Research Reports:

Evaluation of Growth Regulator Effects of Embark, Atrinal, Blazer, and Bayleton on Container-Grown Azaleas[1]

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Abstract

Three chemicals that are not normally used to promote branching were evaluated for their abilities to increase shoot production of containerized outdoor-grown azaleas and compared with Atrinal (dikegulac sodium) and manual shearing. In an initial experiment, spray applications of Embark (mefluidide) at 0.38% ai (active ingredient) promoted more new shoots than the sheared only controls and slightly more than Atrinal (0.5% ai) for most azalea cultivars. In subsequent experiments, applications of Embark at 0.3 and 0.4% ai generally promoted fewer new shoots than Atrinal (0.5% ai) and, in most cases, smaller plants. Applications of Blazer (acifluorfen, 4 mg ai per pot) as a soil drench consistently promoted more new shoots than Atrinal (0.5% ai), however, plant size was also smaller. Lower levels of Blazer (1 to 3 mg ai per pot) resulted in larger plant sizes, but inconsistent shoot production. Spray applications of Bayleton (triadimefon) at 0.06% ai had no significant effect on azalea shoot production or plant growth.

Index words: Chemical pruning, growth regulators, growth inhibitors, dikegulac sodium, mefluidide, acifluorfen, triadimefon, azalea

Introduction

In order to produce well-branched, uniformly shaped plants, azaleas are generally sheared or pinched on a regular basis. Chemical treatments have also been utilized to reduce the amount of hand labor involved. Studies have shown Atrinal (dikegulac sodium) to be effective in stimulating branching and increasing plant density by inducing shoot development from lower nodal positions on many azalea cultivars (5,6,7). However, response to Atrinal is not always obtained with some cultivars (7), and Atrinal can cause temporary leaf chlorosis and retarded plant growth (5,6). The following studies were conducted to evaluate the vegetative and phytotoxicity responses of selected chemicals that have shown some growth regulator activities, but that have not been specifically studied for use on azaleas for promotion of branching. Embark (mefluidide), used pri-

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marily to suppress growth of grasses and to control certain weeds in soybean production, has increased lateral branching of peach trees (2). Its effect on lateral branching of azaleas was evaluated in this study. Blazer (acifluorfen) is a herbicide used for control of certain broadleaf weeds in soybeans. In an unrelated earlier study (3) Blazer, applied as a soil treatment, appeared to promote branching of azaleas without causing foliar discoloration. Blazer was included in this study to verify this observation and to provide a preliminary evaluation of its potential use as a growth regulator. Bayleton (triadimefon) is a fungicide currently labeled for use on azaleas. Suppression of growth of some woody plants has been reported with applications of Bayleton (1,4). Therefore, growth regulating effects of Bayleton on several azalea cultivars were evaluated in this study.

Materials and Methods

1982 Experiments. Azaleas used were the cultivars 'Marion Lee,' 'Effie Bunce,' 'Laura,' 'Helen,' 'Hershey Red,' and unnamed azaleas designated R-19, and T17-6. On May 28, 1982, rooted cuttings growing in 2.8 l (3 qt) pots in a pine bark:sand (4:1 v/v) medium were sheared to a uniform height of 12.7 cm (5 in). On June 5, Embark, (0.38% ai), Atrinal (0.5% ai) and Bayleton (0.06% ai) were sprayed to runoff. Blazer was applied as a soil drench (4 mg ai per container). Untreated (sheared only) plants of each cultivar were included for comparisons. A completely randomized experimental design was used with 4 replicates of 2 plants per treatment for each cultivar. Each cultivar was analyzed separately. The plants were maintained outside and watered as needed with overhead sprinklers. Fertilization was with Osmocote 18N-2.6P-9.9K (18-6-12), 9 g per container, applied May 20, 1982. On September 16, 1982, measurements were taken and total numbers of shoots per plant were determined. Individual plant heights and diameters were added together and divided by 2 to provide growth index values as a measure of overall plant growth.

