Atrimmec Suppresses Shoot Length and Promotes Branching of *Lonicera* x *heckrottii* 'Goldflame' (Goldflame Honeysuckle)[1]

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Abstract

Studies were conducted in 1999 and 2000 to determine effects of Atrimmec (dikegulac-sodium) applied at 0, 2340 or 4680 ppm and pruning just prior to Atrimmec application (1999 only) on shoot length and shoot number of *Lonicera* x *heckrottii* 'Goldflame' (Goldflame honeysuckle). When Atrimmec was applied in June 1999, shoot lengths were suppressed in non-pruned plants 21–24% 2 weeks after treatment (WAT), 16–19% 4 WAT, 16–17% 8 WAT, and 15–16% 10 WAT compared to control plants. Shoot length was suppressed 9–33% in pruned plants from 2 through 10 WAT, with increased suppression from concurrent pruning evident in control plants 2 WAT, and for plants treated with the higher Atrimmec rate 2 through 10 WAT. Following 10 WAT, increasing Atrimmec rate suppressed shoot length linearly and independent of pruning, 15–21% 12 WAT and 14–21% 14 WAT. When Atrimmec was applied in April 2000, shoot length of non-pruned plants was suppressed quadratically by increasing Atrimmec rate with suppression at the highest rate (4680 ppm) of 17% 2 WAT, 24% 4 WAT, 21% 6 WAT, 22% 8 WAT, and 20% 10 WAT. In 1999, Atrimmec and pruning affected shoot number independently. There was a linear and later a quadratic increase in shoot number with increasing Atrimmec rate of 44–122% 6 WAT, 18–68% 8 WAT, and up to 24% 10 WAT. Shoot number of non-pruned plants was greater than pruned with mean increases of 8 shoots 6 and 8 WAT and 5 shoots 10 WAT. Increasing rates of Atrimmec increased shoot number in the 2000 study up to 62% 2 WAT, 47–106% 4 WAT, 57–67% 6 WAT, and 9–27% 8 WAT.

Index words: growth retardant, plant growth regulator, branching.

Growth regulators used in this study: Atrimmec (dikegulac-sodium) sodium salt of 2,3:4,6-bis-O-(1-methylethylidene)-α-L-xylo-2-hexulofuranosonic acid.

Species used in this study: *Lonicera* x *heckrottii* Rehd. 'Goldflame' (Goldflame honeysuckle)

Significance to the Nursery Industry

Goldflame honeysuckle is often difficult to manage during container production due to its rapid growth and twining nature. Repeated pruning is the traditional means of controlling shoot length and promoting branching; however, pruning is time-consuming and can detract from plant appearance. Atrimmec, alone or in combination with pruning, may be a viable option for shoot length control and increased branching.

Extensively pruning overgrown and woody shoots of Goldflame honeysuckle in May before a later (June) Atrimmec application and pruning just prior to a June application of Atrimmec effectively suppressed shoot growth for up to 10 weeks, and may extend the market window of Goldflame honeysuckle through the summer. Atrimmec also increased shoot numbers at 6, 8, and 10 WAT independently of pruning. In addition, Atrimmec applied during the early season (April) to young, rapidly growing plants proved to be effective in suppressing shoot length and increasing the number of shoots without time-consuming pruning.

Introduction

Lonicera x *heckrottii* or Goldflame honeysuckle is characterized by 3–6 m (10–20 ft) long shoots and continuous blooming throughout spring and summer (3). This semi-evergreen vine fills a niche in the landscape due to its twining, climbing habit, and long season of prolific flowering. These characteristics, combined with its attractive carmine flowers opening to expose a yellow corolla (3), make it a popular plant with consumers.

New Goldflame honeysuckle shoots are supple, lithe, and twine readily. The lower portions of the plant become woody and rigid as the season progresses. New growth late in the season differs from early season growth by not twining as readily. Container production of this plant can be difficult due to its rapid growth and twining nature. Plants often grow to an undesirable size and intertwine with adjacent plants making handling and transport to market difficult. Hand pruning is a standard maintenance practice for controlling plant shoot length and increasing branching. It must be begun early and repeated frequently to develop compact, full plants. However, pruning is time-consuming, labor-intensive, and often removes flowers.

