, 1997, in the first experiment and on March 15, 1997, in the second experiment. Cuttings were transplanted on January 29, 1997, in the first experiment and on April 11, 1997, in the second experiment to 10 cm (4 in, 8.3 cm deep, 0.485 liter) square plastic pots containing Sunshine Mix 1 (Sun Gro Horticulture Canada Ltd., Vancouver, British Columbia, Canada) and initially placed pot-to-pot on a greenhouse bench. Fertilization began when plants had roots to the sides and bottom of the pots and was applied at 150 ppm of N using a 20N–4.4P–16.6K (Pro Sol 20–10–20, Frit Industries, Inc., Ozark, AL) fertilizer with one water application per week to prevent soluble salts buildup. Plants were watered or fertilized when the medium appeared dry, but before plants wilted.

All cuttings were pruned to a uniform height of 6.4 cm (2.5 in) above the pot rim on February 11, 1997, in the first experiment and on April 29, 1997, in the second experiment. In the first experiment, growth retardant treatments consisted of one application of ancymidol (A-Rest) drench at 0, 2, 4, or 6 ppm; paclobutrazol (Bonzi) drench at 0, 2, 4, or 6 ppm; daminozide (B-Nine) spray at 0, 2550, 5100, or 7650 ppm; paclobutrazol spray at 0, 12, 24, 36, 48, or 60 ppm; flurprimidol (Cutless) spray at 0, 25, 50, 75, 100, 150, or 200 ppm; and maleic hydrazide (Royal Slo-Gro) spray at 0, 360, 720, 1080, 1440, or 1800 ppm. In the second experiment, growth retardant treatments consisted of one application of daminozide spray at 0, 2550, 5100, or 7650 ppm; paclobutrazol spray at 0, 60, or 120 ppm; daminozide/paclobutrazol combination spray at 0, 2550/16, 2550/32, 2550/48, or 2550/64 ppm, respectively; chloromequat spray at 0, 767, 1534, or 2301 ppm; and daminozide/chloromequat combination spray at 0, 1275/1534, 2550/1534, 3825/1534, or 5100/1534 ppm, respectively. Treatments were applied on February 21, 1997, [25C (77F), and 72% relative humidity] in the first experiment and May 1, 1997, [28C (82F), and 66% relative humidity] in the second experiment. Spray treatments were applied uniformly at a rate of 0.2 liter/m^2 (equivalent to 2 qt/100 ft^2) using a pressurized CO_2 sprayer with a flat spray nozzle (XR TeeJet 8003 VK, Bellspray, Inc., Opelousas, LA) calibrated at 138 kPa (20 psi). Dry and wet-bulb temperatures were recorded at treatment and relative humidity was determined from these measurements. Ancymidol and paclobutrazol drenches were applied at 0, 0.12, 0.24, or 0.35 mg a.i. per pot in 60 ml (2 oz) of water. Night-interrupted lighting started the day of treatment by lighting from 10:00 pm to 2:00 am using a minimum 10 foot candles from incandescent lamps in both experiments. After treatment, plants were spaced on greenhouse benches at 20.3 cm (8 in) from the center of one pot to another pot.

Data recorded at the time of first open flower was first flower date, shoot height, growth index [GI = (height + widest width + width 90°) / 3], the length of the five longest lateral shoots, and a market quality rating consisting of 1 = very poor, unsalable; 2 = poor, unsalable; 3 = average, salable; 4 = good, salable; or 5 = excellent, salable. Both experiments were randomized complete block designs with nine single-pot replications per treatment. Because of differing rates among the plant growth retardants, each was analyzed separately. Quantitative responses were analyzer using PROC MIXED in PC-SAS (SAS Institute, Cary, NC). Response to growth retardant rate was determined using linear and quadratic orthogonal polynomials (P = 0.05). The five longest lateral shoots were analyzed as repeated measurements. Quality ratings were analyzed as ordinal responses (12). Mean separation of quality ratings were determined using t-tests, P = 0.05, from PROC GLIMMIX (11).

Results and Discussion

Experiment 1. There was a linear decrease in shoot height (SH), growth index (GI), and lateral shoot length (LS) with increasing ancymidol drench rate without affecting the number of days from treatment to first open flower (DTF) (Table 1). The highest ancymidol rate reduced SH by 36%, GI by 29% and LS by 43% when compared to the controls, while quality rating (QR) was highest at the highest rate. The ancymidol product label (13) recommends that 2–4 ppm be applied as a drench to bedding plants. In this study, 6 ppm resulted in the highest quality ratings for 'Moonbeam' coreopsis.