1983 Experiments. On June 2, 1983, individual rooted cuttings of azaleas 'Effie Bunce,' 'Tradition,' 'Marion Lee,' 'Helen,' and T17-6 were planted in 2.8 l (3 qt) containers, in a pine bark:sand medium (4:1 v/v) placed outdoors, fertilized and watered as in the previous study. On June 3 the plants were cut back to a height of 10 cm (3.9 in) except for 'Helen' which was cut back to 14 cm (5.5 in). On June 23 Embark was sprayed to runoff at concentrations of 0.1, 0.2, 0.3, and 0.4% (ai). Atrinal (0.5% ai) and a distilled water control were also applied in the same manner. The 6 treatments were arranged in a randomized complete block design with 5 replications, and 1 plant per replication of 'Effie Bunce,' 'Marion Lee,' and 'Helen,' and 2 plants per replication of 'Tradition' and T17-6. Data, including plant height, diameter, total number of shoots per plant, and lengths of the 3 longest shoots on each plant were taken November 7, 1983. Data on each cultivar were analyzed separately.

Azalea cultivars 'Laura,' 'Hino Crimson,' and R-19 were potted into 2.8 l (3 qt) containers on June 2, 1983 with a medium of pine bark:sand (4:1 v/v). On June 13, 1983 the plants were sheared. Treatments of Blazer at rates of 1, 2, 3, and 4 mg ai per container (approximately equal to 0.5, 1, 1.5, and 2 lbs ai per acre) were applied as a soil drench in 50 ml distilled water on June 22, 1983. A 50 ml distilled water drench was applied as a control treatment, and a 0.5% (ai) Atrinal treatment sprayed to runoff was used as a standard. The 6 treatments were arranged in a randomized complete block design with 5 replications, and 2 plants per replication of 'Laura,' and 1 plant per replication of 'Hino Crimson' and R-19. Plant heights, diameters, numbers of shoots per plant, and lengths of the three longest shoots of each plant were determined on November 2, 1983. Growth index values were calculated as before.

Results and Discussion

1982 Experiments. The Blazer treatment promoted significantly ($P < 5\%$) more shoots than the controls in 5 of the 7 cultivars evaluated, while Atrinal promoted significantly more shoots in only 1 cultivar and Embark in 3 cultivars (Table 1). However, the Blazer and Embark treatments each resulted in significantly smaller plants in 6 of the 7 cultivars compared to the controls. Atrinal caused significantly smaller plants in 3 cultivars. About 1 week after the Atrinal application a temporary leaf chlorosis was exhibited on those plants treated. This discoloration has been reported by other workers (5,6) and is apparently a common azalea response to Atrinal. Conversely, the leaves of the Embark treated plants appeared to become greener than those of the other plants. This enhanced green coloration was retained through the growing season. No leaf discoloration or color enhancement was observed with the Blazer and Bayleton treatments. The Bayleton treatments caused no significant differences in shoot numbers or plant sizes.

1983 Experiments. The 1983 experiments were to evaluate various concentrations of Embark and Blazer to see if an increase in shoot numbers could be obtained without excessive reductions in plant growth with these materials.

'Helen' and 'Tradition' had significantly more shoots ($P < 5\%$) than the controls with Embark at both 0.3% and 0.4% ai while 'Effie Bunce' had significantly more shoots only at the 0.4% level (Table 2). The Atrinal (0.5% ai) treatment promoted more shoots than the Embark treatments and significantly more shoots than the controls on all cvs. except 'Marion Lee,' where none of the treatments produced significant increases in shoot numbers.

There was a trend toward reduced plant size and shoot length with increasing concentrations of Embark; however, only 'Marion Lee' treated with Embark at 0.3 and 0.4% ai had significantly smaller plants than the controls. None of the Atrinal treated cultivars were significantly smaller than the controls.

'Hino Crimson' appeared to be the most sensitive cultivar to Blazer with significantly more shoots than the controls at both the 3 and 4 mg rates (Table 3); however, significantly smaller growth indices also occurred at these levels. With 'Laura,' a significant increase in shoot numbers and decreases in growth index and shoot lengths occurred at the 4 mg rate. For R-19 there was an increase in shoot numbers at the 4 mg rate, without a decrease in the growth index.