Atrimmec is a plant growth regulator (PGR) that can retard growth and stimulate branching. It may offer benefits in the production, shipping, and marketing of Goldflame honeysuckle (1, 2, 4, 6, 8). Atrimmec is labeled for use on numerous woody plant species, but not specifically for use on Goldflame honeysuckle (5). Today's retail nursery market influences cultural practices in production, compelling growers to extend production later into the growing season to meet consumer demands during the summer. One challenge facing growers using PGRs is differences in plant response when PGRs are applied at different physiological stages of development during the growing season (11). Industry guidance suggests PGR efficacy decreases with increasing plant size

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and physiological development (9, 10), and production practices often necessitate size or branching control later in the season on plants marketed in summer when plants are larger and more physiologically advanced. Atrimmec is commonly used in landscape maintenance to reduce the frequency of pruning. Depending on desired plant appearance, the Atrimmec label suggests either pruning immediately before application or pruning and allowing at least 5 cm (2 in) of growth before application. The label states uptake is best on soft, fully developed leaves, and if plants are pruned before application, at least two pairs of expanded leaves should be present at the time of application (5). However, in a previous study with Atrimmec application to pruned and non-pruned *Pyracantha* x 'Teton' and *Ligustrum* x *vicaryi*, Atrimmec treatments were effective in suppressing plant height and there was no added benefit from pruning combined with Atrimmec application (7). The objective of our research was to determine the effects of Atrimmec on non-pruned Goldflame honeysuckle early during the growing season and on non-pruned and pruned Goldflame honeysuckle later in the growing season.

Materials and Methods

On April 2, 1999, and March 14, 2000, Goldflame honeysuckle liners in 5 cm (2 in) containers were repotted into 3.8 liter (#1) containers. The pine bark:sand (7:1, by vol) substrate was amended per m^3 (yd^3) with 7.2 kg (12 lb) 17N–3P–10K (Osmocote 17–7–12, The Scotts Company, Marysville, OH), 0.9 kg (1.5 lb) Micromax (The Scotts Company), and 3.0 kg (5 lb) dolomitic limestone. Plants were grown outdoors in full sun at a 60 cm (2 ft) spacing and under twice daily overhead irrigation for a total of 1.7 cm (0.65 in) per day.

Time of application and stage of plant development differed in the two studies, with a late application in 1999 (early June) and an early application in 2000 (late April). Prior to treatment in 1999, plants were ontogenetically advanced [flowering with shoot lengths > 90 cm (36 in) and lower portions of the stems woody]. Plants were cut back uniformly on May 27 to approximately 30.5 cm (12 in) above the substrate and allowed to grow on average about 10 cm (4 in). On June 5, 1999 initial shoot lengths were determined on half of the plants and the other half were pruned to 31.5 cm (12.4 in). Following pruning, plants were 8–11 cm (3.5–4.3 in) shorter than non-pruned plants. All plants had at least two or three leaves remaining following each pruning. Non-pruned plants were blocked by shoot length. Atrimmec treatments were applied on June 5 to both non-pruned and pruned plants.

Plants were relatively uniform in shoot length in the 2000 study and were not pruned during the experiment. In 2000, shoot growth was supple, vegetative or with minimal flowering when Atrimmec was applied. On April 28, 2000, initial shoot lengths were collected and ranged from 24–38 cm (9.4–15.0 in). Plants were blocked by shoot length and the presence of flower buds or fruit. Atrimmec treatments were applied the same day.

In both studies, Atrimmec was applied as foliar sprays in a volume of 0.2 liter/m^2 (2 qt/100 ft^2) using a CO_2 backpack sprayer with an 8004 flat fan nozzle (R&D sprayers, Opelousas, LA) at 1.4 kg/cm^2 (20 psi) in a polyethylene greenhouse. Temperature and relative humidity were 32–37C (90–98F) (1999) and 26.6–32.2C (80–90F) (2000) and 63% (1999) and 42% (2000), respectively, during treatment application. Treatments included Atrimmec at 0, 2340, or 4680 ppm (0, 1.5 or 3.0 oz/gal) to both non-pruned and pruned plants (1999) and non-pruned plants (2000). These rates have been documented as effective on several ornamental crops (1, 2, 4, 5, 6). Treated plants were returned to the nursery container area on the following day and staked as needed for support.