Likewise, there was a linear decrease in SH, GI, and LS with increasing paclobutrazol drench rates without affecting DTF. The highest paclobutrazol rate reduced SH by 21%, GI by 19% and LS by 22% when compared to the controls. However, these percent reductions in plant size were much lower than the same percentages for ancymidol which may explain why there was no difference in quality ratings for

Table 1. **Response of *Coreopsis verticillata* 'Moonbeam' grown in a greenhouse in 10 cm (4 in) pots to drench application of ancymidol or paclobutrazol and spray application of daminozide, flurprimidol, or maleic hydrazide, n = 9.**

Growth retardant	Rate (ppm)	Shoot height (cm)	Growth index[z]	Lateral shoot length (cm)	Quality rating[y]	Days to flower
ancymidol	0	35.1	43.7	34.3	2.0c[x]	33
	2	27.8	41.6	27.9	2.0c	33
	4	26.1	37.1	23.5	2.6b	32
	6	22.4	31.0	19.7	3.1a	33
Significance[w]		L***	L***	L***		NS
paclobutrazol	0	34.4	48.1	34.4	2.0[ns]	34
	2	27.6	45.3	31.1	2.0	31
	4	24.9	40.4	29.4	2.0	33
	6	24.0	38.9	26.9	2.0	33
Significance		L***	L***	L***		NS
daminozide	0	32.7	43.7	30.5	2.0c	34
	2550	28.2	33.6	23.3	3.4b	37
	5100	25.9	29.4	20.6	4.1a	37
	7650	25.9	29.0	20.4	4.1a	40
Significance		Q**	Q***	Q***		L**
flurprimidol	0	33.9	48.0	33.4	2.0d	33
	25	30.7	41.5	30.0	2.1d	33
	50	27.9	38.1	24.1	2.3cd	32
	75	25.9	32.1	20.8	3.0b	32
	100	23.8	31.5	20.6	3.4b	32
	150	23.3	31.7	20.5	4.0a	32
	200	21.7	29.7	16.8	4.1a	32
Significance		L***	L***	L***		NS
maleic hydrazide	0	33.7	46.8	34.0	2.0[ns]	32
	360	39.2	44.0	34.3	2.0	42
	720	40.1	43.7	37.1	2.0	45
	1080	42.3	45.6	39.6	2.0	45
	1440	42.2	44.2	39.2	2.0	47
	1800	43.7	44.0	40.4	2.0	48
Significance		L***	NS	L***		Q***

[z]Growth index = (height + widest width + width 90° to widest width) ÷ 3; in cm.
[y]Quality rating: 1 = very poor, unsalable; 2 = poor, unsalable; 3 = average, salable; 4 = good, salable; 5 = excellent, salable.
[x]Mean separation for quality ratings in columns within plant growth retardants using main effect t-tests, $P = 0.05$, from PROC GLIMMIX, ns = not significant.
[w]Non-significant (NS) or significant linear (L) or quadratic (Q) trend at $P = 0.01$ (**) or 0.001 (***).

paclobutrazol even at the same application rates as ancymidol. Ancymidol was therefore more effective at the same rates as paclobutrazol in improving quality rating. The paclobutrazol product label (15) recommends a 1 ppm drench for annual and perennial herbaceous species. In this study, 6 ppm resulted in the most compact plants but did not affect QR. There was no effect of paclobutrazol sprays on the parameters measured (data not shown).

There was a quadratic change in SH, GI, and LS while DTF increased linearly with increasing daminozide rate. The highest daminozide rate reduced SH by 21%, GI by 34% and LS by 33% when compared to the controls while DTF increased by 6 days from the lowest to highest rate. The highest quality rating occurred at the two highest rates which were 2 and 3 units higher than those found for ancymidol and paclobutrazol drenches, respectively, at the highest rate. The daminozide product label (4) recommends 2500 to 5000 ppm for height control of bedding plants and potted chrysanthemum (*Dendranthema grandiflorum* (Ramat.) Kitam.). The two highest rates used in this study yielded the most compact plants and the highest quality rating.

There was a linear decrease in SH, GI, and LS without affecting DTF with increasing spray rates of flurprimidol. The highest flurprimidol rate reduced SH by 36%, GI by 38%, and LS by 50% when compared to the controls. These percentage reductions in plant size were as large as or larger than those found for ancymidol drenches and daminozide sprays. Quality rating for plants treated with flurprimidol were highest at the two highest rates and was comparable to the ratings found at the two highest rates for daminozide but without the increase in DTF. Despite good performance in controlling growth of 'Moonbeam' coreopsis, flurprimidol is only registered for woody ornamentals and ground covers in the landscape (14). Topflor is the most recent plant growth retardant to be introduced on the market and is labeled for herbaceous perennials including *Coreopsis*.