In general, the 4 mg ai/container rate of Blazer produced more shoots than the Atrinal (0.5% ai) treatments, but also produced slightly smaller plants. The Blazer 3 mg rate was very similar to the Atrinal treatment with respect to shoot numbers, plant size, and shoot lengths.

Significance to the Nursery Industry

Overall, the treatment that increased branching with a minimum effect on plant size was Atrinal at 0.5% ai. Treatments of Embark at 0.4% ai usually produced branching results similar to Atrinal, but with generally

Table 1. Effects of Atrinal, Embark, Bayleton and Blazer on mean number of shoots and plant size of seven azalea cultivars.

Cultivar	Foliar spray			Soil drench	
	Atrinal	Embark	Bayleton	Blazer 4 mg ai/pot	Control
'Marion Lee'					
No. of shoots	28.5 ab [z]	32.8 b	27.3 ab	33.0 b	24.8 a
Growth index[y]	20.5 abc	16.5 a	25.3 c	19.3 ab	24.0 bc
'Effie Bunce'					
No. of shoots	27.8 ab	19.3 a	22.3 ab	31.0 b	23.5 ab
Growth index	21.3 b	21.0 b	31.8 c	13.5 a	29.0 c
'Laura'					
No. of shoots	32.0 a	28.3 a	—[x]	59.5 b	28.5 a
Growth index	23.3 b	17.3 a	—	15.5 a	30.8 c
'Helen'					
No. of shoots	26.0 ab	38.3 c	18.5 a	29.5 bc	16.3 a
Growth index	37.5 bc	34.3 b	36.8 bc	25.5 a	38.8 c
'Hershey Red'					
No. of shoots	51.3 a	58.8 a	45.5 a	76.8 b	53.0 a
Growth index	22.3 b	18.5 a	21.8 b	17.0 a	22.5 b
R-19					
No. of shoots	25.5 b	40.0 c	20.0 ab	39.8 c	18.8 a
Growth index	28.0 b	28.0 b	30.5 bc	24.0 a	32.8 c
T17-6					
No. of shoots	31.0 a	32.8 a	32.8 a	35.9 a	32.5 a
Growth index	20.0 c	17.3 abc	16.3 ab	14.8 a	19.0 bc

[z]Mean separation within rows followed by the same letter or letters are not significant using Duncan's Multiple Range Test at the 5% level.

[y]Growth index, in cm = (plant height + diameter) / 2.

[x]Bayleton treatment not included for 'Laura.'

Table 2. Effects of Embark and Atrinal on mean number of shoots, shoot growth, and plant size of five azalea cultivars.

Treatments % ai	Azalea Cultivars														
	'Effie Bunce'			'Marion Lee'			T17-6			'Helen'			'Tradition'		
	No. of shoots	Growth[z] index	Shoot length (cm)	No. of shoots	Growth index	Shoot length (cm)	No. of shoots	Growth index	Shoot length (cm)	No. of shoots	Growth index	Shoot length (cm)	No. of shoots	Growth index	Shoot length (cm)
Embark															
0.1	17.6	34.0	29.1	16.8	24.8	22.6	25.8	26.4	19.1	28.8	38.0	28.4	24.1	20.0	15.2
0.2	13.4	33.4	28.8	21.0	24.2	20.0	28.3	25.0	18.8	30.0	34.0	24.1*	21.7	18.6	12.1
0.3	18.0	29.4	21.8*	16.3	17.0	13.5	25.4	25.0	18.4	35.2*	29.1	19.4*	29.3*	20.2	14.0
0.4	23.5*	27.6	20.2*	26.0	14.0*	10.2*	33.4	24.6	17.4	40.0*	32.9	25.0	36.8*	18.0	10.2*
Atrinal															
0.5	43.4*	30.0	19.8*	22.4	24.4	20.4	48.6*	25.5	15.2	44.4*	37.0	26.1	43.8*	17.4	8.6*
Control	11.6	34.8	31.6	18.4	24.8	20.8	26.4	25.4	20.2	19.8	33.2	29.3	21.7	20.8	16.4
LSD (0.05)	11.4	NS[y]	8.9	NS	8.1	8.7	8.4	NS	NS	13.4	NS	4.8	7.1	NS	4.9

[z]Growth index, in cm = (plant height + diameter) / 2.