Fungicides were applied repeatedly in both 1999 and 2000 in an attempt to control powdery mildew. Applications of Cleary's 3336 WP at a rate of 1.2 g/liter (0.2 oz/gal) were applied as needed in 1999. In 2000, plants were treated with alternating fungicide applications of Terraguard 50W at 0.45 g/liter (0.06 oz/gal), Cleary's 3336 WP at 1.2 g/liter (0.2 oz/gal), and Heritage at 0.15 g/liter (0.02 oz/gal) applied to the foliage at about 2-week intervals.

In the 1999 study, treatments in the 3 × 2 factorial experiment were arranged in a randomized complete block design with 10 single-plant replications. Treatments in the 2000 study were arranged in a randomized complete block design with 10 single-plant replications. Plant shoot length and shoot number were determined at 2-week intervals through 14 weeks after treatment (WAT) in 1999 and through 10 WAT in 2000. Shoot length was measured from the substrate surface to the furthest extended shoot tip. Shoots were quantified by counting axillary and basal shoots, without distinguishing between the two. Shoots were counted when axillary buds originating at nodes or from below the substrate had elongated at least 1 cm (0.4 in).

Data were subjected to analysis of variance to determine significant main effects and interactions. Regression analyses were used to determine rate response to Atrimmec, and Duncan's multiple range test ($P = 0.05$) was used to compare pruning treatments.

Results and Discussion

Shoot length suppression. In 1999, increasing Atrimmec rates suppressed shoot length in both non-pruned and pruned plants. Shoot lengths of non-pruned plants were suppressed, quadratically then linearly, by increasing Atrimmec rate 21–24% 2 WAT, 16–19% 4 WAT, 16–17% 8 WAT, and 15–16% 10 WAT, with the exception of 6 WAT when there was no evident suppression (Table 1). Shoot lengths of pruned plants were suppressed linearly by increasing Atrimmec rate 9–30% 2 WAT, 14–33% 4 WAT, 14–28% 6 WAT, 12–31% 8 WAT, and 12–28% 10 WAT. Concurrent pruning suppressed shoot length initially (around 26%) with pruned plants 8–11 cm (3.5–4.3 in) shorter than non-pruned plants.

At 2 through 10 WAT, there was a significant interaction between Atrimmec and pruning for shoot length. The interaction was strongest at 2 and 4 WAT with P values of 0.003 and 0.026, respectively, but lessened 6, 8, and 10 WAT with P values between 0.05 and 0.10. Growth of pruned plants was suppressed to a greater extent than that of non-pruned in non-treated control plants 2 WAT and those treated with 4680 ppm Atrimmec at 2 through 10 WAT. Pruned, control plants were 26% shorter than non-pruned controls at 2 WAT. Pruned plants, treated with 4680 ppm Atrimmec, were 36% (2 WAT), 29% (4 WAT), 20% (6 WAT), 19% (8 WAT), and 15% (10 WAT) shorter than non-pruned plants treated with the same rate. By 12 WAT, pruned plants were similar in shoot length to non-pruned plants resulting from a greater increase in length from pruned plants.

Increasing Atrimmec rate suppressed shoot length linearly 16–21% 12 WAT, and 14–21% 14 WAT. Between 0 and 4

Table 1. Shoot length of non-pruned and pruned Lonicera x *heckrottii* 'Goldflame' (Goldflame honeysuckle) 0 through 14 WAT[z] with Atrimmec (1999).