There was a linear increase in SH and LS, no effect on GI, and a quadratic change in DTF with increasing maleic hydrazide rates. The highest maleic hydrazide rate increased SH by 30%, LS by 19%, and DTF by 16 days when compared to the controls. When considering no effect of maleic hydrazide on GI and a 10 cm (4 in) increase in shoot height

Table 2. Response of *Coreopsis verticillata* 'Moonbeam' grown in a greenhouse in 10 cm (4 in) pots to spray application of daminozide, paclobutrazol, and chloromequat alone or in combination, n = 9.

Growth retardant	Rate (ppm)	Shoot height (cm)	Growth index[z]	Lateral shoot length (cm)	Quality rating[y]	Days to flower
Daminozide	0	37.0	48.5	32.6	2.1[ns x]	32
	1275	38.1	45.0	31.0	2.1	35
	2550	33.3	39.0	28.4	2.6	35
	3825	35.1	42.0	27.7	2.3	37
	5100	35.1	41.5	28.1	2.4	36
Significance[w]		NS	Q*	Q**		L***
Paclobutrazol	0	40.2	51.8	33.8	2.0[ns]	31
	60	37.7	49.5	33.3	2.0	32
	120	35.9	49.3	31.5	2.0	30
Significance		L*	NS	L*		NS
Daminozide plus	0	40.6	52.7	35.1	2.0[ns]	33
Paclobutrazol	2550/16	40.1	47.9	31.9	2.0	38
	2550/32	41.4	45.5	32.4	2.1	38
	2550/48	38.4	45.1	32.5	2.1	37
	2550/64	41.2	46.2	31.9	2.1	36
Significance		NS	Q*	L**		Q***
Daminozide plus	0	37.9	51.3	32.1	2.0c	30
Chloromequat	1275/1534	37.6	46.3	30.7	2.0c	33
	2550/1534	36.0	43.5	29.4	2.1bc	35
	3825/1534	33.2	40.0	28.1	2.7a	36
	5100/1534	33.4	39.4	28.2	2.7a	36
Significance		L*	L***	L***		L***

[z]Growth index = (height + widest width + width 90° to widest width) ÷ 3; in cm.

[y]Quality rating: 1 = very poor, unsalable; 2 = poor, unsalable; 3 = average, salable; 4 = good, salable; 5 = excellent, salable.

[x]Mean separation for quality ratings in columns within plant growth retardants using main effect t-tests, $P = 0.05$, from PROC GLIMMIX, ns = not significant.

[w]Non-significant (NS) or significant linear (L) or quadratic (Q) trend at $P = 0.05$ (*), 0.01 (**), or 0.001 (***).

from the lowest to highest rate, it is not surprising that quality ratings were poor. Maleic hydrazide at the highest rate increased DTF by 16 days, Daminozide increased DTF by 6 days, and ancymidol and paclobutrazol drench and flurprimidol spray did not affect DTF. The maleic hydrazide product label (5) indicates that it is used to suppress excessive vegetative growth on turfgrass, shrubs, and deciduous trees. In this study, 'Moonbeam' coreopsis was larger, required longer to flower, and QR were unaffected by the range of concentrations used when compared to the control. Therefore, maleic hydrazide could not be recommended in the production of 'Moonbeam' coreopsis.

Experiment 2. There was no effect on SH, a quadratic change in GI and LS, and a linear increase in DTF with increasing daminozide rates (Table 2). Growth index and LS decreased by 20% and by 15% from the control to 2550 ppm and 3825 ppm daminozide, respectively. Days to flower increased by 5 days from the control to 3825 ppm.

There was a linear decrease in SH and LS but no effect on GI, QR, or DTF with increasing paclobutrazol rate. Shoot height and LS decreased 11 and 7%, respectively, from the highest rates to the controls. The paclobutrazol label (15) recommends that 30 ppm be applied as a spray to annual and perennial herbaceous species. The rates used here were 2- and 3-times the recommended rates with little or no impact on growth, DTF, or QR.

There was a quadratic change in GI and DTF, a linear decrease in LS, but no effect on SH or QR with increasing daminozide rate in the daminozide/paclobutrazol combinations. Growth index decreased 14% from the control to 2550/48 ppm, LS decreased 9% from the highest rates to the controls, and DTF increased by 5 days from the control to 2550/16 ppm and 2550/32 ppm. Daminozide alone or in combination with paclobutrazol did not effect SH of 'Moonbeam' coreopsis though paclobutrazol alone did, but at 2- and 3-times the paclobutrazol label rate. Daminozide alone decreased GI more at 2550 ppm and LS more at 3825 ppm than any of the combined rates with paclobutrazol. Days to flowers were increased by the same number by daminozide and the daminozide/paclobutrazol combinations while daminozide, paclobutrazol, and the combinations did not affect QR. Based on these results, there is no advantage to combining daminozide and paclobutrazol for greenhouse production of 'Moonbeam' coreopsis.