NS = no significant difference within a column, LSD (0.05).

*Indicates significant difference from the control within a column, LSD (0.05).

Table 3. Effects of Blazer and Atrinal on mean number of shoots, shoot growth, and plant size of three azalea cultivars.

Treatments		'Laura'			'Hino Crimson'			R-19		
		No. of Shoots	Growth[z] index	Shoot length (cm)	No. of Shoots	Growth[z] index	Shoot length (cm)	No. of Shoots	Growth[z] index	Shoot length (cm)
Blazer,	1 mg[y]	23.4	32.0	25.4	36.0	20.2	12.8	17.6	29.6	19.6
	2 mg	31.8	30.1	21.4	37.6	18.8	9.6	18.8	29.4	22.8
	3 mg	28.1	30.6	24.7	43.6*	15.7*	7.2	28.6	24.8	14.6
	4 mg	44.0*	26.7*	16.2*	48.1*	16.1*	4.7	30.2*	25.1	14.8
Atrinal,	0.5%	32.7	28.7	18.2*	46.0*	17.2*	7.8	26.8	28.0	17.2
Control		25.7	33.5	27.2	29.4	22.0	9.8	18.0	24.8	19.8
LSD (0.05)		8.8	6.6	6.1	10.3	3.2	NS[x]	11.9	NS	NS

[z]Growth index in cm = (plant height + diameter) / 2

[y]Active ingredient rates per 2.8 l container

[x]NS = no significant difference within a column, LSD (0.05)

*Indicates significant difference from the control within a column, LSD (0.05).

smaller plants. This would be a disadvantage in the production of azaleas, but could be an advantage in some landscape maintenance situations where growth control is the objective. An additional advantage in this situation would be the absence of temporary chlorosis that sometimes occurs with Atrinal. Additional research on the use of Embark on landscape azaleas should be worthwhile.

Blazer was highly effective in promotion branching of azaleas but smaller plants usually resulted. Reducing Blazer rates to eliminate the growth retarding effect reduced the shoot promoting effect as well. Use of Blazer to promote branching does not appear to be practical. Blazer is not registered for use on azaleas for any purpose.

Of additional significance in this study are the results showing that the fungicide Bayleton did not affect branching or cause a significant reduction in growth of any of the azalea cultivars tested.

(*Ed note:* This paper reports the results of research only, and does not imply registration of a chemical growth regulator under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by appropriate state and/or federal authorities.)

Literature Cited

1. Abdel-Rahman, M. 1977. Morphological effects of fungicides on apple trees. Proc. Phytopathol. Soc. 4:213 (Abstract).

2. Arnold, C.E., J.H. Aldrich, and J.A. Cornell. 1981. Physiological dwarfing of peach with mefluidide. HortScience 16:170-171.

3. Banko, T.J. 1981. Rooting of cuttings from stock plants treated with preemergent herbicides. Virginia Truck and Ornamentals Res. Sta. Nursery Res. Sum. pp. 1, 2.

4. Cobb, G.S. and L.C. Parrott. 1984. Control of entomosporium leaf spot on *Photinia*. Proc. Southern Nurserymen's Res. Conf. 29:158-159.

5. Sanderson, K.C., and W.C. Martin Jr. 1977. Effect of dikegulac as a post-shearing shoot-inducing agent on azaleas, *Rhododendron* spp. HortScience 12:337-338.

6. Shu, L.-J. and K.C. Sanderson. 1980. Dikegulac sodium influences shoot growth of greenhouse azaleas. HortScience 15:813-814.

7. Shu, L.-J., K.C. Sanderson, and J.C. Williams. 1981. Comparison of several chemical pinching agents on greenhouse forcing azaleas, *Rhododendron* cv. J. Amer. Soc. Hort. Sci. 106:557-561.