Atrimmec rate (ppm)	Shoot length (cm)							
	0 WAT	2 WAT	4 WAT	6 WAT	8 WAT	10 WAT	12 WAT	14 WAT
	Non-pruned							
0	43.0	73.4[y]	80.3	83.3	90.5	92.5	92.7	98.5
2,340	39.7	55.6	65.0	70.8	75.4	78.0	80.3	83.7
4,680	41.9	58.4[y]	67.3[y]	74.2[y]	75.9[y]	78.9[y]	81.0	82.6
Significance[x]	NS	Q**	L*	NS	L*	L*	L*	L*
	Pruned							
0	31.5	54.1	71.6	83.1	89.4	93.9	97.8	99.8
2,340	31.5	49.3	61.9	71.6	78.3	82.8	83.1	86.2
4,680	31.5	37.6	47.7	59.5	61.7	67.4	71.7	74.9
Significance	NS	L***	L***	L***	L***	L***	L***	L***
Pruning	0.0001	0.0001	0.0083	0.2708	0.3493	0.7850	0.8909	0.8272
Atrimmec rate	0.4708	0.0001	0.0004	0.0014	0.0001	0.0001	0.0001	0.0001
Pruning × Atrimmec	0.3355	0.003	0.0258	0.0959	0.0687	0.1000	0.1823	0.4245

[z]WAT = weeks after treatment.

[y]Indicates significant difference between pruned and non-pruned plants within an Atrimmec treatment, $P = 0.05$.

[x]Nonsignificant (NS), Linear (L) or quadratic (Q) response at the 5% (*). 1% (**), or 0.1% (***) level; Atrimmec × pruning significant at 2 and 4 WAT ($P < 0.05$) and at 6 through 10 WAT ($P < 0.10$).

WAT, shoots grew rapidly with about 40 cm (16 in) of new growth occurring in control plants (both non-pruned and pruned) and between 17–30 cm (7–12 in) occurring in Atrimmec treated plants. Growth slowed dramatically following 6 WAT with only 8–17 cm (3.2–6.7 in) of new growth occurring over the next 8 weeks and through the end of the study. Based on observations, deceleration in growth between 4 and 6 WAT corresponded with the first flowering event in non-pruned plants. Flowering in pruned plants was delayed around 2 weeks compared to non-pruned plants and a similar deceleration in growth occurred in pruned plants between 6 and 8 WAT. Further growth may have slowed later in the 1999 study due to leaf drop related to powdery mildew.

Plants in the 2000 experiment were more uniform in size initially and were not pruned. Throughout the study, shoot length suppression was quadratic in response to increasing Atrimmec rate (Table 2). Shoots of plants treated at the 2360 ppm rate were consistently longer than those of control plants at all sampling events. Shoot lengths of plants treated at the 4680 ppm rate were 17% 2 WAT, 23% 4 WAT, 21% 6 WAT, 22% 8 WAT, and 20% 10 WAT shorter than those of control plants.

Shoot number. Shoot number at 2 and 4 WAT in 1999 was not affected by either pruning or Atrimmec rate (Table 3). Atrimmec and pruning affected shoot number independently at 6 through 10 WAT. Shoot number increased with increasing Atrimmec rate, linearly 44–122% 6 WAT, quadratically 18–68% 8 WAT, and quadratically up to 24% 10 WAT. Pruned plants had slightly fewer shoots than non-pruned at these sampling dates for decreases of 24% 6 and 8 WAT and 15% 10 WAT. This decrease in shoot number for pruned Goldflame honeysuckle, though statistically significant, was not visibly distinguishable and would likely not be discernable to the consumer. Shoot numbers collected following 10 WAT misrepresented actual plant branching due to leaf drop on lower

Table 2. Shoot length of non-pruned *Lonicera* x *heckrottii* 'Goldflame' (Goldflame honeysuckle) 0 through 10 WAT[z] with Atrimmec (2000).

Atrimmec rate (ppm)	Shoot length (cm)					
	0 WAT	2 WAT	4 WAT	6 WAT	8 WAT	10 WAT
0	29.3	64.0	102.1	114.7	119.3	120.0
2,340	28.4	66.5	115.3	128.6	135.3	137.0
4,680	30.2	53.3	78.1	90.6	93.5	96.0
Significance[y]	NS	Q*	Q**	Q**	Q**	Q**

[z]WAT = weeks after treatment.

[y]Nonsignificant (NS) or quadratic (Q) response at the 5% (*) or 1% (**) level.

Table 3. Shoot number of non-pruned and pruned *Lonicera* x *heckrottii* 'Goldflame' (Goldflame honeysuckle) 2, 4, 6, 8, and 10 WAT[z] with Atrimmec (1999).