Chloromequat did not affect the parameters measured in this study (data not shown). The chloromequat product label (3) recommends spray application of 800 to 1500 ppm on poinsettia (*Euphorbia pulcherrima* Willd. ex Klotzsch), geranium (*Pelargonium* ×*hortorum* Bailey), and bedding plants but warns of considerable leaf yellowing when applied frequently at 1500 to 3000 ppm. No leaf yellowing was observed in 'Moonbeam' coreopsis at 1534 or 2301 ppm chloromequat in this study nor was it effective in plant size control.

There was a linear decrease in SH, GI, LS, and DTF with increasing daminozide rate in the daminozide/chloromequat combination. Shoot height decreased by 12%, GI decreased by 23%, LS decreased by 13%, and DTF increased by 6 days with increasing rate. Quality ratings were highest at the two highest rates of daminozide/chloromequat. The magnitude of percentage decrease in GI and LS and the increase in DTF between daminozide alone and the daminozide/chloromequat combinations were approximately comparable while SH and QR were not affected by daminozide. In addition, chloromequat was ineffective on the parameters measured. Based on these results, there is an advantage to combining daminozide and chloromequat for improving 'Moonbeam' coreopsis size and quality. The chloromequat product label (3) classifies 1500 ppm chloromequat plus 2500 and 5000 ppm daminozide as a high and very high rate, respectively.

In the first experiment, spray applications of daminozide at 5100 or 7650 ppm and flurprimidol at 150 or 200 ppm resulted in the highest QR and the largest decrease in SH, GI, and LS when compared to the controls. However, flurprimidol is not registered for greenhouse ornamentals and daminozide caused a 6 day delay in flowering. Ancymidol yielded the highest QR when applied as a drench at 6 ppm and also resulted in the largest decrease in SH, GI, and LS. Though paclobutrazol applied as a drench reduced SH, GI, and LS, QR was not affected. Maleic hydrazide increased SH and LS by 30 and 19%, respectively, caused a 16 day delay in flowering, but did not affect QR or GI with increasing rates. Considering that GI decreased by only 6% with increasing rate, plants treated with maleic hydrazide appeared to have put more resources into upward stem elongation and less into horizontal growth.

In the second experiment, chloromequat did not alter the parameters measured in this study but when combined with daminozide at increasing rates, it decreased SH, GI, and LS and increased DTF. The highest QR was found at the two highest daminozide/chloromequat rates. Unlike in this study, Amling et al. (2) found a linear decrease in SH of 'Moonbeam' coreopsis 5 weeks after treatment when chloromequat was applied at 0, 1,000, 1,500, or 2,000 ppm. They also found that daminozide alone was more effective in reducing SH when combined with chloromequat at 0, 2,500, 5,000, and 7,500 ppm. In this study, the combination of daminozide/chloromequat was more effective than daminozide alone in reducing SH.

In the first experiment, paclobutrazol applied as a spray did not alter the parameters measured. Therefore, higher rates were used in the second experiment. While SH and LS decreased linearly with increasing rate, it was only by 11 and 7%, respectively, and had no effect on QR. When daminozide was combined with paclobutrazol at increasing rates, GI decreased by only 14% from the control to 2550 ppm daminozide/48 ppm paclobutrazol and LS decreased by only 9% from the highest rate to the controls. Therefore, combining paclobutrazol with daminozide did not improve paclobutrazol's effectiveness.

In the first experiment, daminozide decreased SH by 21% at 5100 and 7650 ppm when compared to the controls but was ineffective in reducing SH in the second experiment. Likewise in the first experiment, GI and LS both decreased by 33% at 5100 ppm daminozide when compared to the controls but in the second experiment, 5100 ppm decreased these parameters by only 14%. In addition, daminozide increased quality rating in the first but not in the second experiment. We propose two possible reasons for these discrepancies: 1) 'Moonbeam' coreopsis cuttings were propagated in December and flowering took place in late March while in the second experiment cuttings were propagated in February and flowering took place in early June. The warmer, brighter environment may account for the reduced effectiveness of daminozide in the second experiment. However, Amling et al. (2) initially applied daminozide and chloromequat to 'Moonbeam' coreopsis on June 13 and flowering occurred in July, a time of the year that is very warm and bright. 2) In the first experiment, cuttings were pruned to a uniform height on February 11, 1997, and treatments were applied on February 21, 1997, a difference of 10 days. In the second experiment, cuttings were pruned on April 29, 1997, and treatments were applied on May 1, 1997, a difference of 2 days. Therefore, differences in the degree of lateral shoot development after pruning may have affected the response of plants growth retardant treatments. However, given the treatments used in these studies, the best quality ratings and the most compact plants of 'Moonbeam' coreopsis resulted from spray applications of daminozide at 5100 or 7650 ppm and flurprimidol at 150 or 200 ppm.

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