	Shoot number				
	2 WAT	4 WAT	6 WAT	8 WAT	10 WAT
Non-pruned	11	14	33a[y]	33a	34a
Pruned	10	16	25b	25b	29b
Atrimmec rate (ppm)					
0	10	16	18	22	29
2,340	9	14	26	26	27
4,680	11	16	40	37	36
Significance[x]	NS	NS	L***	Q*	Q*

[z]WAT = weeks after treatment.

[y]Means within columns followed by different letter are significantly different at $P = 0.05$.

[x]Nonsignficant (NS), linear (L), or quadratic (Q) response at the 5% (*) or 0.1% (***) level; Atrimmec × pruning non-significant.

Table 4. Shoot number of non-pruned *Lonicera* x *heckrottii* 'Goldflame' (Goldflame honeysuckle) 2 through 10 WAT[z] with Atrimmec (2000).

Atrimmec rate (ppm)	Shoot number				
	2 WAT	4 WAT	6 WAT	8 WAT	10 WAT
0	8	15	21	33	40
2,340	8	22	35	36	42
4,680	13	31	33	42	51
Significance[y]	L**	L***	Q***	L***	NS

[z]WAT = weeks after treatment.

[y]Nonsignificant (NS), linear (L), or quadratic (Q) response at the 1% (**) or 0.1% (***) level.

portions of the plant caused by powdery mildew and is, therefore, not included.

In 2000, increasing Atrimmec rate increased shoot number linearly up to 62% 2 WAT, 47–106% 4 WAT, 9–27% 8 WAT, and quadratically 57–67% 6 WAT (Table 4). At 10 WAT, Atrimmec effects on shoot numbers were non-significant due to increases between 8 and 10 WAT in shoot number in non-treated control plants.

Effects of Atrimmec on shoot length suppression differed in 1999 and 2000. The difference was likely associated with pruning (prior to application allowing regrowth, concurrent with application, or not at all) and with plant stage of development at treatment. Plants in the 1999 study were treated later in the growing season (early June), were more physiologically advanced [consistently flowering with shoot lengths > 90 cm (36 in), and lower portions of plant had become woody]. Following pruning in 1999, new shoot growth occurring in late May and in June was less supple and did not readily twine around plant stakes. In contrast, plants in the 2000 study were treated earlier (late April), were supple and vegetative at treatment.

In 2000, shoot length suppression was achieved with only the highest Atrimmec rate, while shoots of plants treated with 2340 ppm Atrimmec were generally longer than those of non-treated plants. Overall, shoot length suppression at the 4680 ppm rate in 2000 resulted in shoots on treated plants 17–24% shorter than non-treated. This suppression was similar to the suppression observed for shoots of non-pruned plants in 1999 (11–21%) and somewhat less than observed for shoots of pruned plants (28–33%). In 2000, the lack of suppression at the 2340 ppm Atrimmec rate may be attributed to the increased vigor of plants treated in April compared to plants treated in June. At the time of Atrimmec application in the 2000 study, all plants were vegetative and non-treated plants grew rapidly in the following 4 weeks until flowering began extensively. In the 2000 experiment, non-treated control plants grew, on average, 73.0 cm (28.7 in), in 4 weeks compared to 39 cm (15.4 in) in non-pruned plants (1999) and 41.6 cm (16.4 in) in pruned plants (1999).

In summary, an early season application (April 2000) of Atrimmec at 4680 ppm suppressed shoot length of Goldflame honeysuckle about 20%. However, due to plant vigor at this stage, greater shoot length suppression may require higher concentrations. Shoot number was increased up to 106% compared to non-treated controls 2 through 6 WAT with Atrimmec applications of 2340 ppm and 4680 ppm. In another experiment, Goldflame honeysuckle that had become woody and was flowering heavily was extensively pruned in late spring to target plants for summer sales. In this situation, Atrimmec at rates of 2340 and 4680 ppm suppressed shoot length 15–24%. Pruning just prior to Atrimmec application at 4680 ppm in late spring suppressed shoot length 9–33% compared to similarly treated plants not pruned just prior to application. Shoot number of Goldflame honeysuckle increased up to 106% with Atrimmec applications. In neither experiment was there any visible effects on flowering from Atrimmec application.

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